

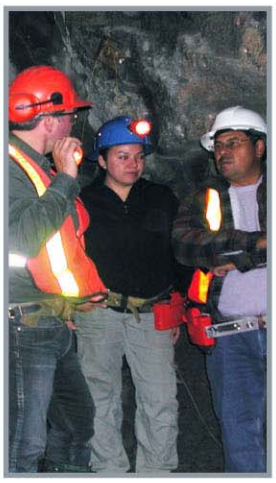
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

Renard Diamond Project

VOLUME 1 - MAIN REPORT

File number: 061470.001-400

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Chapter 1

Introduction

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Appendix 1.1.1 List of Mining Projects in the Nord-du-Québec Region in 2010

Appendix 1.1.2 List of Non-exclusive License Outfitters on the General Location Map (map 1.1.1)

1 Introduction

The document presented herein constitutes the environmental and social impact assessment (ESIA) for the Renard Project that aims to develop the diamond deposits on the Foxtrot Property, situated in the Municipality of James Bay (MJB) in north-central Quebec.

1.1 Project Overview and Location

The Renard Diamond Mine site is located in the James Bay territory, approximately 70 km north of the Otish Mountains region. The site is located at longitude 72°11' West and latitude 52°49' North, some 150 km southeast of Hydro-Québec's LG-4 complex and approximately 200 km northeast of Lake Mistassini (Map 1.1.1).

The Foxtrot Property is located in the Municipality of James Bay, in the Nord-du-Québec N°10 administrative region. The mining industry plays an important role in the development of the Nord-du-Québec region. There are currently four active mines in the James Bay region: three develop gold deposits (Casa Berardi, Sleeping Giant, and Bachelor Lake) while the fourth (Perseverance) develops zinc and copper deposits. In fact, exploration activities are underway on a multitude of natural resources such as diamond, gold, copper, silver, zinc, nickel, platinum, palladium, and chromium. Furthermore, approximately 66 exploration projects are actually taking place in the region, and, in addition to the Renard Project, 6 other mines are in advanced stages of development in the short to medium term (Map 1.1.1; Appendix 1.1.1: List of Projects). The Nord-du-Québec region is the most important electricity production region in Quebec contributing 49 % of total production. There are no less than eight hydro-electric power stations developed on the Grande River by Hydro-Québec (Map 1.1.1). The regional economy also relies heavily on the recreational tourist industry. According to the *Ministère des Ressources naturelles et de la Faune (MRNF)* (Ministry of Natural Resources and Wildlife), more than 37,000 sport fishers and nearly 12,000 hunters visit the region annually. Moreover, 37 non-exclusive license outfitters can be found in the region (Map 1.1.1; Appendix 1.1.2 List of Outfitters).

The Stornoway Diamond Corporation (Stornoway) wishes to develop the Foxtrot Property deposit which represents an important diamond resource. According to a revised resource published in February 2011 (GeoStrat Consulting Services, 2011), the diamond resource deposit would be at least 23 million carats (indicated Mineral Resource), a value which currently exceeds CAD$ 4 billion.

The project implementation requires the development of a number of mining infrastructures and related ancillary facilities that would be used throughout the mine operation, which has an estimated lifespan of approximately 20 years. The inferred Mineral Resource of 17 million carats and potential mineral deposit of between 24 and 29 million carats (Geostat Consulting Services, 2011) could extend the lifespan of the mine.

The Renard Project includes, but is not limited to, the following elements:

- Open pits for the mining of three kimberlite pipes (R-2, R-3, R-65);
- A 740 m deep shaft and access drifts will provide underground extraction of the kimberlite pipes (R-2, R-3, R-4, R-9);
- An access ramp to the underground mine;
- A kimberlite process plant;
- A processed kimberlite confinement area;
- A waste rock stockpile and a temporary ore stockpile;
- An overburden stockpile;
- A water management system with sedimentation ponds;
- An industrial wastewater treatment system;
- An accommodation and service complex;
- A drinking water supply and treatment system;
- A domestic wastewater treatment system;
- An airstrip to ensure transportation of personnel with ancillary facilities;
- A quarry and borrow pits;
- A solid waste and hazardous material storage, treatment, and recycling facility;
- A solid waste trench landfill site;
- An explosive storage area;
- On-site secondary roads;
- Power generating sets equipped with heat recovery system used for industrial heating;
- A fuel storage area and fueling stations.

1.2 Project Proponent

The Renard Project is being developed by Stornoway who holds all the exploration rights to the Foxtrot Property. Stornoway is a wholly-owned subsidiary of the Stornoway Diamond Corporation.

1.2.1 Stornoway Diamond Corporation

The Stornoway Diamond Corporation was founded in 1986. It is now one of the most important diamond exploration and development companies in Canada. Stornoway was involved in the discovery of some 200 kimberlite bodies in seven Canadian diamond districts. The company has direct interest or partnerships in 18 properties in Canada.

80° 200 000 mE 78° 400 000 mE 76° 74° 600 000 mE 72° 800 000 mE 70°

6 000 000 mN
5 800 000 mN
52°
5 600 000 mN
50°
5 400 000 mN
48°

Chisasibi
LG-1
Robert-Bourassa
Radisson
LG-2-A
Réservoir Robert-Bourassa
LG-3
Réservoir La Grande 3
LG-4
Route Transtaïga
Réservoir La Grande 4
LaForge-1
LaForge-2
Réservoir Laforge 1
Réservoir Laforge 2
Brisay
Réservoir Caniapiscau
Wemindji
Eastmain
Baie James
Eastmain-1
Réservoir de l'Eastmain 1
Route de la Baie-James
Nemaska
Waskaganish
Route du Nord
Amos
Lebel-sur-Quévillon
Géant dormant
Matagami
Persévérance
Casa Berardi
Waswanipi
Oujé-Bougoumou
Chapais
Chibougamau
Mistissini
Lac Saint-Jean
Saguenay

Projet Renard / Renard project

ELEONORE / Goldcorp inc.
JAMES BAY LITHIUM, Lithium One
PIVERT-ROSE, Critical Elements
WHABOUCHI, Exploration Nemaska
LAC MACLEOD / Western Troy Capital Resources Inc.
MATOUSH / Ressources Strateco
BRACEMAC-MCLEOD, Xstrata
VEZZA (N.A. Palladium)
LANGLOIS, Nyrstar Canada
LAC BACHELOR, Métanor
BLACKROCK / Blackrock Metals inc.
TROILUS

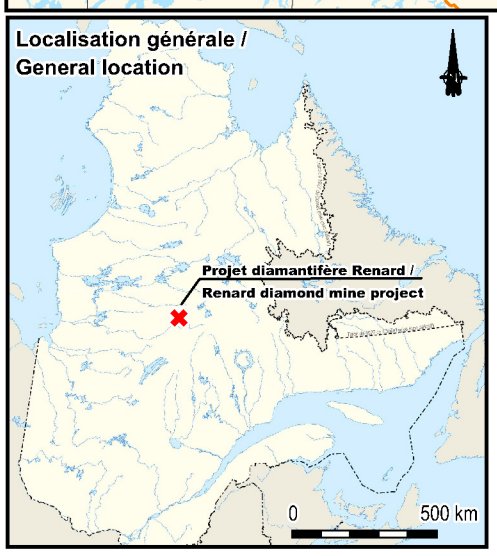
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Réserve faunique Assinica
Réserve de biodiversité projetée Hirondelle
Parc national projeté Albanel-Témiscamie-Otish
Lac Albanel
Lac Mistassini

10526-07 10511-04 10610-A 10536-03 10620-01 10536-01 10611-01 10616-01 10537-02 10536-02 10609-01 10537-01 10605-01 10526-06 10612-01 10526-02 10526-03 10526-05 10554-08 10554-09 10554-05 10554-06 10554-03 10554-04 10554-10 10554-11 10554-07 10554-02 10554-01 10621-01 10619-01 10580-04 10580-03 10580-02 10580-01 10525-01 10552-02 10552-01 10549-01 10555-01 10623-01 10565-01 10553-01 10564-01 10557-01 10556-01 10563-01 10563-02 10613-01

Route 167

0 50 100 km
Échelle / Scale : 1 : 2 750 000
UTM, zone 18 (NAD 83)

Localisation générale / General location



- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Pourvoirie sans droit exclusif / outfitter without exclusive rights
- Aéroport / Airport
- Hydrobase / Hydrobase
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec electricity transport lines
- Réseau routier principal / Main road network
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Mine active / Operating mine
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Mines qui pourraient être mises en exploitation à court ou moyen termes / Short and medium term potential mining projects
- Ancienne mine / Old mine
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Limites de l'aire d'étude / Study area limits
- Propriété Foxtrot / Foxtrot property

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Localisation générale du projet diamantifère Renard/ General location of the Renard diamond mine project

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_LocGen_111213.WOR
Source : - Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010
Pouvoiries / Outfitter, MRNF, 2010
Décembre 2011 / December 2011

Carte / Map 1.1.1

The company has a diversified portfolio of diamond properties; it is financially sound and can count on an experienced team of managers and technicians for each step of diamond production, from exploration to commercialization.

The Stornoway Diamond Corporation is headquartered in Vancouver, British Columbia, and has 3 offices in Quebec. The Renard Project office is located in Longueuil with 2 satellite offices located in Quebec City and in the Cree community in Mistissini. A third office will eventually open in Chibougamau when project start-up operations begin.

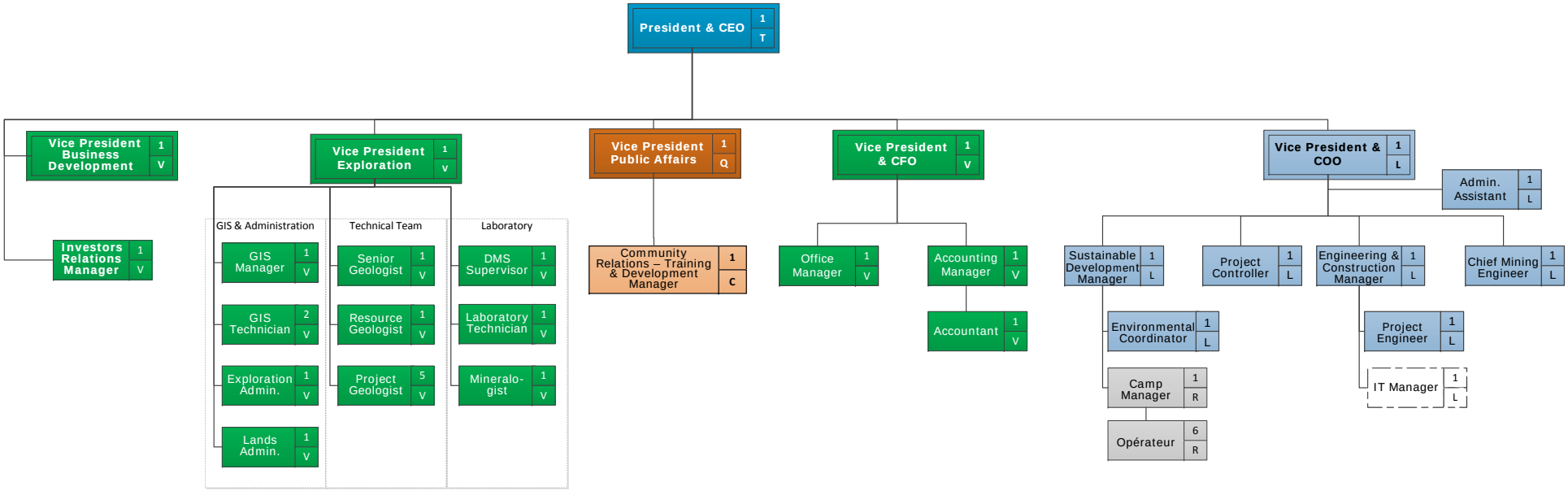
The Stornoway team counts many decades of experience in exploration and mining; this experience was acquired on Canadian (Abitibi, New Brunswick, Ontario, Nunavik, Northwest Territories) and international (Burkina Faso, Guyana, Jamaica, New Caledonia) projects.

Stornoway is the proponent for the Renard Project. The company's organizational chart is presented in figure 1.2.1. The company has 49 employees in 5 offices.

Updated: 2011-11-18

les diamants stornoway (canada) inc.

Stornoway – Organizational Chart



Legend

A | B | C

A: Job Title B: Number of employee C: Working Location and total employees

V: Vancouver 22 T: Toronto 1 C: Chibougamau 1

L: Longueuil 8 Q: Quebec 1 R: On-Site 7 O: Other 1

Box Contour Line

President & Vice President — Position — Manager — Consultant & Contractor

1.2.2 Consulting firm mandated to carry out the impact assessment

In November 2010, the mandate to prepare the environmental and social impact assessment (ESIA) for the Renard Project was awarded to Roche, Ltd., Consulting Group (hereafter Roche) in partnership with EnviroCree.

Roche is a Quebec company founded in 1963 at Malbaie in the Charlevoix region. Roche has completed over one hundred projects in the mining sector, notably environmental baseline studies, environmental and social impact assessments, monitoring and surveillance programs, environmental management plans, scoping and feasibility studies, technical assistance services, resource evaluations, and preparing investment programs.

The company is headquartered in Quebec City and has several regional offices scattered throughout Quebec, including in Chibougamau and Malartic. EnviroCree, Ltd. is an aboriginal company run by Cree administrators and specializes in environmental services. EnviroCree is headquartered in Mistissini.

The environmental and social impact assessment (ESIA) is prepared by a team of some 40 people including Roche employees, EnviroCree employees, and other sub-contractors each specialized in their respective fields of expertise. The team's organizational chart is presented in figure 1.2.2.

1.3 Proponent's Environmental, Social Acceptability, and Sustainable Development Policy

For the Renard Diamond Project and for all its projects, Stornoway Diamond Corporation and its non-public subsidiary companies are committed to best environmental practices when planning and developing all of its activities.

To achieve this, Stornoway, its employees and contractors will:

- Examine the potential impact to the environment of all planned activities and take steps to minimize, or where possible eliminate, the impact;
- Ensure that all activities are in compliance with all environmental legislation and regulations;
- On a continuous basis, determine their impact to the environment and through continuous improvement, strive to attain higher levels of environmentally performance;
- Maintain a high level of environmental protection by applying practices and technologies that minimize impacts and enhance environmental quality;
- Maintain dialogue with the communities and other stakeholders within the area of influence of its exploration programs;
- Progressively rehabilitate disturbed areas, develop closure plans that can be continuously improved, and incorporate new technologies where practical;
- Train all employees and contractors to understand their environmental responsibility related to its Mineral Exploration Properties.

1.4 Impact and Benefit Agreement (IBA)

At the beginning of 2007, Stornoway began discussions with the Mistissini Cree community to define an agreement to superintend their relationship. In June 2010, the negotiations resulted in a Pre-Development Agreement (PDA) between Stornoway, the Cree Nation of Mistissini, and the Grand Council of the Crees (Eeyou Istchee). The PDA provides for business and employment opportunities for the Cree during the pre-operation phase, the evaluation of the business and employment capacity for the production phase, the creation of a joint communication strategy, and the collaboration of the Cree in the completion of the ESIA and all other relevant studies. This undertaking led to, throughout 2011, the completion of a study of the Cree business and employment capacity for the operation phase of the Renard mine and six meetings with an environmental exchange group in Mistissini.

From a social acceptability perspective, the stakeholders then began discussions on the creation of an Impact and Benefit Agreement (IBA). The agreement is expected to establish and maintain a productive and harmonious long-term working relationship based on mutual trust and respect, all within the context of sustainable development. The IBA constitutes the Renard Project's main impacts mitigation measures and benefits maximization for the Cree people.

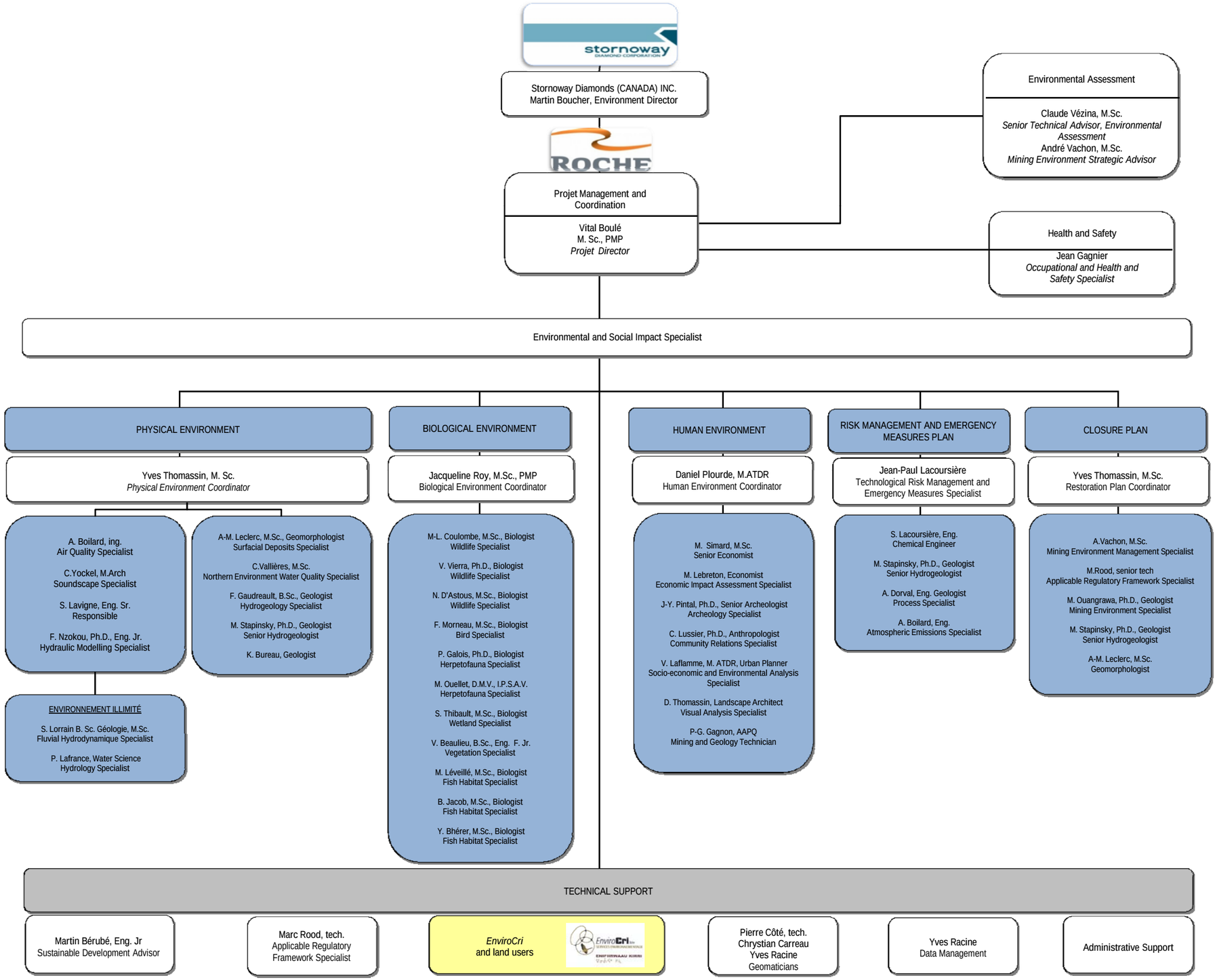
The IBA includes guidelines regarding the granting of contracts and the hiring of Cree workers as well as various training and assistance programs for the workers.

The agreement identifies various actions that will be taken by Stornoway to promote and protect the Cree society and culture, specifically by maintaining traditional hunting, fishing, and trapping activities.

Concerning environmental protection, the IBA evokes the environmental management practices that will be implemented during mining, and the agreement provides for participation by the Cree in environmental monitoring activities. A particular emphasis is put on optimizing local Cree knowledge.

The IBA equally highlights the agreement of the parties with respect to participation, collaboration, exchange, and communication. To achieve this, we anticipate notably the creation of the Renard Committee responsible for ensuring that the agreement provisions are followed. This committee consists of representatives from Stornoway, the Cree Nation of Mistissini, and the Grand Council of the Crees (Eeyou Istchee). The committee will meet at least four times a year and may use services from other technical committees that it judges pertinent. Therein, the IBA expects the immediate creation of an Education and Training Committee, and an Environmental Committee. The members of these two committees must be equally divided between the Cree and Stornoway.

Figure 1.2.2 ESIA project team organizational chart



Finally, the IBA includes financial commitment with regard to the Cree community. The benefits agreed upon will be transferred to different dedicated funds, potentially being used, for example, for training, social and economic development, environmental monitoring, etc.

1.5 Land Ownership and Exploration Rights

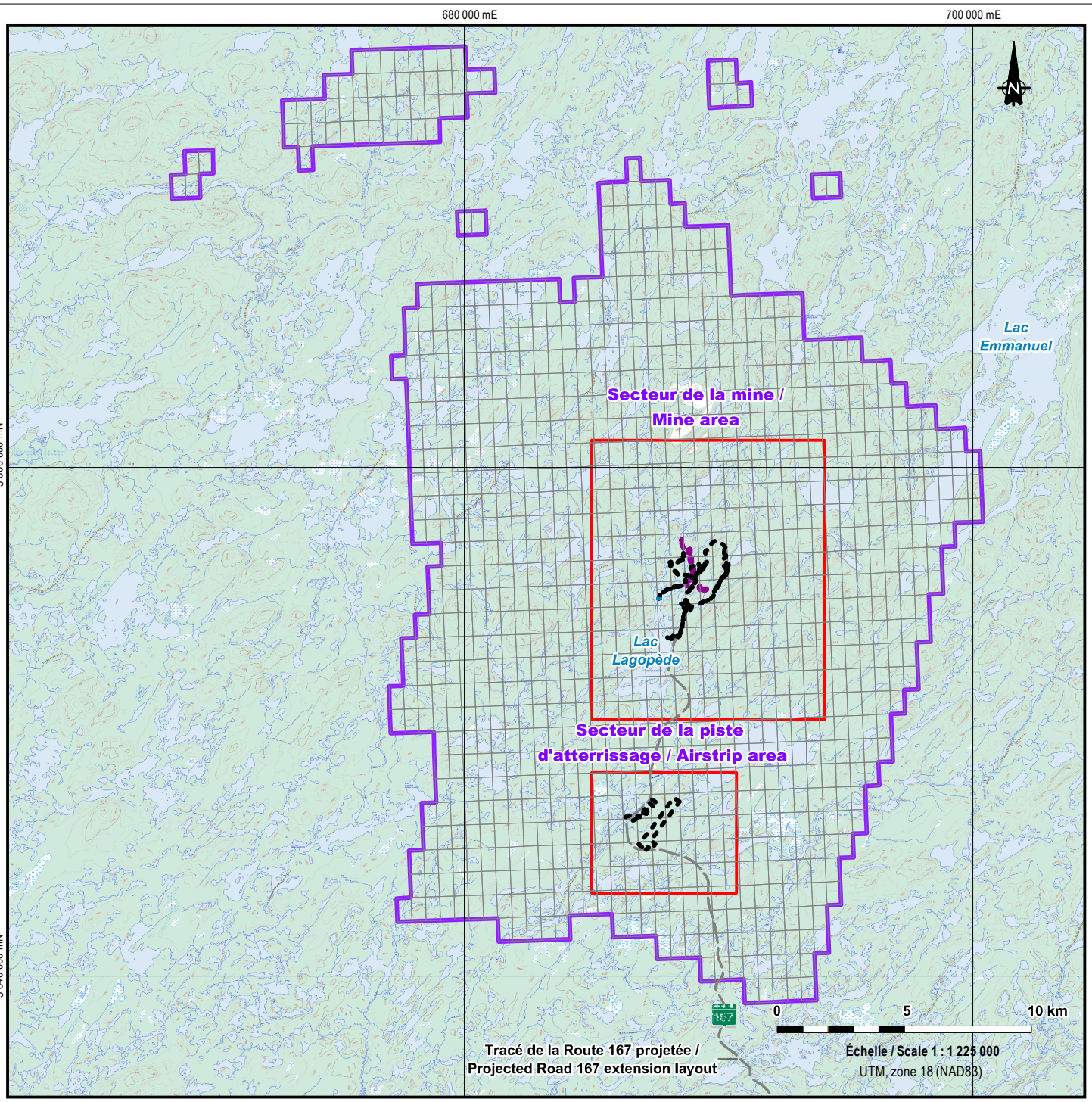
The Renard Diamond Mine, also known as the Foxtrot Property, is located on Quebec Government land. The province of Quebec covers a territory of approximately 1,700,000 km^2, of which 92 % is public land. This vast expanse of land constitutes the main reserve of natural resources in Quebec. To stimulate economic development, the government grants the applicable intervention rights to the territory and the natural resources, while preserving the environment. Consequently, exploration rights can be given to parties with mining interests. The claim (including the "mining exploration permit" or MEP) is the only valid exploration title in Quebec. The claim gives its title owner the exclusive right to research all Crown mineral substances, with the exception of sand, gravel, slate, and other unconsolidated deposits, on the territory concerned.

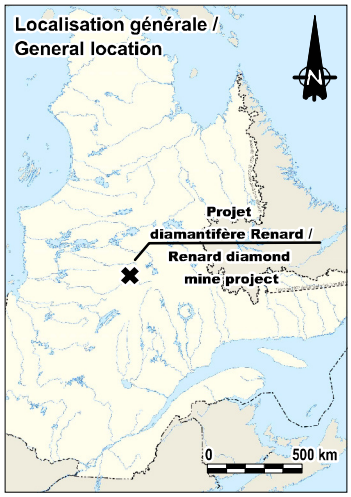
The Foxtrot Property includes 1,047 individual, essentially contiguous, claims that cover an area of approximately 54,550 ha (map 1.1.2). The claims and the MEPs are registered under Stornoway. All the kimberlite bodies, as well as the facilities associated with the Renard Diamond Mine project, are located on 49 claims covering an area of 2,548 ha.

The geographic coordinates of the four corners of the Foxtrot property are as follows:

- Northwest: latitude 53°00' North and longitude 72°22' West;
- Northeast: latitude 52°57' North and longitude 71°06' West;
- Southwest: latitude 52°42' North and longitude 72°22' West;
- Southeast: latitude 52°40' North and longitude 72°08' West.

The Foxtrot Property, including the Renard kimberlite pipes and the Lynx and Hibou kimberlite dykes, is located in the Nord-du-Québec region which is governed by the James Bay and Northern Quebec Agreement (JBNQA). Section 2.2 contains a detailed description of the landholdings on the territory covered by the JBNQA.





Emprise du projet / Project footprint

Cheminées kimberlitiques /
Kimberlite Pipe

Titres miniers actifs /
Active claims

Propriété Foxtrot / Foxtrot Property

Aires d'étude /
Study area

les diamants stornoway (canada) inc.

**Projet diamantifère Renard /
Renard diamond mine project**

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Titres miniers de la propriété Foxtrot / Foxtrot property mining claims

ROCHE

Carte de base : CCarte de base / Base Map : BDGA, 1M, 2010
Fichier : 61470_EIES_Claims_111213.WOR
Décembre 2011 / December 2011

Carte / Map 1.1.2

1.6 General Description of the Renard Project

1.6.1 Construction Phase

Construction of the Renard Project will last a little over two years and will require the participation of some 500 workers. A construction site of this magnitude represents a business and employment opportunity for the workers and companies in the region. Moreover, note that between 2004 and 2009, the advanced exploration work generated more than 32,000 work days in the field, 23.5% of which was completed by the Cree.

Through several site alternatives analyses, it was possible to optimize and reduce the Renard project's environmental footprint on the receiving environment.

The work during the construction phase for the development of the Renard Project will consist essentially of civil engineering operations. It will mainly pertain to the preparation and layout of the sites (clearing, earthworks, cut and fill) in order to obtain the surfaces and levels necessary for building the mining infrastructures (mining roadways, open pit mines, storage areas, kimberlite process plant, access ramp, and underground shafts). In particular, the storage areas include a processed kimberlite confinement area, a waste rock stockpile, an overburden stockpile, and an ore stockpile. An airstrip is planned for the safe transport of personnel all year around. Finally, a series of ancillary or mining facilities will be built to support the mining. This includes power generating sets, an accommodation complex, a drinking water supply and treatment system, domestic and industrial wastewater management and treatment systems, a solid waste and hazardous waste management system, and fuel and explosive storage facilities.

During construction, an environmental surveillance plan will be implemented on the site. The plan will ensure that workers are adequately informed of Stornoway's environmental management system, that mitigation measures prescribed in the environmental assessment are implemented, and that all the necessary environmental permits have been acquired. The environmental surveillance plan will help prevent accidental spillage of fuel or inadequate storage of hazardous products. An emergency response plan will also be implemented from the beginning of the construction phase and a task force will be established to prevent and minimize the impact of the development work on the environment.

1.6.2 Operation Phase

Based on the known mineral resources, it is expected that the Renard Mine will be in operation for 20 years, with the possibility of mining thereafter. The mine is planned to begin mining in 2015.

Two types of mining will be used for extraction of the ore: open pit and underground. The open pit mining will mainly occur through dynamiting and lead to pits between 100 m to 130 m in depth. The underground mining will require the construction of a vertical shaft and an inclined access ramp. Ore extraction could therefore be done using the blast hole shrinkage method.

Once extracted, the ore will be mechanically crushed followed by a gravity separation process. Other steps will follow to remove all the coarse fractions. This treatment process requires no chemicals and the plant will recycle 100 % of the water used in the process. The final sorting will be done by x-ray which will isolate the diamonds from the other material. The ore extraction rate is estimated in the order of 5,000 to 7,000 tons per day.

Based on the results of several laboratory tests and analyses, the extraction of the kimberlite will not cause acid mine drainage and will not generate waste rock that are susceptible to leach metals in concentrations likely to affect the environment and the aquatic fauna.

The Renard Mine operation requires, nevertheless, the implementation of various activities related notably to the management of materials resulting from the mining operations (overburden, waste rock, processed kimberlite), to storage, water supply and management, solid waste and hazardous material management as well as fuel and all usual activities related to transportation, administration, communications, and workers' accommodation. Various measures will be put in place to reduce the risk of water and wind erosion and to prevent sediment transport. The site's drainage system and the water management plan were designed in a way to preclude and limit the impact of the mine site on the hydrographical network. All effluents discharged to the environment will be strictly controlled and monitored to ensure that all applicable standards are respected. The environmental monitoring will also check the accuracy of the environmental and social impact assessment as well as the efficiency of the suggested mitigation measures and aim to detect all changes in the environment's baseline conditions. The parameters of particular interest that will be monitored are from the Quebec provincial Guideline 019 for the mining industry (*Directive 019*) as well as from the *Mining Industry* and the *Metal Mining Effluent Regulation (MMER)*. They mainly deal with the quality of effluents as well as the surface water and groundwater, noise, vibrations, and air quality. Fish, benthic fauna, and various socioeconomic elements such as the impacts and benefit agreement (IBA) with the Cree community will also be monitored.

Environmental monitoring is a part of the environmental and social management plan for the Renard Project which is based on the ISO 14001 standard, one of the fundamental objectives of which is to conciliate the mine's operation constraints with the applicable regulations and best practices generally applied in the industry. The development of the management plan requires the establishment of an organizational structure that specifies the roles and responsibilities of everyone with respect to the environment, in this instance: the site director, the foremen, the professional staff, the other workers and employees, the person responsible for the environment, the businessmen and suppliers, and land users.

During the operation phase, the Renard Mine will offer employment to approximately 450 workers annually. The mine personnel will work rotating shifts based on two weeks on and two weeks off. The workers will travel by air from Montreal or Chibougamau while the supplies and equipment will mainly be

transported via Highway 167, the extension of which has already been approved by the Quebec Government. Stornoway intends to implement an employment and procurement policy that would favour the regional economy. To this end, the company has initiated various meetings with regional bodies in order to optimize business relationships with regional development and manpower training organizations, which included, among others, pre-consultation meetings in the autumn of 2010 in the Chibougamau and Mistissini communities.

1.6.3 Closure Phase

When the mine is closed, the infrastructures will be taken down and the land will be restored. Prior to closing, a rehabilitation plan will be submitted to the MRNF for approval. This plan will specify the work that will eventually take place (demolition and recycling of the facilities, reclamation, decontamination, securing the pits, shafts and other openings, replanting, etc.). Wherever possible, the area will be progressively restored while the project is ongoing. To accomplish this, overburden and topsoil will be used, which were removed during the installation of the mining facilities. The vegetation that will be used for the landscaping of the area will be adapted to the conditions of the surroundings and will aim to control erosion and sediment transport and to return the mine site to its natural state.

The rehabilitation plan will include, moreover, all financial reserves ensuring the completion of the work as well as the environmental rehabilitation monitoring program. This program must allow for the follow up of the qualitative and quantitative evolution of the environmental work during the transition period prior to complete site rehabilitation. The progressive restoration work during the operation phase will allow valuable lessons to be learned that may be applied to the work done in the definitive closure phase thereby ensuring success.

1.6.4 Post-Closure Phase

The rehabilitation plan will specify all environmental and agronomical monitoring measures that will occur after the definitive closure of the mine and the site reclamation. This monitoring will rely on the surface and underground water monitoring network, of which the instrumentation will most likely have been used during the mine operation. The selection of monitoring parameters will be determined, if necessary, when the results of an environmental report, completed after the restoration work, will be known. The monitoring program will end when it will be possible to show that the requirements from the Quebec provincial Guideline 019 have been met as well as the requirements from the MDDEP (*Ministère du Développement durable, Environnement et Parcs*), the MRNF, and other pertinent authorities.

1.7 Related Projects and Studies

The *Ministère des Transports du Québec (MTQ)* carried out a feasibility study and an environmental and social impact assessment for the extension of Highway 167 up to the Project Renard site. Should the construction of the extension of Highway 167 be delayed, the possibility to access the site via a winter road during the construction phase of the project as well as the possibility to access the site from the north will be considered by Stornoway.

Moreover, to evaluate the possibility of linking the Renard Project to the power distribution network, a feasibility study, and an environmental impact assessment for the construction of a high-voltage power line will be undertaken by Hydro-Québec. If the power line in question is delayed or refused, Stornoway plans to install a 22.6 MW power generating set (generators) in order to meet its energy requirements.

Chapter 2

Regulatory Framework and the Environmental Assessment Process

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2 Regulatory Framework and the Environmental Assessment Process

2.1 Introduction

Concerning the environment, the Renard Project must obtain global environmental authorization under several legislative documents such as the *James Bay and Northern Quebec Agreement* (JBNQA), the *Environment Quality Act* (R.S.Q., c. Q-2) (EQA), the *Mining Act* (R.S.Q., c. M-13.1, r.2), and the *Canadian Environmental Assessment Act* (S.C., c. 37) (CEAA).

Below, Section 2.2 presents the provincial and federal regulatory framework within which the project has been implemented. In particular, this section describes the environmental assessment process to which the project has been subject. Sections 2.3 to 2.7 present the specific permits that must be obtained following the global environmental authorization of the project.

Figure 2.2.1 is a schematic representation of the progression of the environmental authorization and permitting process.

2.2 Approval Process

2.2.1 Conditions Specific to JBNQA Jurisdiction

The JBNQA was put in place in 1975 by the government of Quebec, the government of Canada, the Grand Counsil of the Crees (Eeyou Itschee) (GCC(EI)), and the Northern Quebec Inuit Association. It enacts the environmental and social protection regimes for the James Bay and Nunavik regions.

The JBNQA establishes three categories of lands, numbered I, II, and III and defines specific rights for each category. The “Foxtrot Property” is located on category III lands, near the Mistissini community (Cree Nation of Mistissini, or “CNM”).

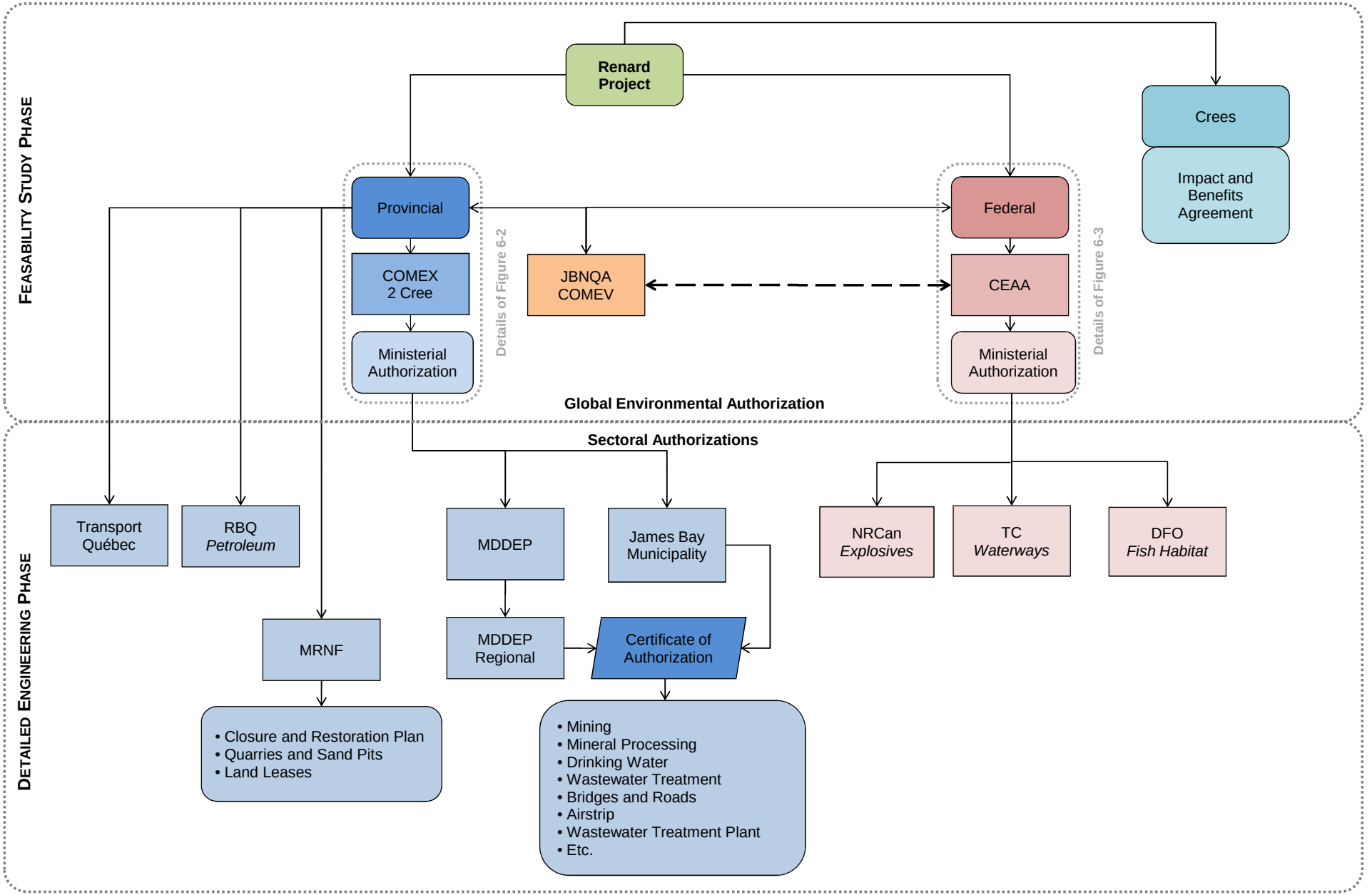
Category III lands are those where the Crees have certain rights, particularly concerning hunting, fishing, trapping, and operation of outfitting facilities. Residents of the CNM participate in hunting, fishing and trapping activities on the Foxtrot Property. The Renard Diamond Mine site is located in a place that they call “yuus kanchiisu-saakahiikan” (mild rock ptarmigan lake). More specifically, Renard’s kimberlites are located on the M11 trapline, under the responsibility of Roderick and Sydney Swallow (known as “tallymen”).

Under the terms of the JBNQA, a person authorized by law has the right to develop category III lands. However, developers must respect the environmental and social protection regime insuring the Crees’ hunting, fishing, and trapping rights.

Mining and surface rights on category III lands belong to the Quebec government and are managed under acts and regulations applicable to land use established by the regulatory authorities.

Chapter II of the *Environment Quality Act* (EQA) provides for specific arrangements with regards to environmental assessment applicable to the James Bay territory in accordance with the provisions contained in the JBNQA. The environmental assessment process for this region differs from the provincial process in that the local aboriginal peoples are active participants (Figure 2.2.1).

Figure 2.2.1 Environmental Authorization Procedure and Permits for the Renard Project



2.2.2 Provincial Environmental Assessment Process

The Renard Project is subject to the provincial environmental and social impact assessment and review process under of the JBNQA, Division 1, Schedule 1, Section 22 and the EQA, Paragraph 3, Division II, Chapter II and Paragraph (a), Schedule A, Chapter II.

Figure 2.2.2 illustrates the provincial environmental and social impact assessment and review process as established in the specific provisions of the EQA applicable to the James Bay territory located south of the 55th parallel (Division II, Chapter II of the EQA). The figure shows the first phase of the general authorization process presented in Figure 2.2.1. The provincial environmental assessment procedure is a five-step process. The steps are summarized below, as defined by the MDDEP (2002a):

1. Project Proponent's Declaration

The first step of the process is the project proponent declaration. This step begins with the preliminary planning of the project, when the proponent is reviewing the possible project alternatives on the basis of technical, economic, environmental, and social aspects of the project in order to select the best options for subsequent studies. The project proponent must send a notice of intent and preliminary information about the project to the relevant Administrator (COMEV and the relevant federal authority). This information concerns the goal, nature and scale of the project, as well as the sites considered or the various development options.

2. Assessment

The Administrator then sends the file to the committee responsible for defining the nature and the scope of the impact assessment. In this case, the committee is COMEV because the project is located south of the 55th parallel.

In the case of a project that is not automatically subject to or exempt from the process, COMEV makes a recommendation to the Administrator regarding whether or not the development project must undergo an impact assessment.

In the case of a project subject to the procedure, the COMEV formulates guidelines detailing the scope of the impact assessment that the proponent must complete. The guidelines are submitted to the Administrator, who forwards them to the proponent with or without amendments. The COMEV guideline for the Renard Project is provided in Appendix 2.2.1.

If the Administrator deems it necessary to amend a COMEV recommendation, he must consult COMEV beforehand.

3. Impact Assessment

During the third step, the project proponent completes an impact assessment in accordance with the guideline issued by the Administrator.

It should be noted that the *Regulation respecting environmental and social impact assessment and review procedure applicable to the territory of James Bay and Northern Quebec* defines the essential elements that must be included in an impact assessment. These include a description of the project and the physical and social environment concerned, an assessment of the potential impacts of the project, a description of alternatives, and a description and assessment of remedial measures.

4. Review

The project proponent presents the impact assessment to the Administrator, who forwards it to the review committee (COMEX) because the project is located south of the 55th parallel.

Aboriginal administrations and the public may make submissions to the committee, which may hold public hearings or any other type of consultation activity.

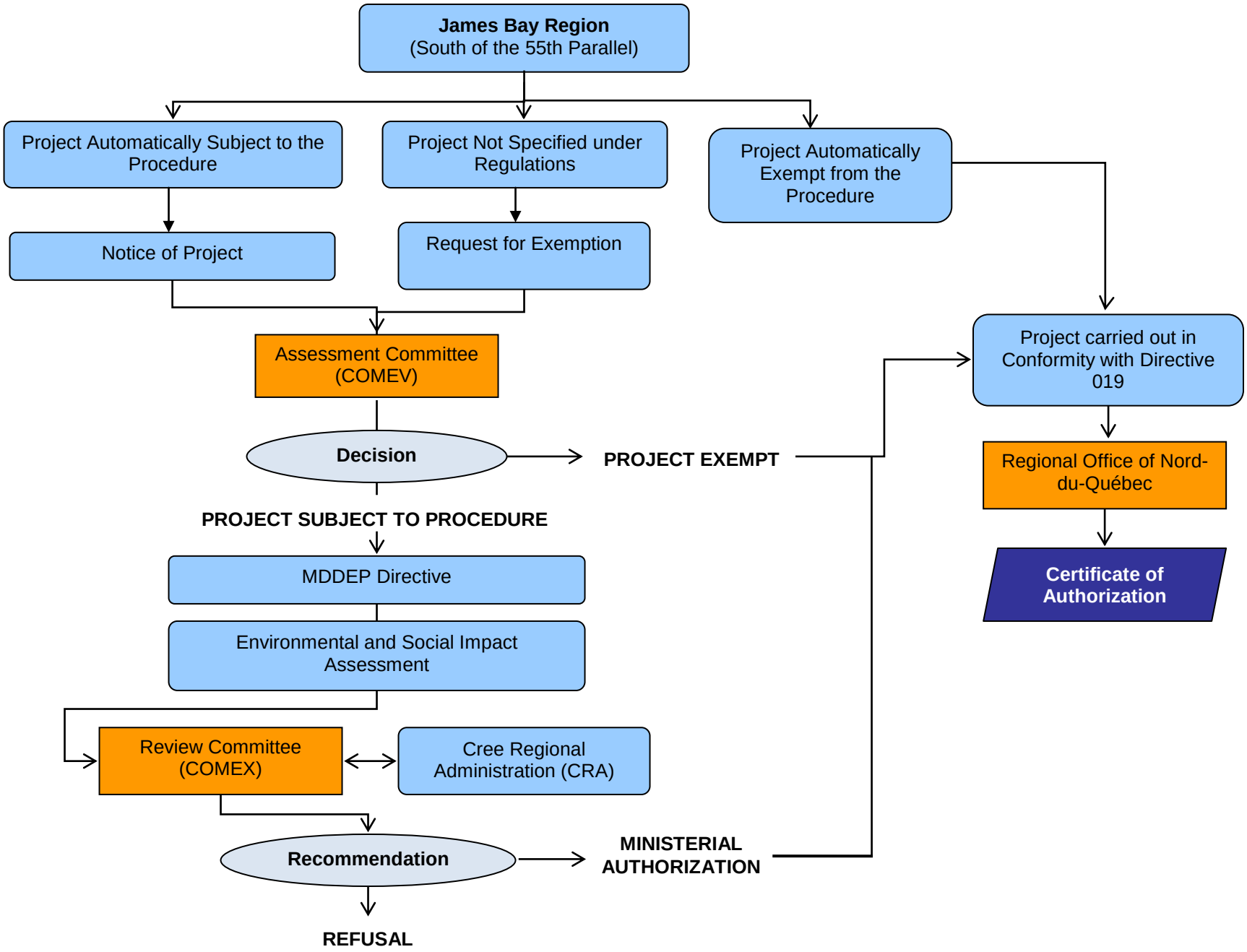
COMEX recommends refusal or authorization of the development project and, if necessary, determines the applicable conditions. It is the responsibility of COMEX to specify the amendments or additional measures it considers appropriate.

5. Decision

Taking into consideration the COMEX recommendations, the Administrator decides whether or not to authorize the project. If unable to accept the committee's recommendations, the Administrator must consult the committee before making a final decision and informing the project proponent. The final decision is also forwarded to the relevant aboriginal administrations. In addition, sectoral authorizations (concerning, for example, quarries and sand pits, wastewater treatment, camps, etc.) must be issued pursuant to the various provisions of Chapter I of the *Environment Quality Act*.

The Environment Quality Act provides different periods of time, varying from 30 to 90 days, for each step of the process. The duration of those steps may however be extended, if necessary, by the Administrator. Figure 2.2.2 presents the environmental assessment process.

Figure 2.2.2 Provincial Environmental Impact Assessment and Review Process for the Renard Project



2.2.3 The *Mining Act*

The government of Quebec is responsible for mining activity in the province. This activity is regulated by the *Mining Act* (R.S.Q. c. M-13.1), which defines ownership of rights to mineral substances (mineral claims, mining exploration licenses, mining leases, mining concessions, etc.) and the rights and obligations of the holder of a mineral right granted by the State.

Concerning the environment, Chapter IV, Division III of the *Mining Act* specifies that the holder of a mineral right must rehabilitate and restore lands on which exploration and mining activities have taken place. This work must be completed in accordance with the restoration plan previously approved by the ministère des Ressources naturelles et de la Faune (MRNF).

Under the *Mining Act*, the *Regulation respecting mineral substances other than petroleum, natural gas, and brine* (R.S.Q., c. M-13.1 r.2) specifies certain procedural requirements of the Act, including information and documents that must be submitted to the MNRF on the restoration measures and the locations established to store tailings.

Any enterprise engaging in mineral activities subject to articles 108 and 109 of the *Regulation respecting mineral substances other than petroleum, natural gas, and brine* must submit a restoration plan to the MNRF. After consulting with the ministère du Développement durable, de l'Environnement et des Parcs (MDDEP), the Minister approves the plan and its implementation schedule.

2.2.4 Federal Environmental Assessment Process

The *Canadian Environmental Assessment Act* (CEAA) applies to projects for which the federal government holds decision-making authority under Section 5 of the CEAA, whether as proponent, land administrator, source of funding, or regulator. In the case of the Renard Project, the Department of Fisheries and Oceans Canada (DFO) must provide authorization to alter fish habitat under subsection 35(2) of the *Fisheries Act*. There is also a possibility that an explosives factory will be used on site, which would require the issuance of a licence by Natural Resources Canada (NRCan) under paragraph 7(1)(a) of the *Explosives Act*. According to the Law List Regulations, subsection 35(2) of the *Fisheries Act*, subsection 5(2) of the *Navigable Waters Protection Act* (NWPA), and paragraph 7(1)(a) of the *Explosives Act* are environmental assessment triggers.

In this context, Stornoway Diamonds (Canada) Inc. submitted a project notice to federal authorities in February 2010 and received a guideline from the DFO and NRCan in July 2010 that defines the scope of the federal environmental assessment, a screening type of assessment that must be conducted in accordance with the CEAA. The current environmental and social impact assessment takes into account the requirements set out in this guidance document.

However, following amendments to the initial project notice, the Renard Project is now subject to a comprehensive study (Figure 2.2.3) in accordance with Section 21 of the CEAA. The Renard Project

falls under Section 10 of the Comprehensive Study List Regulations due to the "proposed construction, decommissioning or abandonment of a facility for the extraction of 200,000 m^3/a or more of ground water […]." In the case of a comprehensive study, the authority responsible for the project is the Canadian Environmental Assessment Agency (CEAA), which issued an updated guideline for the Renard Project in June 2011 defining the scope of the comprehensive study to be carried out (Appendix 2.2.2).

The DFO, NRCan, Transport Canada, Environment Canada, and Aboriginal Affairs and Northern Development Canada will act as expert authorities for the file. The Canadian Environmental Assessment Agency is responsible for the coordination of the federal environmental assessment process, and will be facilitating the exchange of pertinent information with the COMEX. The Renard Project is the subject of an agreement with the federal Major Projects Management Office (MPMO). The purpose of this agreement is to provide an effective tool for efficient completion of the federal review process.

Figure 2.2.3 illustrates the federal environmental assessment process for the Renard Project and Table 2.2.1 indicates the roles of the principal federal government departments involved.

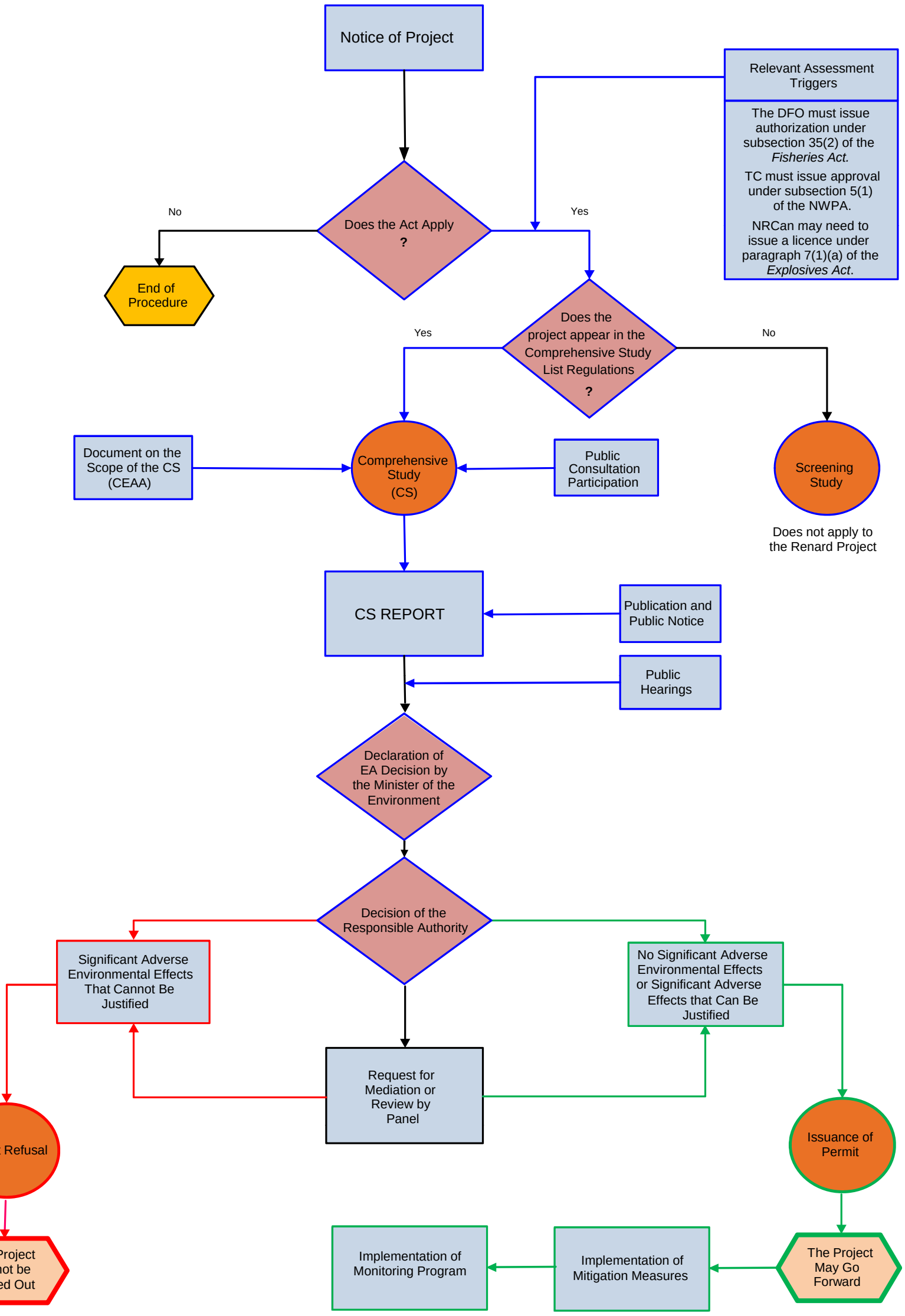
Table 2.2.1 Key Roles of Federal Departments Involved in the Environmental Assessment Process for the Renard Project

Department	Responsible Authority	Expert Authority[2]	Coordination of the Study	Key Applicable Legislation
Fisheries and Oceans Canada		•		*Fisheries Act*
Natural Resources Canada		•		*Explosives Act*
Transport Canada		•		*Navigable Waters Protection Act*
Environment Canada		•		*Canadian Environmental Protection Act*
Aboriginal Affairs and Northern Development Canada		•		*Cree-Naskapi (of Quebec) Act* and *James Bay and Northern Quebec Native Claims Settlement Act*
Canadian Environmental Assessment Agency	•		•	*Canadian Environmental Assessment Act* (CEAA)
Major Project Management Office (MPMO)			•	(CEAA)

[1] *Federal authority with regulatory and statutory responsibilities for a project under the federal legislation in effect*

[2] *Federal authority with specialized information and knowledge or experts concerning the project*

Figure 2.2.3 Federal Environmental Assessment (EA) Process Applicable to the Renard Project



2.3 Permits and Authorizations

Following completion of the impact assessment, after obtaining global environmental authorization from the MDDEP and the federal government under the CEAA, the proponent will be able to begin preparing the final plans and specifications (step of "Detail Engineering" on Figure 2.2.1). In addition to mitigation measures set out in the environmental and social impact assessment, the final project design must comply with applicable standards related to the future equipment and infrastructure. Preparation of plans and specifications should be performed in accordance with the legal framework of the Quebec and Canadian governments.

Before construction work can begin, the proponent must obtain the required permits, authorizations, approvals, attestations, and leases from the relevant provincial and federal authorities. Below is a detailed description of these permits and authorizations and Appendix 2.3.1 presents the register of permits, authorizations, approvals, attestations and leases likely to be required.

Provincial Level

- A closure and rehabilitation plan as required by the *Mining Act* (R.S.Q., c. M-13.1) and a request for authorization for the location of the ore processing plant and waste rock dumps under Sections 240 and 241 of the *Mining Act* and Sections 124 and 125 of the *Regulation respecting mineral substances other than petroleum, natural gas and brine* (R.Q., c M-13.1, r.2) must be prepared and submitted to the MRNF;
- Authorization under Section 22 of the EQA (R.S.Q., c. Q-2) for certain works or activities. Within the framework of the Renard Project, authorization will be required for:
  - Construction of the airstrip;
  - Water intake installation in Lake Poisson and Lake Lagopede;
  - Dredged sediment storage;
  - Stream diversion;
  - Construction and operation of the power generating sets;
  - Mining activities (open pits, stockpiles, and processed kimberlite confinement area);
  - Operation of kimberlite processing plant;
  - Management of treated industrial waters;
  - Construction and operation of explosivestorage area and service building;
  - Construction and management of solid waste trench landfill site and site for waste oil incineration for energy production and waste management;
  - Hazardous material management and storage;
  - Mobile concrete plant;
  - Sand and gravel pit operation (borrow pits).
- Authorization for bulk sampling of more than 50 metric tons under the *Mining Act;*
- Authorization to install apparatus or equipment to prevent, reduce, or cause the cessation of the issuance of contaminants into the atmosphere under Section 48 of the EQA;
- Authorization to establish water intakes, water purification appliances, and devices for the treatment of wastewater under Section 32 of the EQA;

- Approval for the location of tailings concentration and disposal plant under Sections 240 and 241 of the *Mining* Act and Sections 124 and 125 of the *Regulation respecting mineral substances other than petroleum, natural gas and brine* (c. M-13.1, r.2);
- Industrial depollution attestation under Section 31.10 of the EQA and under the Decree 515-2002 respecting the application of subdivision 1 of Division IV.2 of Chapter I of the Environment Quality Act to the mineral industry and primary metal manufacturing sector;
- Forest management permit for mining activities from the MRNF for all clearing activities under Chapter I, Division II of the *Forest Act* and the *Regulation respecting standards of forest management for forests in the domain of the State* (c. F-4.1, r.7);
- Occupation licence for work involving the collection or discharge of water for the water intakes in Lake Poisson and Lake Lagopede under Section 10 of the *Regulation respecting the water property in the domain of the State* (c. R-13, r. 1.1);
- Explosives permit (general permit, magazine licence, and transport permit) under Division II of the *Regulation under the Act Respecting Explosives* (c. E-22, a. 22);
- High-risk petroleum equipment operation permit for the mine site and the airstrip under Section 120 of the *Safety Code* (c. B-1.1, r.0.01.01.1) and Section 8.12 of the *Construction Code* (c. B-1.1, r.0.01.01);
- Mining leases and leases for the operation of borrow pits, quarries and sand pits under Section 100, Division V and Section 140, Division VII of the *Mining Act;*
- Leases to occupy the domain of the State for stockpiles, processed kimberlite confinement area, camp facilities, airstrip, explosives storage area and solid waste trench landfill site ,under Section 239 of the *Mining Act*, Division II of the *Act respecting the lands in the domain of the State* (R.S.Q., c. T-8.1), and Section 35 of the *Regulation respecting the sale, lease, and granting of immovable rights on lands in the domain of the State* (c. T-8.1, r.7) if they are found outside of the mining lease area;
- Notice to the Minister for the establishment of an industrial camp under Section 2 of the *Regulation respecting sanitary conditions in industrial or other camps* (c. Q.-2, r. 11).

Federal Level

- Authorization to alter fish habitat under Section 35 of the *Fisheries Act* (R.S.C., 1985, c. F-14);
- License for the manufacturing of explosives under subsection 7(1) of the *Explosives Act* (R.S.C., 1985, c E-17)(L.R.C., 1985, ch. N-22);
- Registration of the aerodrome under the *Canadian Aviation Regulations*, Part III, Subpart 1 – Aerodromes.

Municipality of James Bay (Municipality outside of RCM)

- Concerning the municipality of James Bay, Certificates of Compliance with Municipal Bylaws for service infrastructure, roads, camps, mining infrastructure, and airstrip infrastructure under the *James Bay Region Development and Municipal Organization Act;*
- Permits for individual work on groundwater catchment and for installation of a septic system planned for the airstrip under the *James Bay Region Development and Municipal Organization Act.*

2.4 Provincial Level

2.4.1 Certificate of Authorization and Authorizations

2.4.1.1 Certificate of authorization

The Renard Project will require one or more certificates of authorization (CA) from the MDDEP under Section 22 of the EQA. A CA application includes a form to which must be attached the documents and information stipulated in Sections 7 and 8 of the *Regulation respecting the application of the Environment Quality Act* (R.Q. c. Q-2, r.1.001). In addition, since the Renard Project involves discharges into the aquatic environment, the form "Demande d'objectifs environnementaux de rejet (OER) pour les industries" [Request for environmental quality objectives for effluent discharge] must be completed and attached to the CA application. The CA application forms and all required documents must be submitted to the MDDEP regional office of Abitibi-Témiscamingue and Nord-du-Québec. The timeline for study of the CA application is directly related to the complexity of the project. In accordance with the Service Statement, the MDDEP is committed to delivering an official response within 75 days of receiving the CA application (MDDEP 2002a).

The number of CA applications to complete depends on the timeline of the project's activities and the number of associated work items. Separation of the project into a work breakdown structure will allow for a step-by-step implementation process. For example, the airstrip and camp must be in place before construction on the other mining infrastructures can begin. Thus, as soon as the plans and specifications of the airstrip and camp are finalized, a CA application can be submitted to the MDDEP so that the assessment process may begin. During this time, plans and specifications for the other project components will be completed and new CA applications will be submitted to the MDDEP sequentially.

Under the *Ministerial Order concerning the fees payable under the Environment Quality Act*, an enterprise requesting issuance of an authorization under the Act will be required to pay certain fees. The fees set out by the Order are approximately $1,000 to $5,000 for each request under Sections 22, 31, 32, 48, and 70.8 of the Act.

2.4.1.2 Authorization to perform an activity that my alter fish habitat

Because certain project activities will affect fish habitat, an authorization must be obtained from the MRNF under Section 128.7 of the *Act respecting the conservation and development of wildlife*. In the present case, this authorization request will be made jointly with the CA under Section 22 of the EQA. For activities planned in aquatic environments and wetlands, the MRNF and the MDDEP have established a single-window service for issuance of authorizations required under the EQA and the *Act respecting the conservation and development of wildlife*.

2.4.1.3 Authorization for bulk sampling

Under Section 69 of the *Mining Act*:

> "*The claim holder shall not extract or dispatch mineral substances except for geological or geochemical sampling nor a quantity in excess of 50 metric tons.*
>
> *If the claim holder shows that it is necessary to extract or dispatch a greater quantity of mineral substances, other than surface mineral substances, the Minister may authorize him to extract or dispatch a fixed quantity of such mineral substances. Within one year after the extraction, the claim holder shall report the quantity of mineral substances extracted and the results of the metallurgical testing to the Minister."*

To obtain authorization from the MRNF, a request for bulk sampling authorization must be submitted following the instructions set out in Appendix 5 of the Guidelines for Preparing a Mining Site Rehabilitation Plan and General Mining Site Rehabilitation Requirements (MRN, 1997).

2.4.1.4 Authorization to establish water intakes and devices for the treatment of drinking water and wastewater

Authorization is required under Section 32 of the EQA for establishing water supply intakes as well as for drinking water and wastewater treatment facilities. The following forms must be completed and signed by the project engineer: "Demande d'autorisation pour réaliser un projet d'aqueduc et d'égout" [Application for authorization to carry out a waterworks or sewage project] and "Présentation des demandes d'autorisation pour les systèmes de traitement des eaux usées d'origine domestique" [Submission of applications for authorization for domestic wastewater treatment systems] for waste water. Required documents, including administrative documents and a technical document signed by the project engineer, must be attached and the authorization application sent to the MDDEP regional office.

2.4.1.5 Authorization to install an apparatus or equipment to prevent, reduce, or cause the cessation of the issuance of contaminants into the atmosphere

Under Section 48 of the EQA, an application for authorization is required for installation of apparatus or equipment to prevent, reduce, or cause the cessation of the issuance of contaminants into the atmosphere. To submit an application, the "Demande d'autorisation pour un projet industriel" [Application for industrial project authorization] must be completed and submitted to the MDDEP regional office. Required supporting documents are specified on the form.

2.4.2 Approval

2.4.2.1 Authorization for the location of the process concentration plant and mine tailings containment area

Under Section 240 of the *Mining Act*, "Any person who intends to operate a mill for the preparation of mineral substances, a concentration plant, a refinery or a smelter shall, before commencing operations, have the site approved by the Minister or, where the project is subject to the environmental impact assessment and review procedure provided for in Division IV.1 of Chapter I of the Environment Quality Act (chapter Q-2), by the Government." In addition, under Section 241 of the Act, "Every person responsible for the management of a concentration plant, refinery or smelter shall, before commencing activities, have the site intended as a storage yard for tailings approved by the Minister. The same applies to every holder of a mining right, owner of mineral substances or operator who intends to establish a mine tailings site." An application for approval must be sent to the MRNF before mining activities begin at the Renard mine. The application must include the information and documents cited in Sections 124 and 125 of the *Regulation respecting mineral substances other than petroleum, natural gas and brine*.

2.4.3 Attestation

2.4.3.1 Depollution attestation

Under Decree 515-2002 issued on May 1 2002,[1] the Renard Project must obtain a depollution attestation from the MDDEP. The depollution attestation, renewable every five years, establishes the environmental conditions related to the operation of an industrial establishment and contains all environmental requirements governing the operation of an industrial establishment. A depollution attestation differs from a certificate of authorization issued under Section 22 of the EQA in that the CA is a statutory certification required before commencement of a project or activity, while the depollution attestation applies specifically to the operation of an industrial establishment (MDDEP, 2002b). The steps of depollution attestation issuance are described on the website of the MDDEP (2002b) as follows:

- Government Decree;
  The issuance process for a depollution attestation is set in motion with the adoption of a decree by the Quebec government concerning certain categories of industrial establishments listed in subsection (1), Division IV.2, Chapter I of the EQA. This subsection establishes the legal framework of the depollution attestation.
- Application for a Depollution Attestation;
  The operator of an industrial establishment that is the subject of a decree must submit an application for a depollution attestation to the Minister within six months of the government decree coming into force. The application consists of a form provided by the Minister detailing the information required.

[1] Concerning the application of subsection (1), Division IV.2, Chapter I of the *Environment Quality Act* to the mining and mineral-processing industries.

- First Depollution Attestation Project;

  The Minister prepares the first depollution attestation project and submits it to the industrial establishment. Regulations grant the establishment 30 days to formulate a response.

- Public Consultation;

  As set out in the regulations, within 90 days of sending the first depollution attestation project, the Ministry must publish a notice of public consultation in a local newspaper and make the application for a depollution attestation and the attestation project accessible for a public consultation. The consultation must take place over a period of at least 45 days. The establishment is also informed of the attestation project submitted for public consultation.

- Second Depollution Attestation Project;

  Following the public consultation, the Minister studies the comments received and prepares a second depollution attestation project, which is submitted to the industrial establishment. The establishment has 30 days to comment.

- Issuance of the Depollution Attestation;

  The Minister studies the establishment's comments and drafts the final version of the depollution attestation, which is issued to the industrial establishment for a period of five years.

  The establishment must apply for renewal of the depollution attestation six months before its expiration. The initial attestation will remain in force until the new attestation is issued.

2.4.4 Permits

2.4.4.1 Forest management permit for mining activities

Under Section 20 of the *Forest Act*, the holder of a mineral right must obtain a forest management permit in order to exercise rights under the *Mining Act*. This permit authorizes the holder, on the land of the mineral right, to perform logging activities for the construction of buildings or other operations necessary for mining operations following the rules set out in the *Forest Act* and its regulations (MRNF, 2003). The acquisition process and the content of the forest management permit for mining activities are described in Chapter 5, Section I of the MRNF (2003) document entitled *Permis d'intervention pour autres fins que l'approvisionnement des usines de transformation du bois et autres autorisations – Instructions* [Management permit for activities other than wood processing plant supply and other authorizations—instructions]. Beforehand, the applicant must obtain the right to perform mining activities on the site. This right is issued by the Secteur des mines of the ministère des Ressources naturelles. To perform logging activities, the holder of a mineral right must submit a written request to the Forêt Québec field unit (natural resources and wildlife field unit of Chibougamau) to obtain a forest management permit for mining activities. The object of the request may be the clearing of a mine site, exploratory drilling of a gravel pit, or clearing of the site of a gravel or sand pit.

The holder of a forest management permit for mining activities must perform scaling on timber harvested from forests in the domain of the State in accordance with the standards set out in government regulations (Section 26 of the *Forest Act*). The permit holder is subject to the payment of prescribed fees as stipulated in Section 6 of the *Regulation respecting forest royalties*.

2.4.4.2 Occupation licence for works enabling water to be collected or evacuated

Under Section 10 of the *Regulation respecting the water property in the domain of the State*, the Minister may authorize a person to occupy a part of the water property in the domain of the State on a non-profit basis to install or maintain works enabling water to be collected or evacuated (CEHQ, 2009). In the case of the Renard Project, this type of permit will be necessary for the installation of water intakes in Lake Poisson and Lake Lagopede.

Requests for occupation licences must be submitted in writing to the CEHQ of the MDDEP. The occupation licence for works enabling water to be collected or evacuated is valid for one year and costs $58. It is renewed annually at no charge.

2.4.4.3 High-risk petroleum equipment operation permit

Under Section 120 of the *Safety Code*, "The owner of a petroleum equipment installation that includes at least one component that is high-risk petroleum equipment must obtain a permit for the use of all the high-risk petroleum equipment situated at the same address, until the equipment is removed from its respective place of use."

"High-risk petroleum equipment" is defined in Section 8.01 of the *Construction Code* as having one of the following characteristics:

- For underground storage systems:
  - Capacity of 500 litres or more if installed to store gasoline or diesel;
  - Capacity of 4,000 litres or more when installed to store fuel oil and heavy oil except equipment used for heating a single-family dwelling.
- For above-ground storage systems:
  - 2,500 litres or more if installed to store gasoline;
  - 10,000 litres or more if installed to store diesel;
  - 10,000 litres or more when installed to store fuel oil and heavy oil except equipment used for heating single-family dwelling;
  - Petroleum equipment installed for the purposes of trade in petroleum products containing gasoline, or fuel oils regardless of capacity.

The form "Demande de permis d'utilisation d'équipements pétroliers à risqué élevé" [Application for a high-risk petroleum equipment operation permit] must be completed and sent to the Régie du bâtiment. The application must contain all information and documents cited in Section 121 of the *Safety Code*. The permit is valid for 24 months. Issuance and renewal of a high-risk petroleum equipment operation permit are subject to performance and compliance verifications under the provisions of the *Construction Code* and the *Safety Code*.

2.4.4.4 Explosives permit

Under the *Act respecting explosives*, no person may possess, store, sell, or transport explosives without a permit. Depending on the nature of their use, several permits are necessary to possess explosives for industrial or commercial means. Division II of the *Regulation under the Act respecting explosives* defines the types of permit required. A general permit allows the holder to be in possession of explosives. Only a holder of a general explosives permit may obtain a magazine, sales, or transport permit. A magazine permit allows the holder to buy and store explosives in a container or building in compliance with regulations. A transport permit allows the holder to transport explosives.

To obtain these permits, the forms "Demande de permis général d'explosifs" [Application for a general explosives permit] and "Demande de permis de vente, de dépôt ou de transport d'explosifs" [Application for a permit for the sale, storage, or transport of explosives], available from Sûreté du Quebec, must be completed. The required documents and fees must be submitted to Sûreté du Québec. Permits are valid for five years.

2.4.5 Leases

2.4.5.1 Mining leases

Under Section 100 of the *Mining Act*, "No person may mine mineral substances, except surface mineral substances, petroleum, natural gas and brine, unless he has previously obtained a mining lease from the Minister […]." To obtain a mining lease, a claim holder must demonstrate evidence indicating the presence of a minable deposit. Applications must be submitted to the Registrar's office or regional office (natural resources and wildlife field unit of Chibougamau). The initial duration of the lease is 20 years. The lease may be renewed every ten years for the duration of operation. The acquisition process for a mining lease is described in the online publication *Le bail minier et la concession minière* [mining leases and claims] by the MRNF (2005).

An annual rental fee of the order of $44/ha is required by the MRNF.

2.4.5.2 Non-exclusive lease for the mining of surface mineral substances

Under Section 109 of the *Mining Act*, "A claim holder may use, for his mining activities, sand or gravel forming part of the domain of the State except where the land subject to his claim is already under an exclusive lease, in favour of a third person, to mine surface mineral substances." A non-exclusive lease for the mining of surface mineral substances must be obtained for the extraction or mining of sand and gravel located outside of the mining lease under Section 140 of the *Mining Act*. An applicant requesting a non-exclusive lease must complete the form "Demande de bail non exclusive (BNE) pour l'exploitation de substances minerals de surface" [Application for a non-exclusive lease for the mining of surface mineral substances] and attach the documents specified in Section 3 of the form (MRNF, 2005-2011).

An annual rental fee is required by the MRNF as well as royalties for the extraction of surface mineral substances. Royalties required by the MRNF are $0.36/mt for sand and gravel and $0.26/mt for stone during construction.

2.4.5.3 Lease for the occupation of the domain of the State

Under Section 239 of the *Mining Act*, "The holder of mining rights or the owner of mineral substances may, in accordance with the Act respecting the lands in the domain of the State (chapter T-8.1), obtain that public lands be transferred or leased to him to establish a storage site for tailings, or a site for mills, shops or facilities necessary for mining activities." Several components of the Renard Project, such as the camp, the airstrip, the trench landfill site, the ore processing plant, the processed kimberlite confinement area, and the waste rock stockpile, may be located outside of the land included in the mining leases. Since the project is located on State land, it will be necessary to rent the land required for the establishment of the aforementioned facilities under Section 47 of the *Act respecting the lands in the domain of the State*. A developer who wishes to implement commercial or industrial projects on lands in the domain of the State may use the document *Projet commercial ou industriel sur une terre du domaine de l'État* [Commercial or industrial project on lands in the domain of the State], available on the MRNF website, as a tool for presentation of the project for buying or leasing the land required for development. In the present case, requests should be directed to the MRNF general regional office of Nord-du-Québec.

The enterprise will be required by the MRNF to pay annual rental fees ranging from $44/ha for a mining lease to $91/ha for a processed kimberlite confinement area. For a conventional lease for occupation of lands in the domain of the State, such as for an airport, the minimum amount would be $300/year for the entire lease.

2.4.6 Notice to the Minister

Under Section 2 of the *Regulation respecting sanitary conditions in industrial or other camps*, "every employer who intends establishing a permanent camp, a permanent summer camp or a temporary camp, must notify the Minister regarding any old or new camps which he intends using during the coming season of operation. The Minister must be notified at least 3 weeks before the start of construction or installation of camps or of the reopening of old camps." The notice must be sent to the Minister of Développement durable, de l'Environnement et des Parcs.

2.5 Federal Level

2.5.1 Authorization

2.5.1.1 Authorization to alter fish habitat

Under Section 35 of the *Fisheries Act*, “No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat,” unless previous authorization has been obtained from the Minister.

A project that presents a known risk of repercussions to fish and fish habitat is subject to a review by the DFO. The general process is presented on the website of the DFO (2010). The required information to submit to the DFO for projects requiring a comprehensive review are presented in the *Proponent’s Guide to Information Requirements for Review Under the Fish Habitat Protection Provisions of the Fisheries Act* (DFO, 2009). To obtain a review, the developer must complete the Request for Review under the Fish Habitat Protection Provisions of the *Fisheries Act*. The request must be sent to the local office of the Regional Habitat Office.

There are three possible results of the DFO review:

- Mitigation measures (included in the project design or proposed by the DFO) are sufficient to avoid or mitigate negative repercussions on fish and fish habitat, and the DFO issues a "Letter of Advice";
- Residual damage to fish habitat cannot be avoided, but the repercussions on fish habitat are acceptable, and an authorization for a HADD and compensation for loss of fish habitat are required;
- The project will have unacceptable repercussions on fish habitat, and the project cannot proceed as designed.

In most cases, the Minister grants authorization if the compensation plan results in no net loss of habitat. In the case of the Renard Project, the expected result is a HADD authorization and compensation for loss of habitat. Generally, a request for authorization triggers the environmental assessment process. In the case of the Renard Project, the environmental assessment will already be completed when the request for authorization is submitted.

2.5.2 Approval

2.5.2.1 Approval of works in, over, under, through, or across any navigable waterway

The development of deposits R4 and R9 will be done through underground mining. Therefore, the construction of a dyke in Lake Lagopede for open pit mining is no longer planned, and thus, the project should not anymore be subject to the Navigable Waters Protection Act (NWPA).

2.5.3 Licence

2.5.3.1 Licence for explosives factories and magazines

Under paragraph 7(1)(a) of the *Explosives Act*, licences issued by the Minister of Natural Resources Canada are required for the operation of explosives factories and magazines in Canada.

However, in the case of the Renard Project, only licences for operation of explosives factories are required. Under Section 2 of the Act, the term “magazine” does not include “a place where an explosive is kept or stored exclusively for use at or in a mine or quarry in a province in which provision is made by the law of that province for efficient inspection and control of explosives stored and used at or in mines and quarries.”

In Quebec, the *Act respecting explosives* provides for the issuance of permits, inspection, and control of activities related to explosives (see Section 6.3.1.4 Explosives permit).

Applications for explosives licences must include the information listed in Section 25 of the *Explosives Regulations.*

2.5.4 Registration

The installation of an airstrip for the Renard Project is not subject to any permit, authorization, or approval from Transport Canada as long as its use remains private and strictly for the transport of personnel and charter flights. There are, however, minimum standards that must be respected to ensure passenger safety. The document *Aerodrome Standards and Recommended Practices* (Transport Canada, 2005)[2] should be consulted regarding this subject.

2.5.4.1 Aerodrome registration

Under Section 301.03 (Part III, Division I) of the *Canadian Aviation Regulations*, Registration of an aerodrome is an optional procedure that offers the advantage of publication in the *Canada Flight Supplement* and on air navigation charts. The goals are to ensure a minimum level of passenger safety in compliance with regulatory requirements and provide for dissemination and recognition of published information on airport characteristics.

An owner or operator of an aerodrome in Canada may voluntarily begin the aerodrome registration process by contacting the TCCA Regional Aerodrome and Air Navigation Office responsible for the region where the aerodrome is located (Transport Canada, 2010b).

To register an aerodrome, the requirements set out in Sections 301.05 to 301.09 (Part III, Division I) of the *Canadian Aviation Regulations* must be met and the form Aerodrome Charting Report [Rapport

[2] Any area of land, water (including the frozen surface thereof) or other supporting surface used, designed, prepared, equipped or set apart for use either in whole or in part for the arrival, departure, movement or servicing of aircraft and includes any buildings, installations and equipment situated thereon or associated therewith.

d'établissement d'une carte d'aérodrome] must be submitted for approval to the Aerodromes and Air Navigation Division of Transport Canada. Information for a registered aerodrome is provided by the owner or operator and verified annually by letter from the operator. The Advisory Circular on aerodrome registration (Transport Canada, 2010b) may be consulted regarding this subject.

Note that any modifications to the operation of the aerodrome (for example, a transportation service for Crees) will require authorization or certification from Transport Canada. It is recommended to contact the Department to ensure compliance with applicable regulations.

2.6 Municipal Level

2.6.1 Certificate of Compliance with Municipal Regulations

Under Section 8 of the *Regulation respecting the application of the Environment Quality Act*, "A person who applies for a certificate of authorization shall also submit to the Minister a certificate attesting that the project does not contravene any municipal by-law."

Certificate requests must be made to the municipality of James Bay at Matagami for the Renard Project's activities, except those specified in Section 246 of the *Act respecting Land use planning and development*:

> *No provision of this Act, or of a metropolitan plan, an RCM plan, an interim control by-law or resolution or a zoning, subdivision or building by-law has the effect of preventing the staking or designation on a map of a claim, or exploration or search for or the development or exploration of mineral substances or underground reservoirs, carried on in accordance with the Mining Act (chapter M-13.1).*
>
> *The first paragraph does not apply to the extraction of sand, gravel or building stone on private lands where, under the Mining Act, the right to those mineral substances belongs to the owner of the soil.*

2.6.2 Municipal Permits

For certain activities that are not subject to the obtaining of a certificate of authorization under Section 22 of the EQA, permits must be obtained from the James Bay Municipality. These activities include groundwater catchment facilities (<75 m^3/day) and septic system at the airstrip (permit for single groundwater catchment works and permit for the aristrip's septic system).

Chapter 3

Renard Project Description

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3 Renard Project Description

3.1 Project Objectives and Rationale

The objective of the Renard Project is to develop an important diamond deposit; it represents a major diamond resource that, based on preliminary studies, has shown economic feasibility as well as a potential for additional resources. According to the latest mineral resource estimates, development could last some twenty years with a good potential for expansion of the operation during the mine life.

3.1.1 Market Situation

In the 1990s, the first world class diamond deposits were discovered in northern Canada (Natural Resources Canada, 2009). Canada became a diamond producer for the first time in 1998 when the Ekati mine, located near Lac de Gras, N.W.T. and owned by BHP Billiton Diamonds, Inc., began production. In April 1999, the mine had already produced 1 million carats. In 2003, Canada became the world's third largest diamonds producer behind Botswana and Russia in terms of diamond value.

At the current consumption rate, the world diamond mine reserves could run out within fourteen years. Therefore, the world is experiencing a diamond shortage, and, as such, the Renard mine would bring a new offer of diamonds to a market that is currently in demand.

In 2003, the global production of rough diamonds reached 141 million carats equal to a value of US$8.9 billion (Spar, 2006). That year, Canada ranked sixth in the number of carats produced (8% of world volume) and third in terms of total production (15% of world value). This is due not only to the fact that Canada is rich in rough diamonds but also rich in high quality rough diamonds (Santarossa, 2004). The quality of a diamond is measured according to four criteria: size, weight, purity, and colour. For example, in 2001, the average price for one carat of Canadian diamond was $228, which was the third highest in the world after diamonds from Namibia and Angola (Statistics Canada, 2006). In Canada, the annual production of diamonds from the Diavik mine went from 7.6 million carats in 2004 to 11.9 million carats in 2007 (Harry Winston Diamond Corporation, 2008). The Ekati mine's average annual production between 2007 and 2009 was approximately 3 million carats per year (BPH Billiton, 2009). The Diavik and Ekati (N.W.T.) mines and Victor (Ontario) mine have an annual production capacity of 1.4 million and 600,000 carats respectively (De Beers Canada, 2009).

Currently, the lifetime of the Renard mine is estimated at 20 years of production with the existing resources plus a good possibility of additional resources. The Renard diamond mine contains a indicated mineral deposit of 24 million carats and an inferred mineral resource of 17 million carats for an estimated value of US$7 billion. The extraction rate is anticipated at approximately 6,000 tons of ore per day, which is equivalent to approximately 2.2 million tons per year (grade of ore ranging between 0.75 and 0.87 carat/ton) with an increase in production in the first years to more than 7,000 tons of ore per day or more than 2.5 million tons per year. The Renard diamond mine will produce high-value,

gem-quality diamonds. There is also the potential of very large diamonds (in the “Specials” category) and the company is currently studying the possibility to include an additional extraction phase in its process.

3.1.2 Economic Impact

Diamond extraction has significantly improved Canadian industry and makes N.W.T industry shine brightly. The current projects bring a substantial economic as well as social contribution to Canada and, more specifically, to the northern regions (Santarossa, 2004). Therefore, it is possible to imagine that the opening of the Renard mine, the first diamond mine in Quebec, would equally have positive socio-economic impacts for Quebec and the communities of the Lake Mistassini and Lake Albanel regions.

The experience in the N.W.T. clearly shows that diamond mining has had a significant effect on the gross domestic product (GDP) of the territory. Before the discovery of diamonds, the GDP for the N.W.T. was clearly lower than the national average: 1.7% compared to 3.3% (Byrd 2006). However, between 1999 (the first year diamonds were exported) and 2004, the GDP per N.W.T. resident grew at an average annual rate of close to 13%, three times the rest of Canada (4.2%).

The effect of the mining industry was felt far beyond the GDP contributions. The Ekati diamond mine generated some $3.5 billion in contracts for northern suppliers and aboriginal suppliers over a 12 year span (AMC, 2010). Moreover, the fact that in the N.W.T the secondary school graduation rates went from 36% to 56% since the discovery of diamonds in 1991, and that reliance on income support decreased by half, clearly illustrates the social benefits that can be attributed to mining (AMC, 2010).

Thus, the Renard diamond project will bring important benefits to the local communities in terms of job creation and long-term contracts. In fact, the project could create more than 500 jobs during the construction phase and 450 jobs during actual mining. Stornoway will favour hiring local personnel and local companies for service contracts as well as purchasing local products whenever possible. Stornoway anticipates investing the equivalent of CAD$802 million in the Renard project in capital costs and approximately CAD$120 to 125 million per year in operating costs.

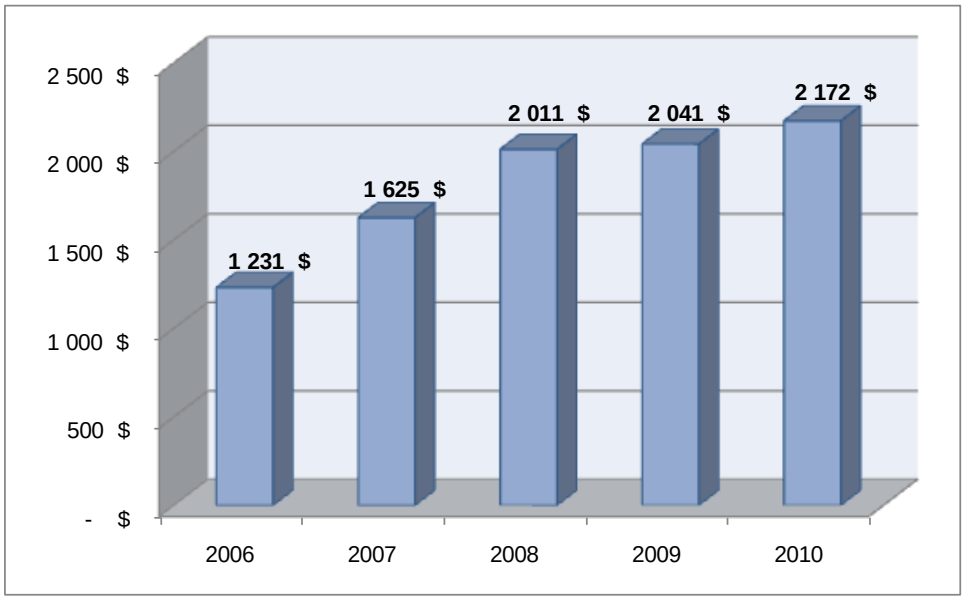
3.2 Comparison and Selection of Project Alternatives

3.2.1 “No Project” Alternative

Each year, the Quebec mining industry generates important benefits for the local, regional, and provincial economies. In 2007, the mining industry contributed to nearly 2.4% of Quebec’s GDP through investments and its 52,000 direct and indirect jobs (AMQ and AEMQ, 2010).

Following the crisis in 2008, the industry is now back on the pace set at the beginning of the 2000s and is expected to maintain this growth rate. Considering the high demand for raw material around the world and a fiscal (MRNF policy) and political (Plan Nord) climate favourable to the Quebec mining industry,

the potential for growth is very promising. In November 2010, the Institut de la statistique du Québec announced that the estimated mining investment for 2010 was $2,172 million, a 76% increase over 2006 (Figure 3.2.1).



Source: Institut de la Statistique du Québec (ISQ), Mines en chiffres (mining investment in Quebec), November 2010.

Figure 3.2.1 Mining Investment in Quebec, 2006-2009 (2010 estimated)

In the coming years, there are several mining projects under development that could actively contribute to the social and economic development of northern Quebec. In fact, ten start-up projects are anticipated between now and 2013, nine of which are major (with $200 million and more per project) representing a total of nearly $4 billion (AMQ and AEMQ, 2010). The Renard Project is one of those that will generate important spending in the local and regional communities as well as significant demand for jobs. From the perspective of abandoning the project, there would be direct and indirect impacts on the economic development in the region of the project.

The direct impacts of abandoning the project relate to, in the first place, the investment of the construction activities. It is anticipated that approximately $802 million will be spent on capital expenditures for the installation of the mining infrastructures and approximately $120 to $125 million per year on annual operating costs over two decades. Consequently, this money would not be injected into the regional economy.

A significant amount of these expenses would have mainly benefitted local suppliers although it is understood that the demand for goods and services would be spread out to other regions in Quebec. Therefore, there would be a net loss of income for local and regional suppliers in the goods and services industry. Consequently, local suppliers would invest less (expansions, new hires, growth in the private sector, etc.). In addition, the project will provide direct employment for at least 500 workers

during the construction phase and almost 450 full-time workers while the mine is in production over a twenty-year period. The potential loss of these well-paid jobs would result in a decrease in household spending, which would reduce other local employment opportunities as well as decrease the activity and profit of local companies. It is important to note that miners are paid 42% more than the average income in Quebec (AMQ and AEMQ, 2010).

With the closure of the Troilus mine, the Renard Project presents a good employment opportunity for those who worked at that mine. Additionally, the Renard Project offers another occasion to develop skills and to train the local workforce. The different expertise developed within the scope of the project, be it during the construction phase, the operation phase, and the closure phase, would improve the qualifications of the regional workforce. In fact, the skills and knowledge acquired in a mining project are not only transferable to jobs in other mines (diamond or other) but also transferable to other employment areas (ex.: heavy-duty equipment mechanics, geology and environmental technicians, etc.).

Thus, the contribution of mining projects cannot only be recognized in terms of the direct costs related to the mining operations. To direct consequences such as a loss of capacity and a decrease in local spending, one must add a decrease in investment related to infrastructures (arena, pool, etc.) that are often made by mining companies through direct contributions during initial financing or through paying local taxes. In addition, a significant part of the mining companies' contribution is in time, material (lending of equipment), and services (ex.: transportation, emergency services, etc.). Mining companies also make donations or sponsor different NPOs, local northern communities, and aboriginal communities.

It is equally known that many mining projects contribute to the development and maintenance of regional transportation infrastructures (terrestrial and maritime). The large mining companies have already contributed an estimated value (full reconstruction) of $6 billion (AMQ and AEMQ). Concerning the project in question, the loss of a partner to share the construction costs of the Route 167 north extension toward the Otish Mountains would be a factor that could reduce the size of investments in the region, and as such limit the penetration and access to the area. In fact, if access to the area is not assured, the interests of other resource exploration companies (mining and forestry) to explore and develop the region could be limited.

Finally, abandoning the project would affect government revenue. The loss of $1.175 billion in tax revenue over 20 years (income taxes, sales taxes, fees, etc.) would add more pressure to the existing resources, limiting the possibility to create or improve social services and community infrastructures. Recall that the mining industry has generated net tax revenue of $281 million on average per year since 2000 for the Quebec government. The development of the Renard Project would create local, regional, and provincial prosperity through the goods and services that the project would purchase over a twenty year period (drilling, blasting, road and air transportation, cleaning, food and lodging, consultants

(operation, environment, etc.), mechanics, fuel, material, equipment, security, civil engineering, landscaping, land clearing, replanting). The government's initial investment to extend Route 167 would, in a large part, be recovered by this one project.

From an environmental standpoint, the absence of the project would, obviously, have no impact on the various ecosystems. However, the project footprint is relatively restrained and local and the main change to the environment that will persist beyond the life of the mine would be the processed kimberlite confinement area that would create a new hill on the landscape and would be revegetated. The integration, from the start, of environmental design and mitigation measures into the project will attenuate the intensity of the impacts and reduce their footprint on the site. Thus, the possibility to develop the project while respecting the environment and with the support of local communities motivates Stornoway to move ahead, particularly in the context of the favourable diamond market and the potential mineral and human development in the Nord-du-Québec (Plan Nord) region.

3.2.2 Access Alternatives

3.2.2.1 Road access alternatives

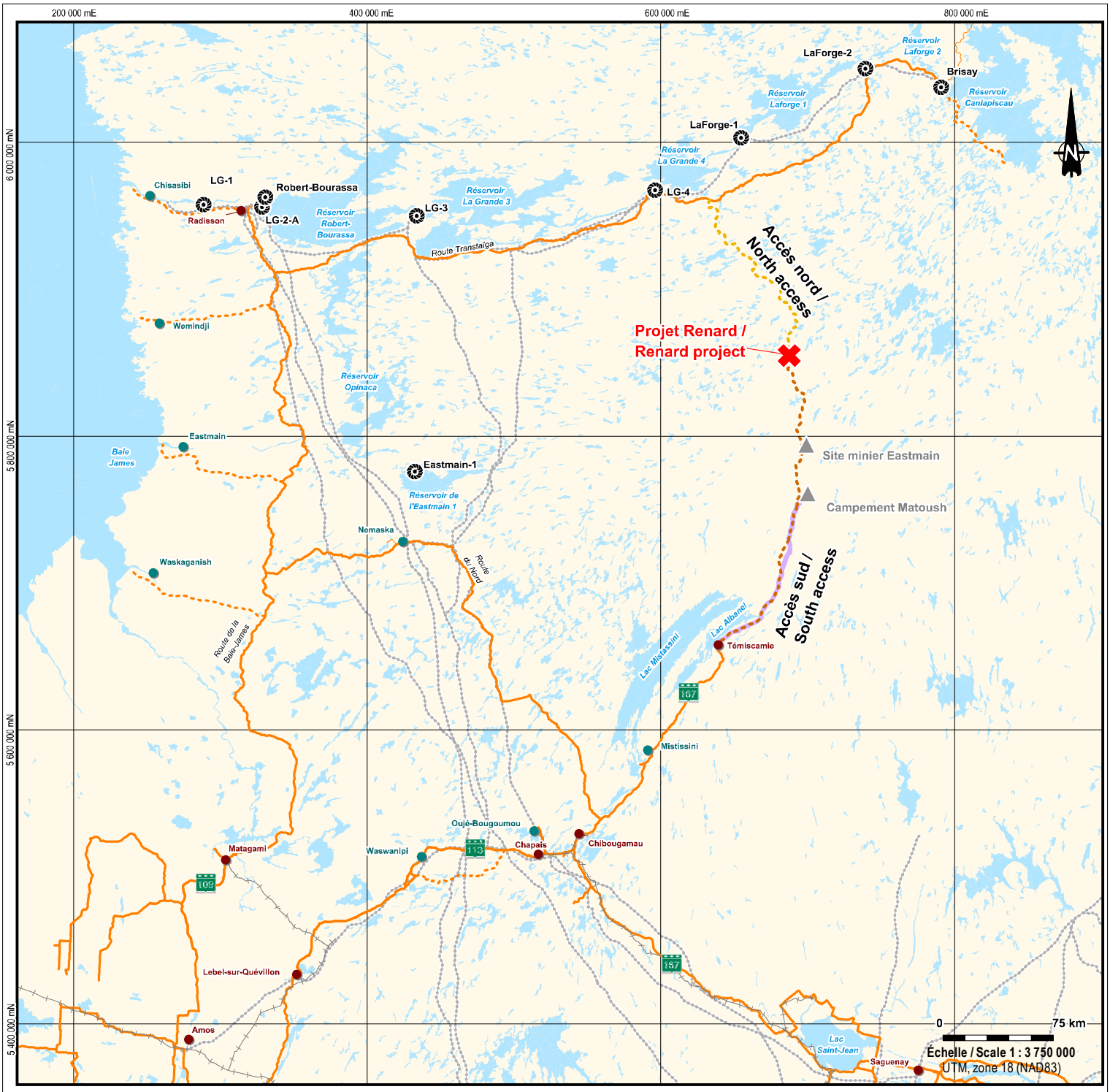
- *JUSTIFICATION FOR THE ALTERNATIVES*

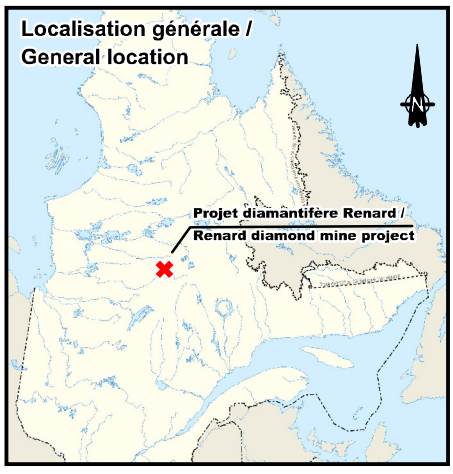
Given that the Renard Project is located in an isolated region of northern Quebec, site access constitutes a critical factor for project development. At this time, it is possible to access the Foxtrot property via airplane by clearing a runway on Lake Lagopede. Outside of the winter months, access is possible by helicopter or by float plane (landing on Lake Lagopede) leaving from one of three hydrobases located at Temiscamie (Lake Albanel), near Tournemine Camp (Lake Tournemine), and Chibougamau (Lake Cache).

There is currently no road access to the site. A winter road exists between Temiscamie, near Lake Albanel, about 240 km south of the Renard Project and the old Eastmain mine site (km 165 on the winter road). Strateco maintains a part of this road (to about km 130) up to its Matoush camp, situated some 110 km south of the Renard Project. The winter road is accessible a few weeks per year. From the north, the closest access is via the Transtaiga Road (Map 3.2.1).

Building road access to the site is essential for the construction phase of the diamond mine as well as for the daily operation of the site during the operation phase in order to transport material and equipment. Indeed, the absence of a permanent road was acceptable during the exploration phase; however, lack of such a road for the construction and operation phases could seriously jeopardize or indefinitely delay the start-up of the Renard Project.

Two, permanent road possibilities exist for Stornoway to access the site: an access via the north or an access road via the south. The choice of the route for the permanent road must not only take into account the technical and financial aspects but the socio-economic and environmental aspects as well.





- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec / Electricity powerline
- Réseau routier principal / Main road network
- Réseau routier secondaire / Road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Tracé nord / North alignment
- Route d'hiver / Winter road
- Chemin de fer / Railroad

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Réseau routier régional / Regional road network

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_RRGeneral_111213.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.1

Access from the north would be via the Transtaiga Road in the LG4 area (Forchemex and Roche, 2003, 2007, 2008), while access from the south would be via the Route 167 extension, which currently ends near Lake Albanel (Roche-SNC-Lavalin Consortium, 2010).

Alternative 1: North alignment

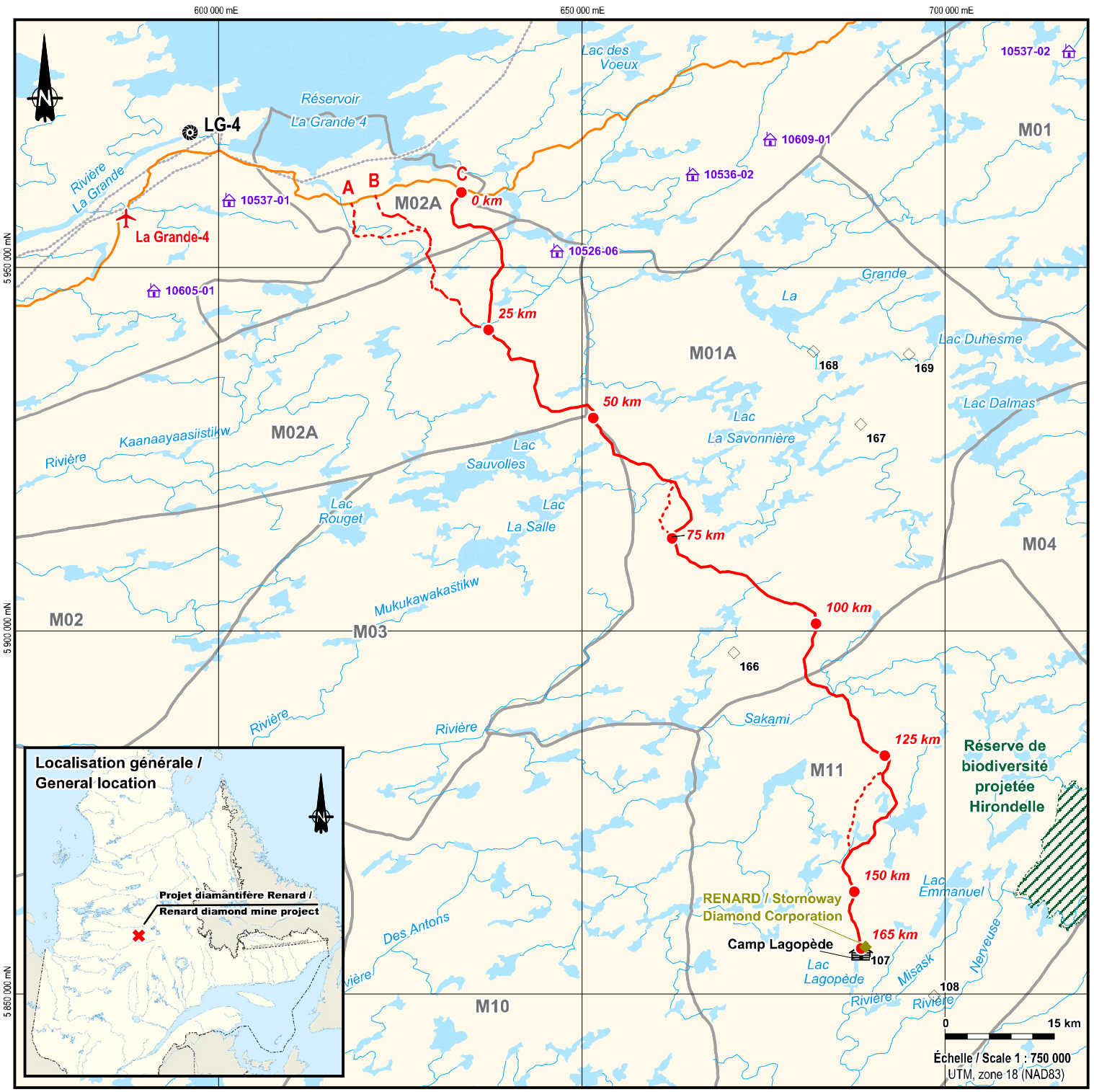
The North alignment has been the subject of several optimization studies over the years. It would be a forestry road between 154 and 165 km in length, depending on where it connects to the Transtaiga Road (A, B, or C). Map 3.2.2 illustrates the alternative analyses for the North alignment.

The first section of the road, from the Transtaiga to a distance of about 135 km south, shows consistent physical characteristics. Indeed, the topology in this area is relatively flat with only a few undulations due to the presence of thick surface deposits. In fact, along this portion of the North alignment, there are abundant fluvioglacial deposits which could be used as construction material for the road; however, there are also boulders that could represent construction constraints. For the last 15 kilometres or so, the terrain is more rugged and contains several bodies of water, limiting the choice of alignment alternatives.

The main alternatives are located in the northern part of the alignment and constitute, in fact, the connection point with the Transtaiga Road; these three points, labelled A, B, and C, are located respectively at 27, 31, and 45 km to the east of LG4. The first two entry points (A and B) must cross a mountain ridge, which increases the level of difficulty for construction. Although further away from LG4, point C offers no similar obstacle and was, therefore, selected as the northern access alternative. Two other alternatives are located in the centre and southern portion of the alignment. The choice of alternatives relies essentially on the topography, the hydrography, and the type of favourable unconsolidated deposits.

Alternative 2: South alignment

The second alternative is an alignment from the south. This alternative requires 240 km of new road to be built between Lake Albanel and the Renard Project site, and uses part of the existing winter road. Part of the South alignment would go through the future Albanel-Temiscamie-Otish Park and Category II lands belonging to the Mistissini community. This alignment has been the subject of MTQ studies and would serve as a multi-service road. The layout of this road (the so-called Route 167 North extension) was optimized from technical and environmental perspectives by the MTQ in the framework of an environmental and social impact assessment. Map 3.2.3 illustrates the South alignment selected by the MTQ after analyzing the alternatives.



Pourvoiries sans droit exclusif / outfitter without exclusive rights

Aéroport / Airport

Aménagement d'Hydro-Québec / Hydro-Quebec facility

Ligne électrique d'Hydro-Québec / Hydro-Québec electric power line

Réseau routier principal / Main road network

Tracé nord (C) / North alignment (C)

Variante / Alternative

Projets d'exploration de ressources minérales / Mineral resources exploration projects

Projet en stade avancé de développement / Mining project in advanced stage of development

Terrain de trappe / Trapline

Réserve de biodiversité projetée / Projected biodiversity reserve

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Tracé nord / North alignment

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_RNord_111213.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.2

The first section of the South alignment, between Lake Albanel and the Tichegami River, covers a distance of approximately 125 km. This section is characterized by very thick glacial deposits as well as by a flat to undulating topography. Fluvioglacial material is present in the region although in lesser quantity than in the North alignment. Several string bogs were discovered in this area; however, particular attention was paid to circumvent them during the alignment study.

The second portion of the South alignment includes a mountainous zone of about 35 km in length near the Tichegami River. It is the most mountainous zone of the two alternative accesses studied (North and South). This distinctive topography, characterized by numerous rocky outcrops, leaves little choice as to a possible alignment, in particular in the last section where the alignment must go through a narrow valley near a waterway.

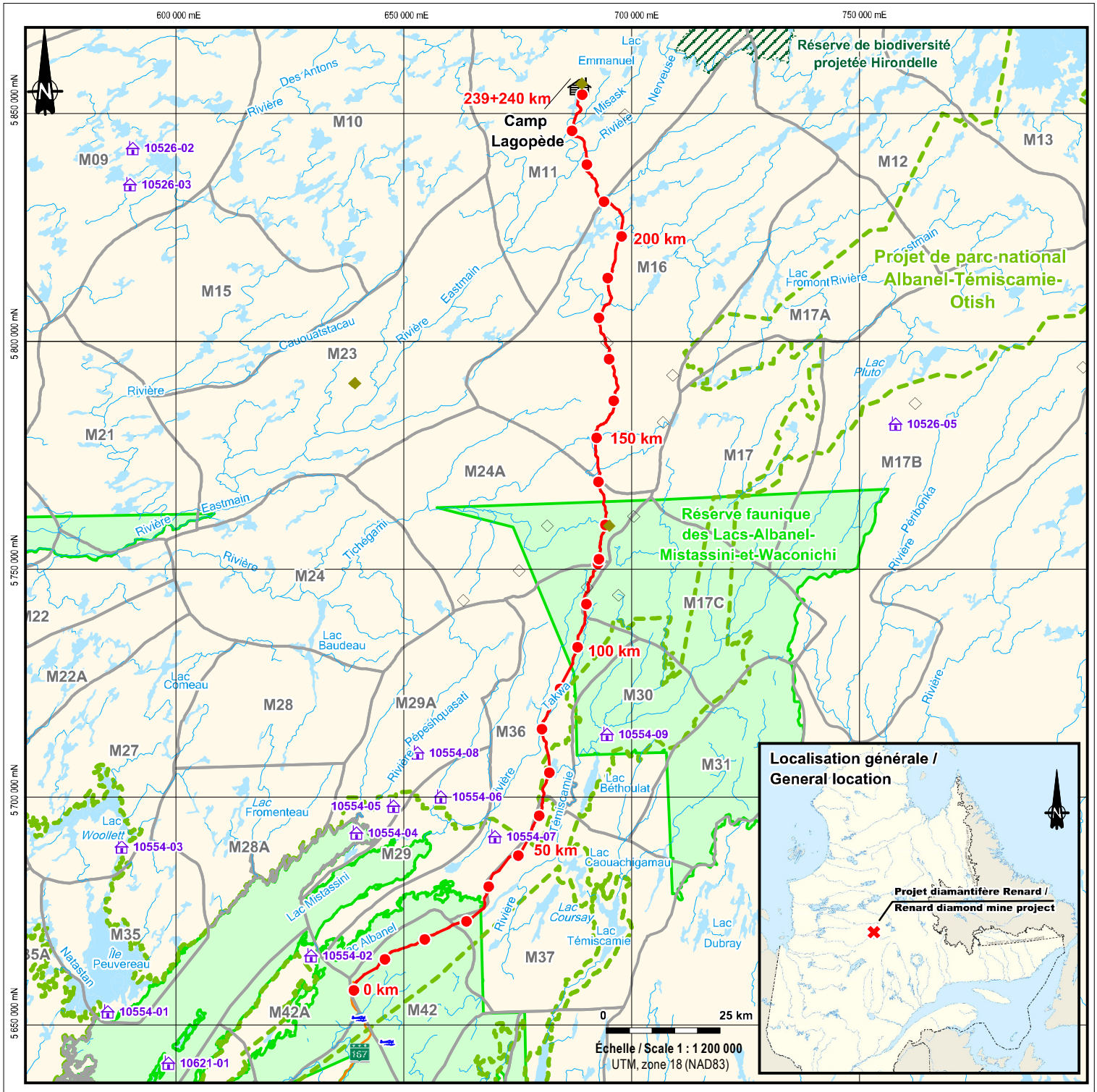
The final section of the road covers the remaining 98 kilometres between the Tichegami River and the Renard Project's site. It is characterized by an uneven terrain and the presence of numerous waterways. Note that this section contains the Eastmain River which is the largest river crossing of the studied alignments (more than 100 m).

- *COMPARATIVE ANALYSIS OF THE ALTERNATIVES*

The analysis of the alternative access routes was carried out based on technical, environmental, socio-economic, and financial criteria, and, notably, in the interests of the potential beneficiaries of the road: the MTQ, the MDDEP, the MRNF, local communities, and mining and forestry companies.

Technical criteria and scheduling

The technical parameters that were examined for the evaluation of the North and South alternatives are mainly related to the anticipated constraints and difficulties for the road construction. Indeed, the required structure works and the proposed road design do not include any new technical elements. They are similar to those commonly used for road construction in the Nord-du-Quebec region. However, the type and number of components (bridges, culverts, earthworks) that will be required for the construction of the road as well as the final alignment will be a function of the topography and the physical conditions (soil, rock, hydrography, etc.). For example, the proximity of the borrow pits, the necessity to excavate rock in certain parts, the width of the stream crossings, etc. are all constraints that will influence the final design, the costs, and the construction schedule of the road.



Pourvoiries sans droit exclusif / outfitter without exclusive rights

Hydrobase / Hydrobase

Réseau routier principal / Main road network

Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains

Projets d'exploration de ressources minérales / Mineral resources exploration projects

Projet en stade avancé de développement / Mining project in advanced stage of development

Terrain de trappe / Trapline

Parc national projeté / National Park project

Réserve de biodiversité projetée / Projected biodiversity reserve

Réserve faunique/ Wildlife reserve

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Tracé sud / South alignment

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_RSud_111213.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.3

The time required to build the road components (e.g.: bridges) will also have an influence on the Renard Project's schedule. In addition to considering the time required to obtain the environmental authorizations to comply with various regulations, it is also essential to consider the climate-related imperatives for the road construction. The periods of use of the existing winter road on the South alignment will control the number of structures that can be completed during each period. The estimated construction time for the South alignment is longer than that for the North alignment, five years vs. three years. However, the MTQ has put together a construction scenario for the South alignment that would give rough access in the summer of 2013, allowing the Renard Project to begin. A more suitable road would be available in the summer of 2014, and finishing work on the road would follow; this scenario would meet Stornoway's construction start-up schedule.

Environmental criteria

The impacts on the environment and the biodiversity, potentially caused by the road construction, will depend, to a large extent, on the characteristics of the two alignment alternatives. In addition to considering the technical criteria, the North and South alignment alternatives were also layed out from a perspective of limiting the potential environmental impact. Indeed, based on the available information, care was taken to keep the alignments away from streams, wetlands, and other sensitive wildlife habitats (e.g.: for the South access, high-density moose areas). However, to provide a more detailed evaluation of the impacts and the optimization of the North alignment, additional field surveys would be necessary.

In the James Bay and Nord-du-Quebec regions, all projects must comply with the regulatory framework applicable in this region of Quebec. Road projects must therefore meet MDDEP requirements, as defined in the *Environment Quality Act* (EQA), and agree with the James Bay and Northern Quebec Agreement; in addition, MRNF requirements must be met as defined in the *Forest Act*, the Act respecting the conservation and protection of wildlife, and the *Mining Act*. Projects must also meet federal government regulations, where they apply, notably within the framework of the environmental assessment processes regulated by the *Canadian Environmental Assessment Act* (CEAA), the *Navigable Waters Protection Act*, and the *Fisheries Act*. The impact assessment for the South alternative access has already been submitted, hearings have been held, provincial authorization was obtained on December 1, 2011, and federal authorization will be issued soon. Concerning the North alignment, the initial steps have been taken and the surveys have begun; however, due to a low level of social acceptability in the region, the process has been interrupted. Should the Route 167 extension project be abandoned by the MTQ, the start-up of the Renard Project would be delayed as well as all other projects north of Temiscamie. Currently, the south access alternative has significant support from the population and the regional authorities as a regional access and development tool.

Another important environmental aspect that must be analyzed is greenhouse gases that will be generated by the trucking required for procurement purposes during the operation phase of the mine.

The comparison between the two alternatives was done according to emission factors presented in the Canadian GHG Inventory Report, 2009. The emission factors are those for a heavy gas vehicle with catalytic converters. Table 3.2.1 presents the factors considered for each GHG emitted during gas combustion.

Table 3.2.1 Emission Factors for Gas Combustion

Greenhouse Gas	Emission Factor (g/l)
Carbon dioxide (CO_2)	2.289
Methane (CH_4)	0.068
Nitrous oxide (N_2O)	0.2

To evaluate the fuel consumption of a merchandise transport truck (10-wheeler), the generally accepted average fuel consumption factor of 35 l/100 km is used. Also, to consolidate the results and evaluate the t CO_2eq emissions, the Global warning potential factors of various gases (CO_2 = 1, NH_4 = 21, N_2O = 310) is used.

The other data used in the calculation are the respective distances of the alternative accesses from Chibougamau. For the North alignment, the distance is calculated between Chibougamau and the Renard Project site via the James Bay and Transtaiga Road (1,114 km), and for the South alignment the distance between Chibougamau and the project site, which is only 417 km. One-way truck travel is the comparison used between the two routes. Here is an example of the calculation for the North alignment:

$$1114\ km \times \frac{35\ l}{100\ km} \times \frac{\left(2289\frac{gCO_2}{l} \times \frac{gCO_2e}{gCO_2} + 0{,}068\frac{gCH_4}{l} \times 21\frac{gCO_2e}{gCH_4} + 0{,}2\frac{gN_2O}{l} \times 310\frac{gCO_2e}{gN_2O}\right)}{1000000 g/t} = 0.9172\ tCO_2e$$

Table 3.2.2 presents the partial results for the two routes.

Table 3.2.2 GHG emission results for road travel between Chibougamau and the Renard Project site for the two alternative alignments

Element	North Alignment	South Alignment
Travel distance (km)	1,114	417
Estimated fuel consumption (l)	389.90	145.95
CO_2 emissions (g)	892,481.1	334,079.55
CH_4 emissions (g)	26.5132	9.9246
N_20 emissions (g)	77.98	29.19
Total GHG emissions (g CO_2e)	917,211.6772	343,336.87
Total GHG emissions (t CO_2e)	0.912	0.343

In terms of GHG emissions, the South alignment is the preferred route. It emits 2.65 times less GHG than the North alignment.

Socio-economic criteria

The preference given to either of the alternatives also depends on socio-economic factors. Indeed, the road must go through Crown land, the future Albanel-Temiscamie-Otish Park, and Cree community lands. Access from the south touches Mistissini community lands whereas the access from the North touches, in addition, Chisasibi community lands. Thus, two communities would be affected, and the social acceptability for access from the north has not been acquired for the North alignment.

Moreover, in terms of regional development, the North alignment would provide few benefits for the Mistissini and Chibougamau communities because all the transportation would be done via the Transtaiga Road, located far from these communities (Map 3.2.1). In addition, the future Albanel-Temiscamie-Ostish Park would not benefit from the road, which could limit or delay its development and the promotion of certain activities planned by the MDDEP. Lastly, other mining companies working south of the Renard Project would not gain any real advantages from a northern access to Stornoway.

Finally, an access from the north would not facilitate in any way access to the traplines of the Mistissini tallymen who would, for example, have to make a considerable detour for road access to their traplines located in the region of the Renard Project.

Therefore, the alternative access from the south is more interesting for the local stakeholders. For example, the proponents of other mining projects in the area could benefit from the road and thus contribute financially to its construction and maintenance. The community of Chibougamau and the Cree Nation of Mistissini are interested in a quick access, which would favour opening up the territory, job creation, and the development of a procurement network. Finally, the road would promote tourism and recreational activities (Albanel-Temiscamie-Otish Park), logging, and an improved access for the trapping activities of the Cree of Mistissini.

Financial criteria

From the perspective of Stornoway contributing financially to a partnership in the construction of a road from the south or assuming sole responsibility for the development of an infrastructure for a forestry road from the north, it is essential to consider the financial aspect of such an undertaking. The main costs to consider are the infrastructure capitalization costs and the operating costs (fuel, equipment, and material transport). The construction costs of a road from the north were estimated based on similar construction experiences of forestry roads (70 km/h max.) in the Nord-du-Quebec region (Forchemex and Roche, 2007). Thus, as a reference, the cost of a road is estimated between $170,000/km for construction on flat, well-drained land with a sand or gravel base, and up to $570,000/km for construction on a rocky and uneven area.

Stornoway was, therefore, able to evaluate the costs of the different potential alternative alignments for the road. The total cost of the North alignment would be lower than that of the South alignment if the

latter was built by Stornoway. The road and bridge construction costs for the North alignment vary between $37.4 M and $40.5 M, whereas for the South alignment, the costs vary between $57.5 M and $66.9 M if this road was designed to forestry road criteria and built by Stornoway. If a south access road was built by the MTQ and to MTQ design criteria, the cost(s) is closer to $330 M; Stornoway would assume part of this cost (around $44 M), as would other mining companies in the area.

Apart from the actual road construction costs, transportation costs during the operation phase must also be mentioned. These costs would be much higher for the North alignment due to the increased travel distance.

Using the same fuel consumption data as those used to evaluate GHG emissions, it is possible to establish the cost of a one-way travel for each of the alternative alignments.

The quantity of fuel consumed combined with a consumption factor of 35 l/100 km allows us to calculate costs using the average fuel price for 2011 at $1.30/l and an average inflation rate of 2% for the next 20 years, which gives an average cost per litre of $1.57.

Table 3.2.3 compares the results of the two alternatives.

Table 3.2.3 Estimated Cost for One-way Travel Between Chibougamau and the Renard Project Site for the Two Alignment Alternatives

Element	North Alignment	South Alignment
Travel distance (km)	1114	417
Estimated fuel consumption (l)	389.9	145.95
Estimated cost ($)	612.14	330

From a cost perspective, the South alignment is 1.8 times less expensive whatever the price of fuel, which could strongly increase in the coming years according to different economic observers.

- *SELECTION OF THE ALTERNATIVE*

Based on the information gathered up until now, the South access alternative has been selected by the project (Table 3.2.4). In fact, this alignment was considered by the MTQ for the development of a permanent road in this region with high potential for natural resource development. The road will not only allow the development of the Renard Project but also the development of all other potential mining projects in the area. It will also benefit the regional communities in terms of employment and economic activities. Finally, the road will allow the promotion of tourism, recreational activities, logging, as well as Cree trapping activities.

As mentioned, an optimization study and an environmental and social impact assessment were done on the South access alternative. The assessment reports have already been submitted to both levels of government to obtain environmental authorization, and project plan and specification mandates have been awarded (km 0 to km 82). An accelerated construction schedule was proposed by the MTQ, which

would give Stornoway a winter access as early as winter 2013 and would meet Stornoway's requirements.

With respect to the construction costs, the North alignment alternative is slightly more advantageous for Stornoway. However, transportation costs during the construction and operation periods clearly favour access from the south. The inconveniences associated with the choice of the South alignment (initial investment cost for construction) are offset by a greater social acceptability, the availability of assessments (technical and environmental), and lower projected transportation costs and greenhouse gas emissions. These conditions also allow for an increased potential for road construction and operation cost sharing. Finally, the South alignment will facilitate regional economic development and access to the traplines for the tallymen.

3.2.2.2 Airstrip alternatives

- *JUSTIFICATION FOR THE AIRSTRIP*

Currently, there exists no viable, year-round land access to the Renard Project site. Employee, equipment, and consumable product transport is done by air with a helicopter or float plane on Lake Lagopede, from three hydrobases located at Temiscamie (Lake Albanel), near Tournemine Camp (Lake Tournemine), and Chibougamau (Lake Caché).

A winter road was built in 2008 between Temiscamie, located at Lake Albanel about 210 km south of the Renard diamond mine site, and the Matoush Camp, located more than 95 km south of Lagopede Camp. Given that no permanent road has been completed to date and that the nearest airstrip is located more than 100 km from the Foxtrot property (Strateco or LG4 airport), the airstrip project was launched in order to transport personnel and certain equipment. The construction of an airstrip is required to ensure the safe transportation of mining personnel on a rotation basis of two weeks on-site and two weeks off.

Table 3.2.4 Comparison of North and South Access Alternatives

Criteria	North Alignment	South Alignment
Technical and scheduling	Forestry road access in 3 years	Multi-service road access in 2 years (good quality, primary access on part of the alignment) and permanent road in 4 years
Environmental	Higher GHG emissions due to the longer distances The impacts are yet to be determined (baseline sampling is required) but could likely be attenuated Possibility that the entire project could be delayed due to delays in environmental authorizations	Lower GHG emissions due to a more direct alignment The impacts could be reduced by mitigation measures and surveillance and monitoring programs The authorization process is well under way
Socio-economic	Less social acceptability Less favourable economic benefits for the region (Chibougamau and Mistissini) Does not favour regional development and minimally favours access to the territory Does not favour trapline access for the numerous Mistissini tallymen	More social acceptability More favourable economic benefits for the region (Chibougamau and Mistissini) Favours regional development with respect to mining, forestry, recreational tourism, and others Favours trapline access for the tallymen of the Mistissini community
Financial	Increase in transportation costs and significantly longer driving time Costs in the order of $37.4 to $40.5 M for a forestry road	Significant reduction in the transportation costs and driving time Costs in the order of $57.5 to $66.9 M for a forestry road or participation in the order of $44 M for the construction of a multi-service road by the MTQ

In addition to the road access alternatives described in the previous section, various air access alternatives were studied.

➢ *DESCRIPTION OF THE ALTERNATIVES*

The site for an airstrip in a northern region must comply with a certain number of environmental requirements such as the following:

- The topography of the land must be flat (1% maximum slope) and must not contain obstacles that could compromise the safety of take offs and landings (e.g.: cliffs or mountains in the path of the runway);
- The site must be located near the mine and the borrow pits;
- The ground must be geotechnically stable;

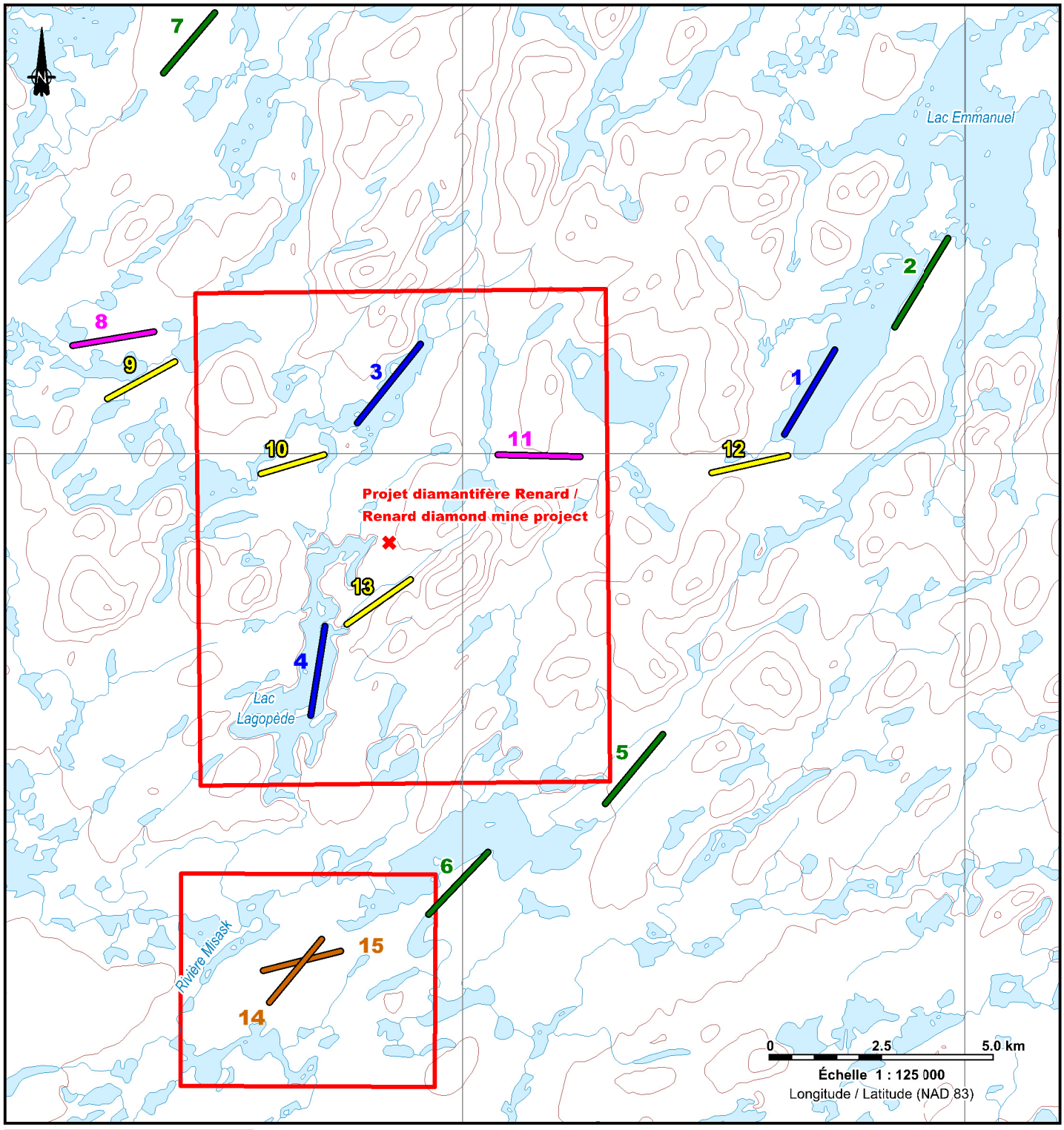
- The length of the runway must comply with the requirements of the aircraft and the civil aviation standards; and
- The positioning of the airstrip must take into account the direction of the prevailing winds.

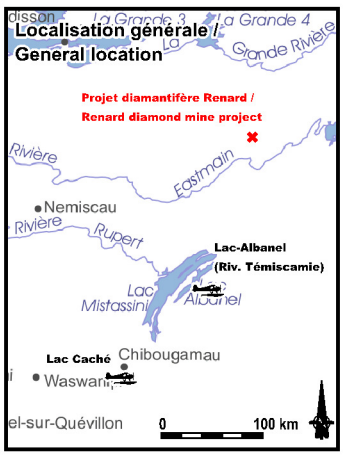
A preliminary assessment on site selection was completed in 2003 by Roche (Roche, 2003). At that time, an ice airstrip was required to meet the short-term needs for construction work that was to be carried out in winter 2004. Part of the assessment was also used to evaluate alternative airstrip sites for the medium and long terms. Thus, based on the needs at that time, seven alternatives were proposed (#1 to #7) to support Hercules 100 type airplanes, and two ice airstrips and two gravel airstrips for DHC-6 type airplanes (map 3.2.4). None of these options was selected as a permanent, operational framework.

Another assessment, completed by Roche in April 2004 (Roche, 2004), brought to light six new potential airstrip site alternatives. The new sites, numbered #8 to #13, were the subject of more detailed studies, and only alternatives #8, #10, and #11 were selected for further field investigation (Map 3.2.4). Following the field investigation, only alternatives #8 and #11 were retained.

In November 2004, the Stavibel Group was given the mandat to perform a field verification of potential sites #8 and #11. Based on these field verifications and the civil aviation technical requirements (clearance potential, presence of fog, environmental constraints related to access road development), neither of these two airstrips were selected. However, Stavibel identified two new potential sites located approximately 10 km south of Lagopede Camp (airstrips #14 and #15) (Map 3.2.4). At the same time, the alignment for the road linking the camp to sites #14 and #15 was evaluated on a technical, economic, and environmental basis.

In summary, Map 3.2.4 illustrates the 15 options that were studied for the location of the airstrip between 2003 and 2004. Of these 15 options, only options #14 and #15 were the subject of a strict comparative analysis, the others having been eliminated after detailed assessments due to important technical and environmental constraints.





Aire d'étude / Study area

Hydrobase / Hydrobase

Variantes de sites pour la piste d'atterrissage / Potential airstrip sites alternatives

Site terrestre identifié dans l'étude de Roche 2003 / Terrestrial site identified in Roche (2003) study.

Site terrestre identifié dans l'étude de Roche 2004 / Terrestrial site identified in Roche (2004) study.

Site terrestre identifié par Stavibel (2004) / Terrestrial site identified by Stavibel (2004)

Variante de piste d'hiver identifiée dans l'étude de Roche 2003 / Potential airstrip site alternative identified in Roche (2004)

Autres variantes de pistes (Forchemex) / Other alternative airstrip (Forchemex)

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Localisation des variantes de sites pour la piste d'atterrissage / Location of the potential airstrip site alternatives

ROCHE

Carte de base / Base Map : RNCan, 250k, 2010
Fichier / File : 61470_EIES_Pistes_111220.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.4

- *COMPARATIVE ANALYSIS OF ALTERNATIVES #14 AND #15*

The two sites that offered the best potential in light of Stavibel's assessment (2004) were sites #14 and #15. These two sites are located near the Route 167 extension alignment. Thus, it was necessary to coordinate the process of the site selection with the Route 167 extension impact assessment team (Roche, 2010). This teamwork resulted in a slight modification of the road alignment to be made to accommodate the respective needs of the two projects.

The analysis of the #14 and #15 alternatives was based on technical, economic, and environmental criteria (Table 3.2.5).

The analysis compares the two sites to each other with the help of a decision matrix, known as a Pugh matrix, and identifies the most advantageous site (Table 3.2.5). The decision matrix analysis highlights the fact that alternative #14 is more advantageous with respect to the selected comparison criteria.

Table 3.2.5 Pugh Decision Matrix Used to Analyze Airstrip Alternatives #14 and #15

CAPEX (+/- 50%)	**0**	**0**
OPEX (+/- 50%)	**0**	**0**
Total Cost - NPV (+/- 50%)	**0**	**0**

	Evaluation Criteria		**BASE CASE Concept 1**		**Concept 2**	
Selection Criteria	**Priority**	**Rank**	**Alternative #14**		**Alternative #15**	
CAPEX (Including Closure Cost)	High	9	Same	0	Worse	-9
OPEX	High	9	Same	0	Same	0
NPV	High	9	Same	0	Worse	-9
Mean for category				0		-18
Weighted subtotal	**50%**			0		-9
Environmental - Impact on the Environment	High	9	Same	0	Worse	-9
Environmental - Long term risks (incl. Liability and Legal)	Moderate	6	Same	0	Same	0
Environmental - Biodiversity restauration	Moderate	6	Same	0	Same	0
Mean for category				0		-9
Weighted subtotal	**20%**			0		-1.8
Communities of Interest - Acceptance by interest groups	Low	3	Same	0	Same	0
Communities of Interest - Acceptance by First Nations	High	9	Same	0	Same	0
Mean for category				0		0
Weighted subtotal	**10%**			0		0
Regulations and Policies - Compliance with	High	9	Same	0	Same	0
Regulations and Policies - Degree of difficulty in obtaining approvals	High	9	Same	0	Better	9
Mean for category				0		9
Weighted subtotal	**10%**			0		0.9
Safety Risk - During Construction	High	9	Same	0	Same	0
Safety Risk - During Operation	High	9	Same	0	Better	9
Operability	Moderate	6	Same	0	Better	6
Constructability / Logistic - Difficulty	Moderate	6	Same	0	Worse	-6
Long term opportunity for future development	Moderate	6	Same	0	Same	0
Mean for category				0		9
Weighted subtotal	**10%**			0		0.9
Raw total				**0**		**-9**
Weighted total	**100%**			**0**		**-9**

Fill Matrix

Better = Better option than Base Case

Same = Same evaluation than Base Case

Worse = Poorer option than Base Case

3.2.3 Mining Facility and Infrastructure Layout

The presence of deposits just northeast of Lake Lagopede implies setting up infrastructures and mining facilities near Lagoped lake while taking into account various constraints. These constraints include notably the topography, the hydrographical network, geotechnically unstable areas, wetlands, the presence of sensitive wildlife habitats, technical mining parameters, the areas used by the Cree, health, safety and risk management considerations, etc. These constraints, combined with the desire to limit the project's environmental footprint on the natural environment as much as possible and to optimize operations, considerably reduces the number of sites where these infrastructures can be installed.

The retained general layout of the facilities (Map 3.2.5; for an enlarged version of this map, see Volume 3) takes into account all the above mentioned constraints. In addition, the layout is designed with the facilities as close together as possible while maintaining a safe distance between the different buildings of the mining complex.

Operational efficiency is the goal of all aspects of the mine layout. The different layout designs for the infrastructures and facilities that were considered ultimately allowed: to limit the facilities footprint, to limit the displacement time between facilities, and to optimize operations. Also, this layout equally improves the security of the various sites and allows cost savings by limiting infrastructure sprawl, required landscaping, and construction and operation costs.

The reduction of the land footprint is made possible notably by an accommodation complex (5120) with a two-story dormitory, thereby reducing the total number of required buildings and generating scale and network economies. Encroachment on the natural environment is also reduced in the airstrip area by repositioning the main gate and the security control post inside the reception building (5110). In the same vein, the garages (5150, 5155), the workshops (5160), and the warehouses (5165) were grouped together as were the offices (5175) and the dryer and laundromat (5180). The explosives storage area were grouped in the same sub-watershed. This sub-watershed was already used for bulk sampling and will ultimately be used for development of the R-65 deposit.

The reduced land footprint of the various buildings also means a reduction in worker itineraries, be they inside or outside the buildings. The strategic positioning of the work areas was equally designed in a way to maximize worker safety around the buildings, at vehicle access points, and while they move about the site. Some access roads were shortened. Platforms were harmonized with the natural topography, thereby reducing the amount of cut and fill needed during their construction.

The selection of the processed kimberlite confinement area was based on the results of an analysis of alternatives that considered five potential sites evaluated on 18 environmental indicators, six social indicators, and nine technical-economic indicators (see Section 3.2.4.5 for the analysis of the alternatives). The selected site represents the best choice based on these criteria and was equally favoured by the M11 area tallymen since the site is located a good distance from their moose hunting grounds and ski-doo trails. In spite of the presence of numerous waterways within the Renard Project's

assessment area, the confinement area was positioned in order to prevent encroachment upon the fish habitat and to limit the number of sub-watersheds affected. In addition, the confinement area was designed to be geotechnically stable while, at the same time, minimizing its area and limiting its maximum height to keep it in harmony with the surrounding hills. Its location above the sub-watershed minimizes its impact on the sub-watershed.

The waste rock and overburden stockpiles were intentionally located near the pits in order to limit the transport of material and to facilitate its reuse. The two stockpiles were optimized in a way that limits their footprint while maintaining acceptable heights for the area.

The alignments selected for the secondary roads are designed to ensure fluid and safe traffic as well as the safety of the workers while decreasing the risk of contaminating the natural environment. In fact, the presence of low-permeability till throughout a large part of the mine site reduces the groundwater vulnerability to contamination should an accidental spill occur.

Finally, the mining and processing facilities were positioned as a function of the evolution of the technical needs of the project and of the mine plan. The processing plant (3110) and the primary crusher (3210) were repositioned to better situate them within the general layout of the site.

Considering the large volume of mine and runoff water to manage on the industrial site, it is necessary to find a site with an area large enough for the sedimentation ponds. Once the mining facilities are in place, there is little space available for these ponds. Therefore, it was decided to place the sedimentation ponds and a water treatment plant at a site that was already cleared and excavated to the bedrock (R-65 deposit area). And since the R-65 deposit will be mined with the open pit mine method, it will be possible to use an actual mining area to manage water without requiring additional clearing and excavation work.

The mining of the R-4 and R-9 deposits was initially planned as an open pit mine and with a 630 m dyke in Lake Lagopede. However, following a site alternative assessment for the dyke, it was decided to mine these deposits with underground methods, thereby reducing the project footprint on land by 3.3 ha or 1.4% and on water by 17.8 ha or 7.6%. This decision eliminated an encroachment of approximately 100,000 m² on Lake Lagopede and avoided having to pump approximately 334,000 m³ of lake water in order to build the dyke.

3.2.4 Mining Method Alternatives

3.2.4.1 Secondary mining road alternatives

The on-site secondary road network was designed to connect the different mining facilities to the extraction zones, the waste rock confinement and storage zones as well as to the accommodation complex and the mine service and support facilities. First, the infrastructures were positioned based on the parameters of the operations and mining techniques. Then, the environmental constraints were

considered such as the topography, the hydrographical network, the wetlands, and the sensitive wildlife habitats or the geotechnically unstable zones.

The general layout of the mine facilities went through several iterations and optimizations, with careful consideration for the above mentioned constraints. The layout was also designed to create the smallest and safest footprint possible, respecting the required distances between the various buildings of the mining complex.

Operational efficiency was the goal of all aspects of the mine layout, including the road network in order to limit the time to move in and around the facilities reduce greenhouse gases emissions, and optimize operations.

Once the general layout of the site was finalized, various alignments for the mining roads could be studied. Figures 3.2.2, 3.2.2, and 3.2.4 illustrate the evolution of the alignments according to the layout of the mining facilities. The secondary roads or mining roads are identified in grey and connect the different site facilities.

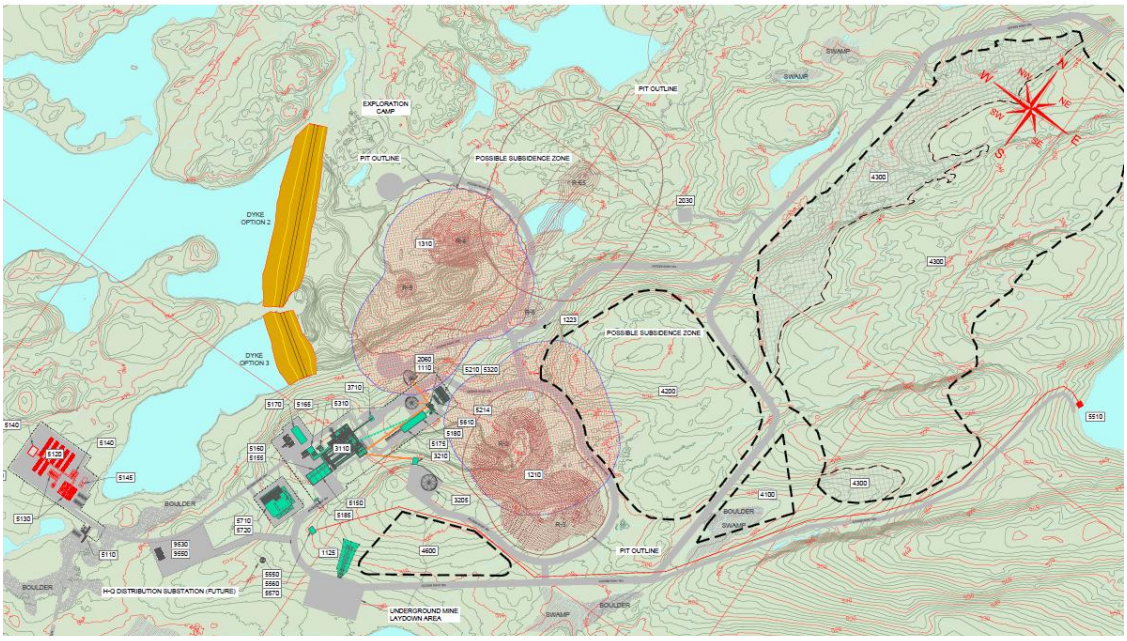


Figure 3.2.2 Layout of Facilities and Secondary Roadways as of February 10, 2011

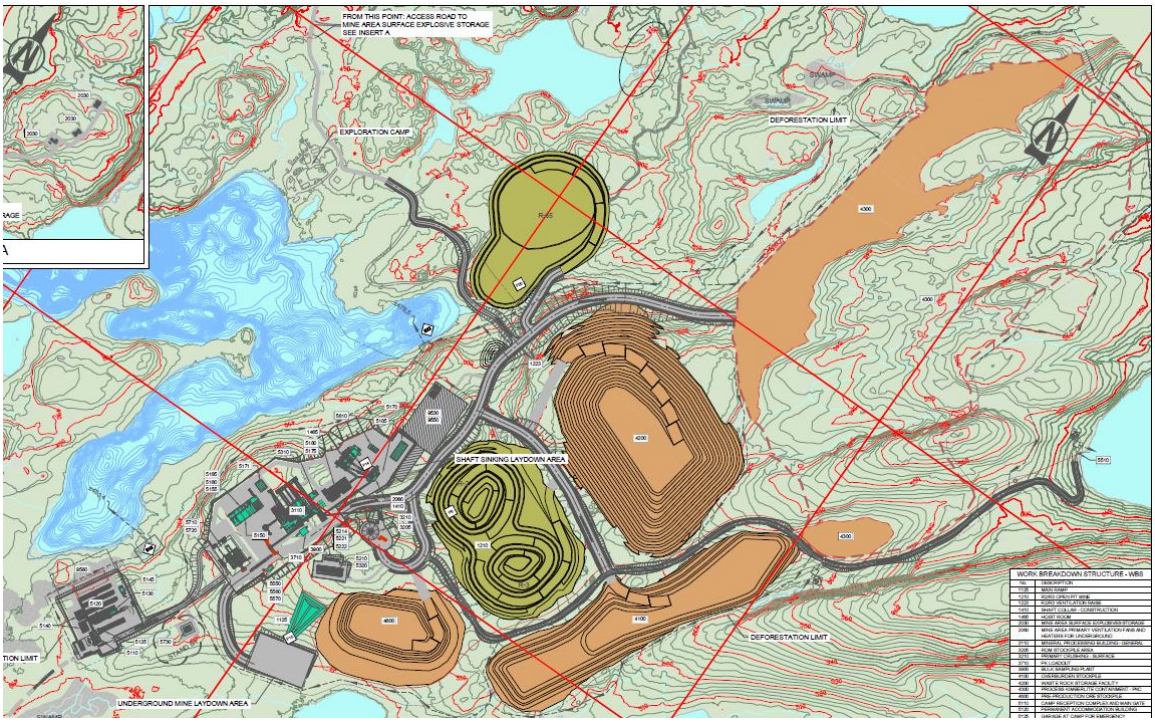


Figure 3.2.3 Layout of Facilities and Secondary Roadways as of June 14, 2011

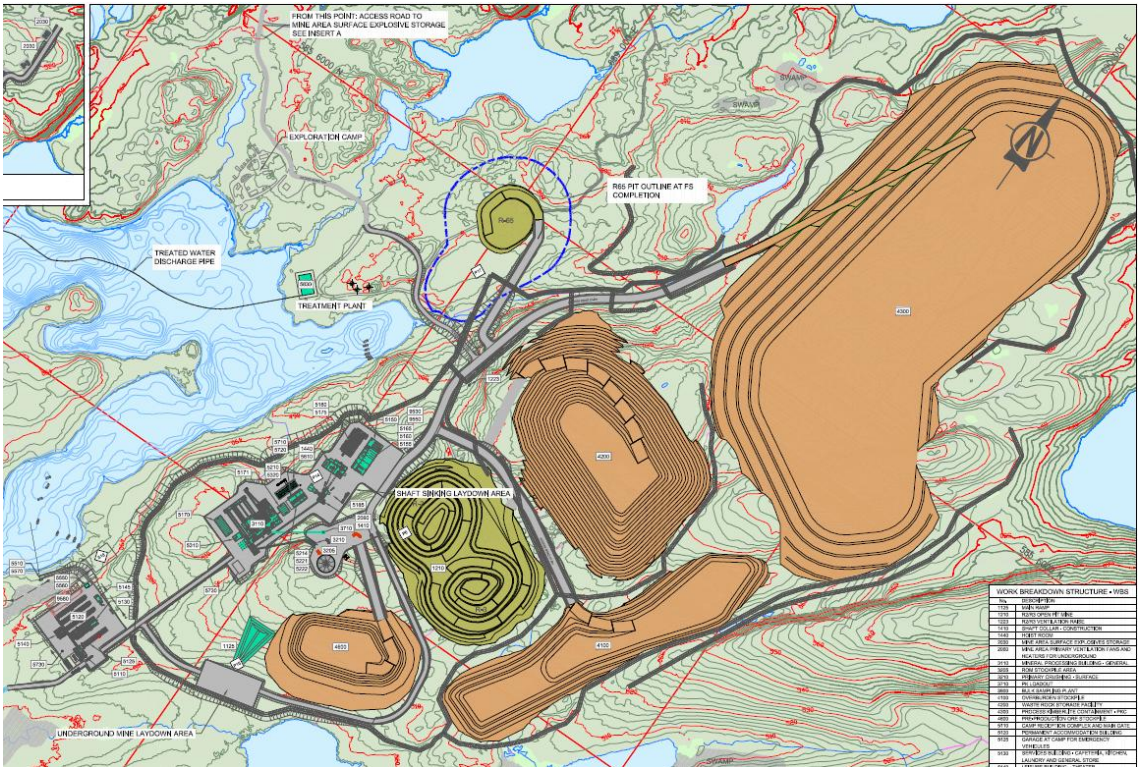


Figure 3.2.4 Layout of Facilities and Secondary Roadways as of October 26, 2011

➢ *SELECTION OF THE ALTERNATIVE RETAINED*

The total length of the roadways is reduced by grouping the garages, workshops, and warehouses under the same roof. The waste rock stockpile and the overburden stockpile are positioned near the pits in order to limit the length of the roadways. Based on the information available on the receiving environment, care was taken to distance the alignments from streams, wetlands, and sensitive wildlife habitats. In general, the roads run alongside the mining facilities thereby reducing the general land footprint. In most cases, the access roads to the facilities are single service but two-way. The selected road alignments are designed to ensure a fluid and safe traffic and, thus, the security of the workers.

The total length of the road network connecting the mining facilities is approximately 2.2 km, excluding MTQ's main access road (Route 167). The road network gives access to the different mining facilities such as the open pits, the underground access ramps, the explosives storage area, the crushing plant, the kimberlite processing plant, the processed kimberlite confinement area, the waste rock and overburden stockpiles, the ore stockpile, the water treatment plants, the accommodation and services complex, etc.

The network consists of three types of roads:

- 15 m heavy-load roads with 1.5 m shoulder on each side;
- 7 m light vehicle roads with 1.5 m shoulder on each side;
- 6 m access roads with no shoulder.

The heavy-load roads were built for Caterpillar 775F trucks. The pit access ramps are 25 m in width with security berms on each side.

3.2.4.2 Underground mining alternatives

The assisted block caving (ABC) method was one of the first extraction methods to be considered to mine the R-2 and R-4 deposits. To improve this method, development levels at 100 m intervals were incorporated into the design model.

With the ABC extraction method, the kimberlite pipe is surrounded by a haul road that the haul trucks use to get to the main shaft. Cemented extraction drifts pass through the kimberlitic mass. A secondary egress is drilled at the end of the drifts that connects to the hoppers (funnels) situated on the ceiling of the drifts. As the dynamiting occurs and under pressure from adjacent rock, the rock collapses and fall into the chute via the hoppers. After a detailed study of the geomechanical behaviour of the host rock, it was determined that the kimberlite pipes could not withstand this technique of progressive caving.

An additional assessment was then completed to select and compare various underground extraction methods: blasthole shrinkage (BHS, Figure 3.2.5), sublevel retreat (SLR, Figure 3.2.6), longhole panel mining with backfill (LHP, Figure 3.2.7), and blasthole shrinkage with pillars (BHSP, Figure 3.2.8).

The optimization exercise was completed based on the characteristics of the Renard 2 deposit. The comparison of the alternatives considered several key performance factors: dilution, recovery, grade/tonnage, production costs, risks, etc.

The LHP and BHSP methods scored the lowest. The mechanically viable methods (BHS and SLR) scored the highest. After analysis, the blasthole shrinkage method was chosen because it proved to be the most economically profitable and simpler for the workers. Another key advantage of this method is the possibility to extract the ore before open-pit mining is completed.

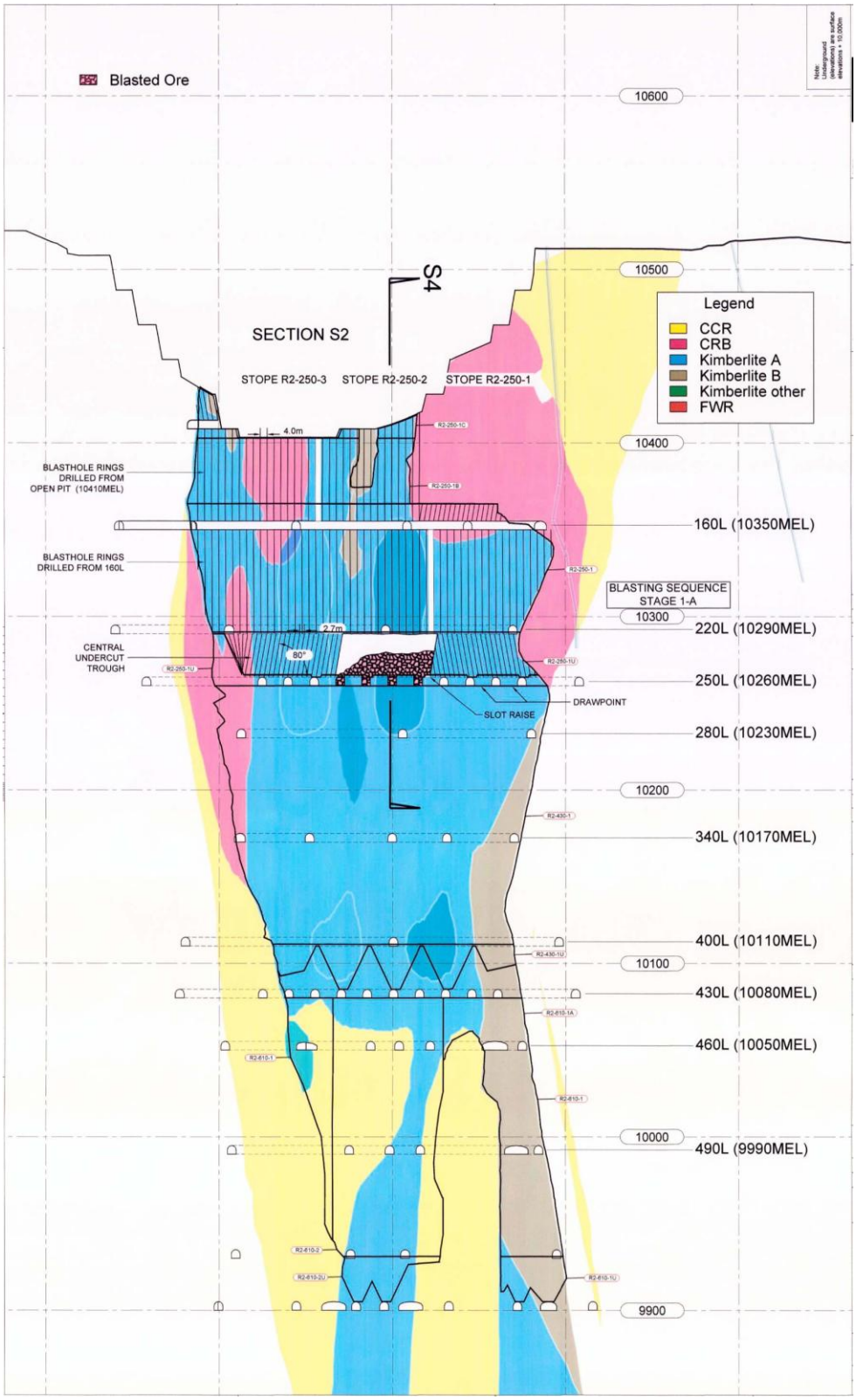


Figure 3.2.5 Blasthole Shrinkage Method (BHS)

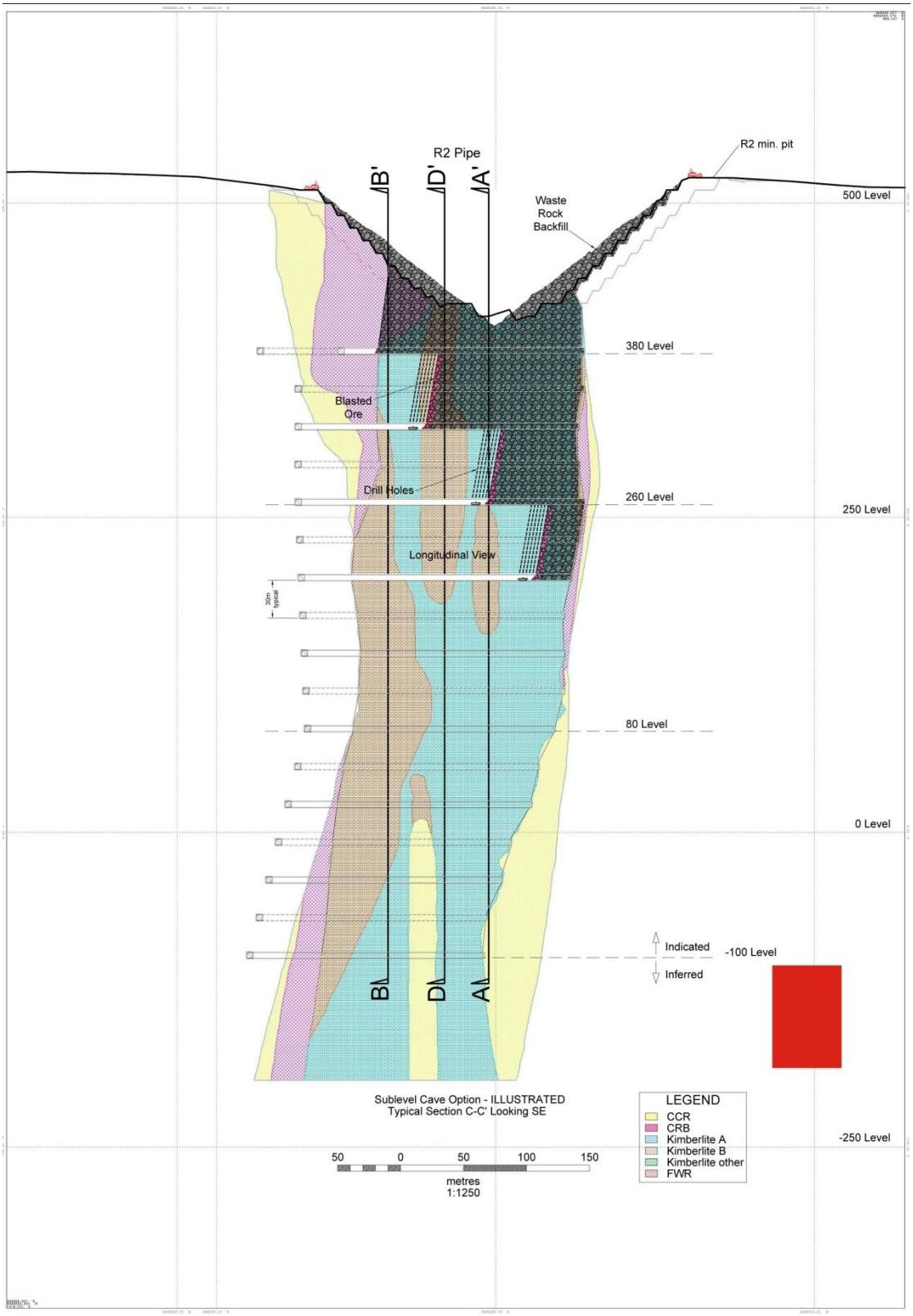


Figure 3.2.6 Sublevel Retreat Method (SLR)

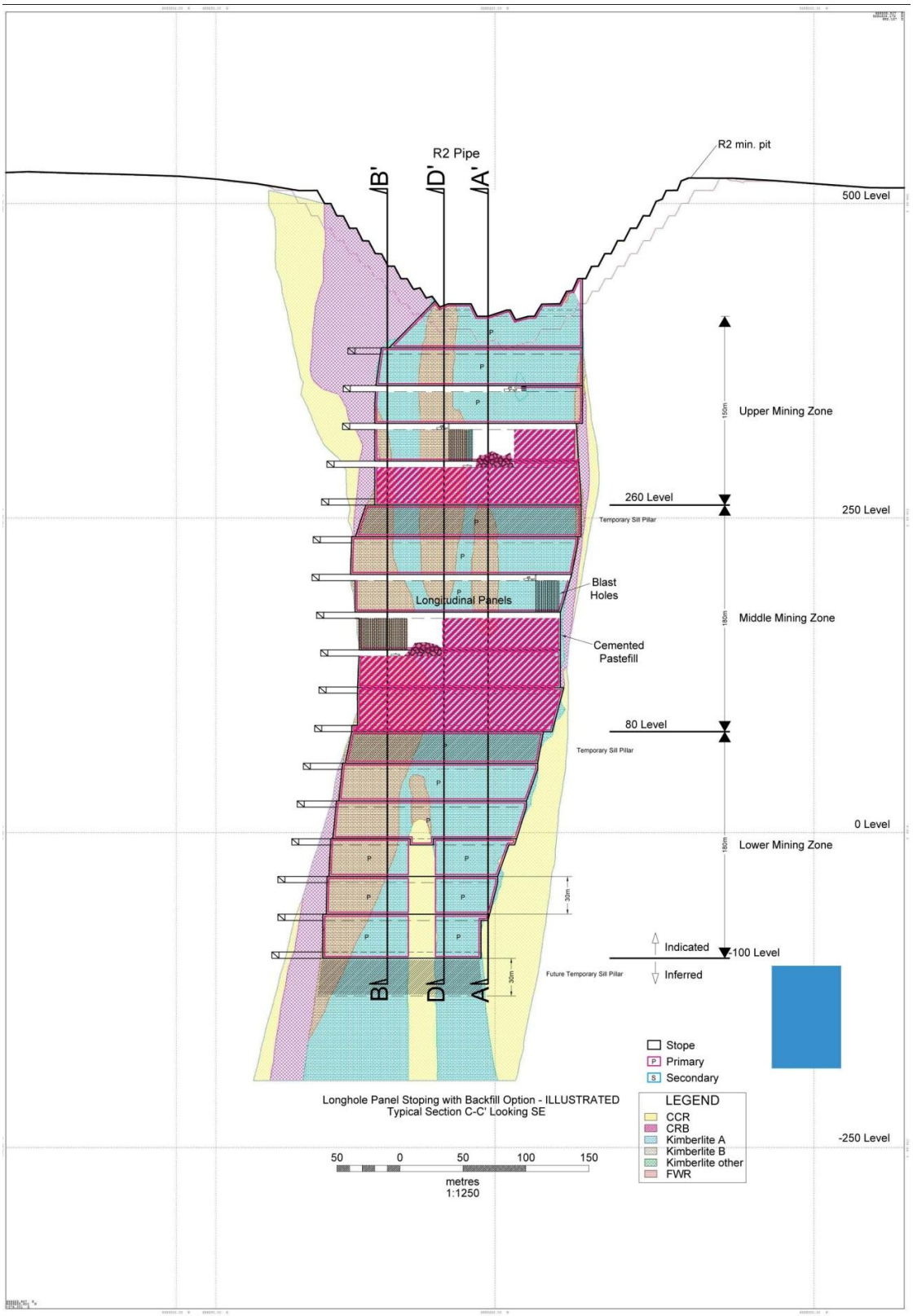


Figure 3.2.7 Longhole Panel Mining with Backfill (LHP)

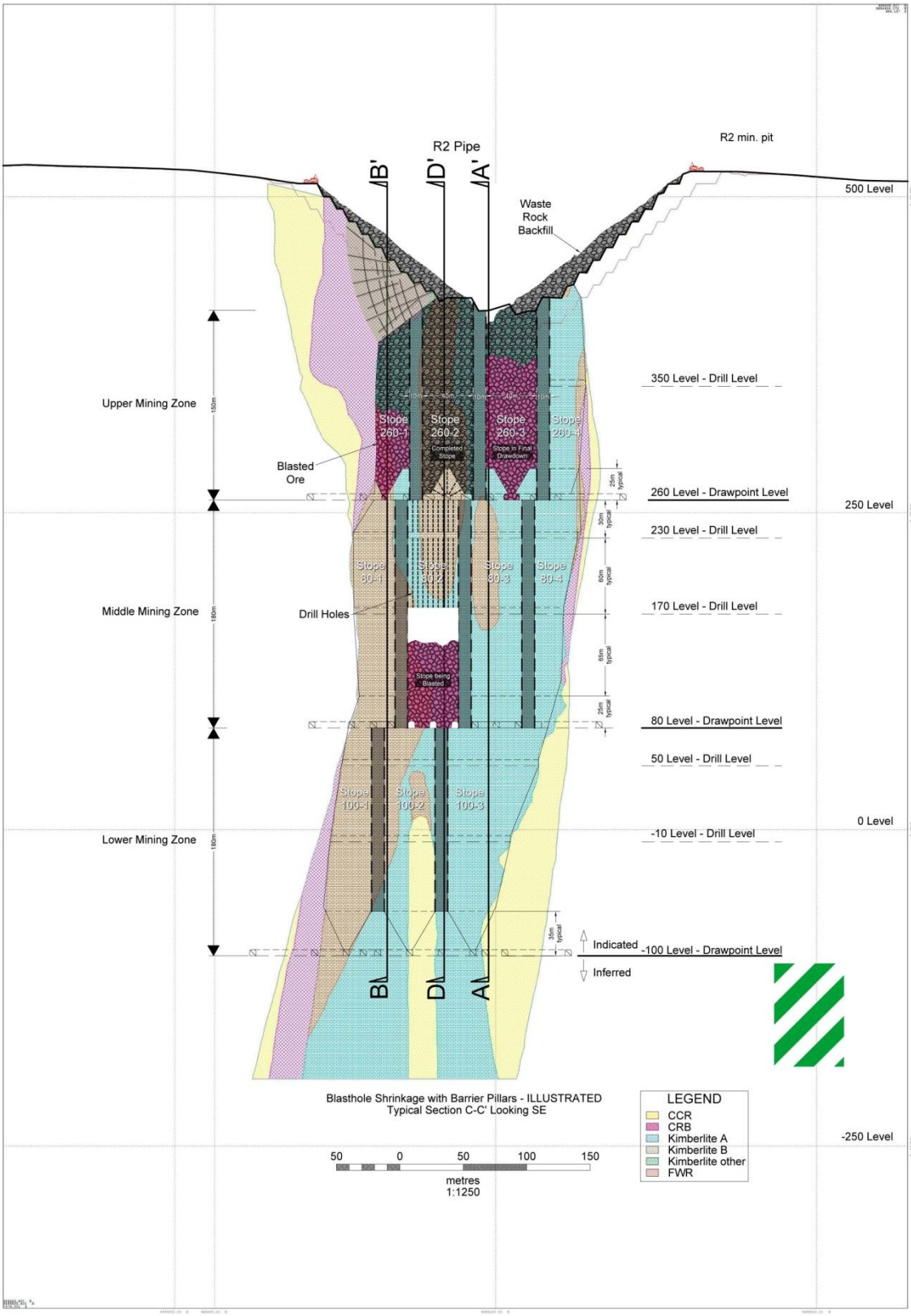


Figure 3.2.8 Blasthole Shrinkage with Pillars (BHSP)

3.2.4.3 Mineral processing alternatives

The process of extracting the diamonds from the kimberlite is essentially a physical process that involves crushing the ore and using gravity to recover the heavier diamonds from the ore. In the industry, this process generally follows the same main steps:

- Primary crushing of the ore;
- Sieving and screening;
- Washing to disaggregate mud and ore;
- Diamond concentration using a variety of methods (e.g.: rotary scrubber, vibrating screens, dense media separation);
- Diamond sorting and recovery with grease tables or x-ray separators.

A few minor adjustments to the general diamond extraction process were made for the Renard Project, and an analysis of alternatives is not required at this point. The mineral processing details can be found in Section 3.6.1.

3.2.4.4 Water management alternatives

➢ *DOMESTIC WASTEWATER TREATMENT ALTERNATIVES*

During the construction phase, approximately 500 workers will be on the mine site while, during the operation phase, 230 workers will be on site; therefore, a domestic wastewater treatment system is required.

The analysis of alternatives involved comparing two treatment systems: facultative aerated lagoons and rotating biological contactor (RBC) (bio-discs). The results of the alternative analysis are presented in Table 3.2.6.

The facultative aerated lagoons are ponds in which the oxygenation is produced by submerged diffused aerators or surface aerators (MDDEP, 2010). RBCs, or bio-discs, are part of a mechanical biological treatment system where the rotating disks are covered with a micro-organic biofilm.

The main constraint of the selected treatment system is related to the fact that the project is located in an isolated region. Aerated lagoon treatment is more advantageous because of its simplicity and because it requires less equipment compared to a bio-disc system (pumps, disks, ultraviolet disinfection system), which also decreases the operational and maintenance costs. Another advantage of aerated ponds resides in their capacity to manage organic and hydraulic loads at peak times due to longer retention times. The management of sludge resulting from the aerated pond treatment facilitates the operation (less frequent sludge removal), and the volume of sludge generated is less due to a more efficient anaerobic degradation. However, the RBC system offers better efficiency than aerated ponds during the winter even though it requires regular maintenance to remain efficient. Nonetheless, aerated ponds are designed to respect effluent standards throughout the year.

Based on the analysis, the facultative aerated lagoon treatment system is the most advantageous of the two systems and was, therefore, selected.

Table 3.2.6 Domestic Wastewater Treatment System Alternative Analysis

Evaluation Criteria for the Alternatives	Criteria Weighting	Criteria Value Based on Class		Result for Each Alternative	
		Class	Weighting (pts)	Facultative Aerated Lagoons	RBC (bio-discs)
Technical Feasibility					
Treatment system operation and maintenance	2.5	Complex	1	Easy	Complex
		Easy	2	5	2.5
Overload efficiency during peak periods	2.5	Low	1	High	Low
		High	2	5	2.5
Sludge management	2.5	Complex	1	Complex	Easy
		Easy	2	5	2.5
Treatment efficiency during winter	2.5	Low/Average	1	Low/Average	High
		High	2	2.5	5
Environmental Aspects					
Respect of effluent standards	5	No	1	Yes	Yes
		Yes	2	**10**	**10**
Encroachment on the territory	5	Moderate	1	Moderate	Weak
		Weak	2	**5**	**10**
Socio-economic Aspects					
Construction and operation costs	10	Moderate	1	Low	Moderate
		Low	2	**20**	**10**
			Total	**52.5**	**42.5**

- *SITE ALTERNATIVES FOR THE DOMESTIC WASTEWATER TREATMENT PLANT AND THE FINAL EFFLUENT DISCHARGE POINT*

The location of the domestic wastewater treatment plant and the final effluent discharge point were selected based on various technical, environmental (physical, biological), and human criteria that are described in the following section.

The location of the wastewater treatment plant is directly related to the location of the effluent discharge point. In fact, the presence of the deposit in the upper watershed means that the waterways that could have been used for the treated effluent discharge point have a limited or intermittent flow. For this reason, it was decided to place the domestic wastewater treatment plant near Lake Lagopede (32302), the largest lake in the study area. To provide a more in-depth analysis of the alternatives, a certain number of potential discharge points were identified in Lake Lagopede at places located downstream from the mine infrastructures and at a reasonable distance from the selected potential treatment plant sites. The discharge points were selected based on consideration criteria for the installation of an outfall discharge point in the following document: *Calculation and Interpretation of Effluent Discharge*

Objectives for Contaminants in the Aquatic Environment (MDDEP, 2007). These criteria intend to favour sites that are conducive to effluent dispersion and have sufficient depth. As such, recessed sites in shallow bays were avoided.

Domestic wastewater treatment plant location

To limit energy consumption, greenhouse gases emissions, and the risk of a pumping station outage, a wastewater treatment plant located at an altitude of approximately 450 m should be given priority; this would allow the domestic water from the accommodation complex to be evacuated by gravity. The use of gravity would also significantly reduce the operation and maintenance costs. Three potential sites were identified for the location of the domestic wastewater treatment plant (Map 3.2.6). Figure 3.2.9 illustrates the topographical profile between the accommodation complex and the three domestic wastewater treatment plant alternatives. This profile clearly illustrates to what extent the topography represents a constraint to the flow of the domestic wastewater towards the treatment plant.

Site A is located nearest to the accommodation complex. A main of approximately 900 m would be necessary to route the wastewater from the accommodation and services complex to the domestic water treatment plant (A). In this case, the treated effluent would be discharged at point #4 (Table 3.2.7).

Site B is located approximately 1.1 km from the accommodation complex. For site B, two potential discharge points are considered for the effluent (#1 and #5) (Table 3.2.7).

Site C is located approximately 1.3 km from the accommodation complex (Table 3.2.7). For site C, two alternative discharge points are considered (#2 and #3).

In order to select the best treatment plant and discharge point sites combination, it is necessary to consider other factors related to the environmental surroundings and use of the lake.

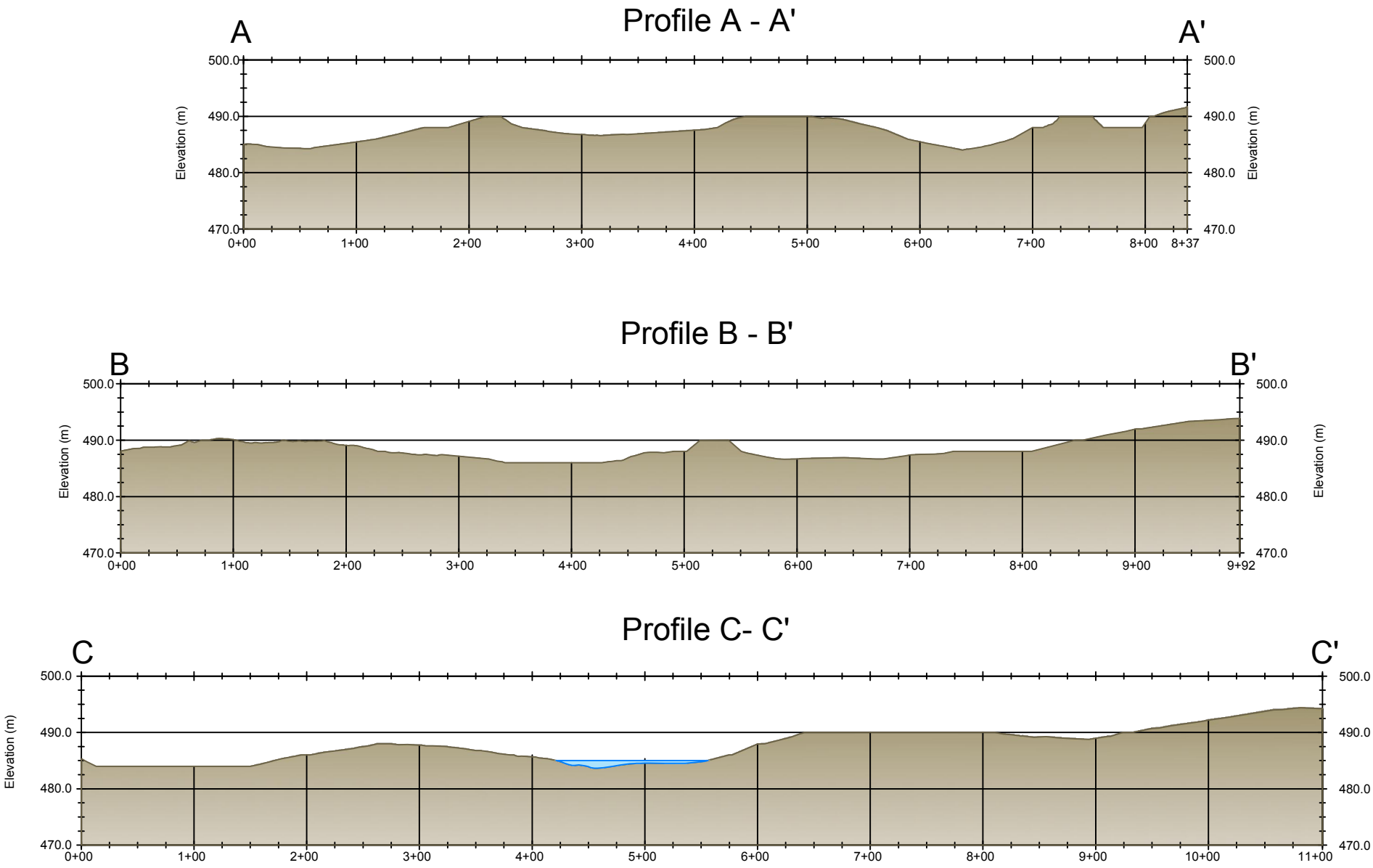


Figure 3.2.9
Topographical Profile Between the Accommodation Complex
and the Domestic Wastewater Treatment Plant

Table 3.2.7 Characteristics of the Site Alternatives for the Domestic Wastewater Treatment Plant

Alternatives Evaluation Criteria	Treated Effluent Discharge Point Alternative	Domestic Wastewater Treatment Plant Alternative		
		A	B	C
Length of effluent pipeline from the water treatment plant to the discharge point (m)	1	630	**490**	760
	2	1 240	450	**160**
	3	1 050	300	**240**
	4	**132**	890	1 260
	5	840	**360**	530
Length of domestic wastewater pipeline from the accommodation complex to the water treatment plant (m)		700	1 100	1 300
Altitude of the treatment plant (m)		484	488	476
Method to distribute the wastewater to the domestic wastewater treatment plant	Maximum change in altitude over the route (m)	488	490	498
	Pump/Gravity	Pump	Pump	Pump

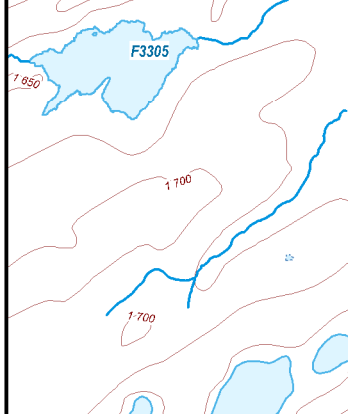
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688 000 m.E
690 000 m.E
5 856 000 m.N
5 854 000 m.N
5 852 000 m.N
5 850 000 m.N

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F3295
F3296
F3303
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R-7
R-1
R-65
R-4
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R-9
R-2
R-3
F3302
F3301
F2607
Baie Nord
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Secteur Sud
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Baie Est
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Lac Lagopède
167

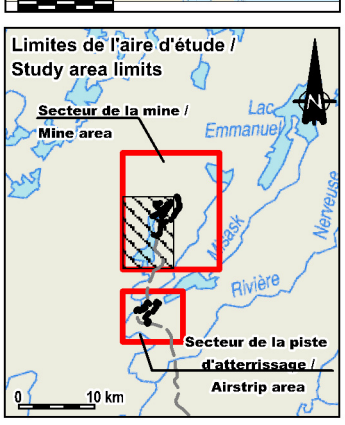
0 500 1000 m
Échelle / Scale 1 : 25 000
UTM, zone 18 (NAD83)
Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

0 250 m

Localisation générale / General location



Limites de l'aire d'étude / Study area limits



Éléments / Components

- R-x — Identification du gisement / Deposit identification
- F3293 — Numéro d'identifiant de lac CEHQ / CEHQ lake ID number
- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
- Écoulement souterrain / Underground flow
- 2.5 — Courbe bathymétrique (profondeur en mètres) / Bathymetric profile (depth in meter)
- Emprise du projet / Project footprint (26/10/2011)
- Fosse d'extraction à ciel ouvert / Open pit
- R-x — Autres ressources minérales / Other mineral resources
- Végétation aquatique / Aquatic vegetation
- Blocs / Boulder
- Zone de potentiel archéologique / Area of archaeological potential
- Point de rejet de l'effluent final / Effluent discharge points
- Station de traitement des eaux usées domestiques / Wastewater treatment plant
- Ancien site de campement / Old camp site
- Prise d'eau potable projetée / Future water intake
- Prise d'eau potable actuelle / Current water intake
- Conduite / Main
- Aire de fraie / Spawning area
- Site de pêche au filet / Gillnet fishing site
- Ancien site de pêche au filet / Former gillnet fishing site

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Variantes de sites pour l'usine de traitement des eaux usées domestiques et le point de rejet de l'effluent final / Site alternatives for the domestic wastewater treatment plant and the final effluent discharge point

ROCHE

Carte de base : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier : 61470_EIES_Domestique_111213.WOR
Décembre 2011 / December 2011

Carte / Map 3.2.6

Site alternatives for the final domestic effluent discharge point

The location of the final treated effluent discharge point in Lake Lagopede must take into account several physical (lake morphology, depth, prevailing wind direction, etc.), biological (fish habitat, migration routes) and human (fishing sites, water intake, etc.) criteria. The five alternatives for the treated effluent discharge point were evaluated based on 18 criteria (Table 3.2.8). The weighting of criteria was done based on Saaty's multi-criteria hierarchy method (MHM) (1980) of analysis. For each class of criteria (technical, physical, biological, and human) the total weighting is equal to 1.

Alternative 1 description (treatment plant B, discharge point 1)

Site 1 is favourable to the dispersion of the treated effluent into Lake Lagopede because, downstream in the main channel, the water is deep (6 m) throughout a large portion of the lake. This site is equally characterized by a widening of the lake where a shallow depth (1 m) has been observed. Water coming from waterways to the north must go through this passage and drain towards the south where the lake outlet is located. The narrowing observed upstream from the site is likely to increase current velocity of the current and thereby better disperse the treated effluent.

A Cree fishing area and a potential spawning ground were noted (Map 3.2.6) 150 m north of discharge point #1. However, the placement of the treated effluent discharge point would not have a direct impact on the two areas located upstream, given that the dispersion of the treated effluent would normally occur towards the south of the lake and not towards the north due to the direction the lake flows and the prevailing winds. Site 1 appears *a priori* to be an excellent choice; however, the discharge point is located the furthest from the domestic wastewater treatment plant and, in addition, the treated effluent plume dispersion could influence the movement of the fish through this mandatory lake passage.

Alternative 2 description (treatment plant C, discharge point 2)

Site 2 is located close to alternative treatment plant C. The absence of a tributary close to the discharge point does not improve the dispersion and dilution of the final effluent. In addition, the shallow water (1 m) will limit dispersion, especially in the winter when the water will be shallow and covered with ice that will act as a barrier to treated effluent dispersion. The advantage of this site stems from the fact that it is not located near any areas used by the Cree for fishing and camping. However, the remains of an old Cree camp were found near the site, which could potentially represent a constraint when the treatment plant is being built. Discharge point #2 for the treated effluent seems to be a good choice *a priori*; however, the shallow water in the area is the limiting parameter for this alternative.

Alternative 3 description (treatment plant C, discharge point #3)

Discharge point #3 is favourable to the dispersion of the treated effluent into Lake Lagopede because it is located on the periphery of a pool that has a maximum depth of approximately 8 m. However, the direction of the prevailing winds favours pushing the surface water towards the shore less than 50 m from the treated effluent discharge point. The main tributary in this area is the F3300V stream that flows into Baie Est (East Bay); the mouth of the stream is close to discharge point #3. The stream's current could favour the dispersion and dilution of the treated effluent. Site #3 is the best alternative because it has all the advantages of discharge point #2 in addition to being deeper, which leaves a larger amount of water for treated effluent dispersion and dilution.

Alternative 4 description (treatment plant A, discharge point #4)

In spite of a favourable site in the lake's main channel, discharge point #4 is located in a section of the lake problematic in respect to several of the analysis criteria. To its advantage, the site is located in a deep part of the lake (10 m); however, it is also located near a shoal of approximately 1 m situated about 600 m to the south. This shoal could cause the effluent to rise quickly to the surface in the shallow area. Also, the narrowing of the lake at this point and the shallow area of water could be a mandatory passage for fish moving north to south in the lake. The direction of the prevailing winds with respect to the discharge point in this area favours pushing the surface water towards the east shore. A Cree fishing area and a spawning site are located near discharge point #4. This discharge point alternative does not comply with the desired criteria for the outfall discharge point in Lake Lagopede.

Alternative 5 description (treatment plant C, discharge point #5

Discharge point #5 favours the dispersion of the treated effluent into Lake Lagopede because it is located on the periphery of a pool with a maximum depth of 5 m. However, the direction of the prevailing winds favours pushing the surface water towards the shore located approximately 30 m to the east of the discharge point. The site is not too far (250 m) from treatment plant C, which reduces the length of the underwater main.

Table 3.2.8 Assessment Results of the Site Alternatives for the Final Effluent Discharge Point of Treated Domestic Wastewater

Alternatives Evaluation criteria	Criteria weighting [2]	Position of the discharge point with respect to the criteria		Value for a criterion parameter		Results for each evaluation criterion for the various plant site alternatives and treated wastewater discharge points				
		Direction	Score (pts)	Class	Score (pts)	B	C		A	B
						1	2	3	4	5
Technical Criteria										
Distance between the discharge point and the shore	0.11			>300 m	1	245 m	41 m	275 m	29 m	37 m
				150 ≥ 300 m	2	**0.21**	**0.32**	**0.21**	**0.32**	**0.32**
				< 150 m	3					
Length of the wastewater pipeline between the accommodation complex and the treatment plant	0.47			>1 000 m	1	1100 m	1300 m	1300 m	900 m	1100 m
				500 ≥ 1 000 m	2	**0.47**	**0.47**	**0.47**	**0.94**	**0.47**
				< 500 m	3					
Length of the pipeline between the treatment plant and the final treated effluent discharge point	0.11			>300 m	1	490 m	160 m	240 m	132 m	360 m
				150 ≥ 300 m	2	**0.11**	**0.22**	**0.22**	**0.33**	**0.11**
				< 150 m	3					
Method to distribute the wastewater to the treatment plant	0.31			Pump	1	Gravity	Pump	Pump	Gravity	Gravity
				Gravity	2	**0.6192**	**0.3096**	**0.3096**	**0.6192**	**0.6192**
					Sub-total	**1.42**	**1.33**	**1.22**	**2.22**	**1.52**
Physical Criteria										
Maximum water depth near the discharge point	0.20			<3 m	1	5 m	1 m	7,5 m	7,5 m	5 m
				3 ≥ 6 m	2	**0.40**	**0.20**	**0.60**	**0.60**	**0.40**
				> 6 m	3					
Thermocline presence (summer)	0.11			No	1	Yes	Yes	Yes	Yes	Yes
				Yes	2	**0.2256**	**0.1128**	**0.2256**	**0.2256**	**0.2256**
Distance of a tributary that can favour the dispersion and diliution of the treated effluent	0.06			< 500 m	1	400 m	600 m	600 m	300 m	400 m
				500 ≥ 1000 m	2	**0.06**	**0.11**	**0.11**	**0.06**	**0.06**
				> 1000 m	3					
Environmental characteristics: dissolved oxygen on the surface (% O2)	0.17			< 90 %	1	88.6%	95.7%	97.5%	90.3%	86.8%
				> 90 %	2	**0.1703**	**0.3406**	**0.3406**	**0.3406**	**0.1703**
Type of substrate	0.13			Unconsolidated sediment (Om)	1	Om	Om	Om	Om	Om
				Rocks (potential fraying substrate for whitefish)	2	**0.1338**	**0.1338**	**0.1338**	**0.1338**	**0.1338**
				Sand (potential fraying substrate for whitefish)	2					
				Gravel (potential fraying substrate for brook trout and whitefish)	3					
				Blocks and large blocks (potential fraying substrate for lake trout and whitefish)	3					
Distance from an aquatic grass bed	0.05			< 0.5km	1	0.5 ≥ 1km	< 0.5km	< 0.5km	0.5 ≥ 1km	0.5 ≥ 1km
				0.5 ≥ 1km	2	**0.0988**	**0**	**0**	**0.0988**	**0.0988**
				>1km	3					
Current in the area	0.18			Weak (+ to ++)	1	+++++	+	+++	++++	++
				Moderate (+++ to ++++)	2	**0.5451**	**0.1817**	**0.3634**	**0.3634**	**0.1817**
				Strong (+++++)	3					
Exposure to prevailing winds (west)	0.10			Downwash	1	2	1	1	1	1
				Dispersion	2	**0.19**	**0.10**	**0.10**	**0.10**	**0.10**
					Sub-total	**1.82**	**1.18**	**1.87**	**1.91**	**1.36**
Biological Criteria										
Distance from a known spawning ground	0.54	Upstream	1	< 500 m	1	495 m	1200 m	1100 m	200 m	700 m
				500 m ≥ 1000 m	2	**1.07**	**3.22**	**3.22**	**0.54**	**2.14**
		Downstream	2	>1000 m	3					
Distance from a known rearing area	0.30	Upstream	1	< 500 m	1	500 ≥ 1000 m	>1000 m	>1000 m	< 500 m	500 ≥ 1000 m
				500 ≥ 1000 m	2	**1.2036**	**1.8054**	**1.8054**	**0.3009**	**1.2036**
		Downstream	2	>1000 m	3					
Distance from a narrowing in the lake that could consititute a fish migration route	0.10			< 500 m	1	< 500 m	< 500 m	< 500 m	500 ≥ 1000 m	< 500 m
				500 ≥ 1000 m	2	**0.1007**	**0.1007**	**0.1007**	**0.2014**	**0.1007**
				>1000 m	3					
Presence of structural elements that could serve as fish shelters	0.06			Yes	1	Yes	No	No	No	Yes
				No	2	**0.0625**	**0.125**	**0.125**	**0.125**	**0.0625**
					Sub-total	**2.44**	**5.25**	**5.25**	**1.16**	**3.51**
Human Criteria										
Distance from a fishing site mapped by the Cree	0.5	Upstream	1	< 500 m	1	200 m	900 m	700 m	500 m	400 m
		Downstream	2	500 ≥ 1000 m	2	**1**	**2**	**2**	**1**	**1**
				>1000 m	3					
Distance from the planned drinking water intake	0.5	Upstream	1	< 500 m	1	> 1000 m	> 1000 m	> 1000 m	> 1000 m	> 1000 m
		Downstream	2	500 ≥ 1000 m	2	**3**	**3**	**3**	**3**	**3**
				>1000 m	3					
					Sub-total	**4**	**5**	**5**	**4**	**4**
					Total	**9.68**	**12.75**	**13.34**	**9.29**	**10.40**
					Rank	**4**	**2**	**1**	**5**	**3**

[2]Weighting was done using the multi-criteria hierarchy method (MHM) (CCI software): http://www.cci-icc.gc.ca/tools/ahp/index_e.aspx.

Selected site for the discharge point of the domestic effluent

In light of the analysis of the alternatives, the treated effluent discharge point #3 was selected as the best discharge point because, according to the site alternative analysis in Table 3.2.8, alternative #3 has, in addition to all the advantages of site #2, a sufficient depth to favour quick dispersion and quick dilution of the treated effluent plume.

- *SITE ALTERNATIVES FOR THE FINAL MINE EFFLUENT DISCHARGE POINT*

A system of drainage ditches will be built to collect the surface runoff coming from the infrastructures and mine facilities. The runoff will be directed to the R-65 pit, part of which will act as a sedimentation pond. The water in the sedimentation pond will be managed and treated before being released into Lake Lagopede.

The selection process for the location of the mine effluent discharge point in Lake Lagopede is controlled by the same four criteria categories (technical, physical, biological, and human) used for the selection of the domestic wastewater discharge point. For the purpose of the analysis, four treated mine effluent discharge points were identified in Lake Lagopede (Map 3.2.7). The discharge points were selected based on the criteria recommended in the following guide: *Calculation and Interpretation of Effluent Discharge Objectives for Contaminants in the Aquatic Environment* (MDDEP, 2007). The four site alternatives for the mine effluent discharge point were evaluated on the basis of ten criteria (Table 3.2.9).

The criteria weighting was done based on Saaty's multi-criteria hierarchy method (MHM) (1980) of analysis. For each class of criteria (technical, physical, biological, and human) the total weighting is equal to 1.

Discharge point #1 description

Site #1 is not favourable to the dispersion of the mine effluent because it is enclosed in the R-49 Bay of Lake Lagopede. This bay is characterized by a depth of approximately 5.5 m. However, a small island is located half way between the east and west banks where the bay and the main channel intersect. The channel on either side of this island is approximately 1.5 m deep.

Site #1 does not constitute a good discharge *a priori* point because the prevailing winds in this area blow from west to east, which could push the plume back towards the bay.

The tributaries that feed R-49 Bay do not have enough current during low-water periods to favour the dispersion and dilution of the mine effluent. This situation worsens during the winter when the ice can reach a thickness of more than 1.5 m and act as a barrier to the dispersion of the mine effluent.

Discharge point #1 is located less than 100 m downstream of the projected water supply intake for the mine camp. At this distance, the dispersion and dilution of the mine effluent may not be sufficient and could influence the quality of the drinking water.

In conclusion, discharge point #1 alternative does not meet the desired criteria for the final discharge point of the treated mine effluent.

Discharge point #2 description

Site #2 is favourable to the dispersion and the dilution of the mine effluent because it is located in a very deep part (10.5 m) of the lake and where the lake narrows causing an increase in current velocity. However, this could constitute a mandatory fish passage, which implies that the plume could potentially constitute an obstacle for fish moving from the north to the south of the lake.

The prevailing winds in this area blow from west to east which could push contaminants back to the north-east part of Lake Lagopede.

Discharge point #2 could cause problems for a potential lake trout spawning ground because the substrate (various size boulders) that characterizes the right bank downstream from the discharge point is theoretically a preferred spawning ground for this species.

In addition, the area around discharge point #2 was already used by the Cree for fishing and could theoretically be used again. As a precautionary measure, it would be preferable to avoid this fish habitat and the area once used by the Cree and select another site alternative.

688 000 m.E

690 000 m.E

5 856 000 m.N

5 854 000 m.N

F3294 F3294V F3293 F3293V F3295 F3295M F3296 F3297 F3297V F3298 F3303 F3302 F3301 F3301V F3300 F3300V F3304 F2607 F2607V F2607M Tributaire Nord, F3301V Tributaire Sud, F3301V

Baie Nord Baie Ouest Baie Sud Baie Est Lac Lagopède Étang Étang Secteur Sud

R-1 R-2 R-3 R-4 R-7 R-8 R-9 R-10 R-65

1 2 3 4 32302

167

0 250 500 m

Échelle/Scale 1 : 15 000

UTM, zone 18 (NAD83)

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Localisation générale / General location

Projet diamantifère Renard / Renard diamond mine project

0 500 km

Limites de l'aire d'étude / Study area limits

Secteur de la mine / Mine area

Lac Emmanuel

Nerveuse

Rivière

Secteur de la piste d'atterrissage / Airstrip area

0 10 km

Éléments / Components

R-x	Identification du gisement / Deposit identification
F3293	Numéro d'identifiant de lac CEHQ / CEHQ lake ID number
	Cours d'eau permanent / Permanent stream
	Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
	Écoulement souterrain / Underground flow
2.5	Courbe bathymétrique (profondeur en mètres) / Bathymetric profile (depth in meter)
	Emprise du projet / Project footprint (26/10/2011)
	Fosse d'extraction à ciel ouvert / Open pit
R-x	Autres ressources minérales / Other mineral resources
	Végétation aquatique / Aquatic vegetation
	Blocs / Boulder
	Zone de potentiel archéologique / Area of archaeological potential
	Diffuseur / Diffuser
	Variante retenue pour le point de rejet de l'effluent minier / The alternative site for the mining final effluent discharge point
	Point de rejet de l'effluent minier / Mining effluent discharge point
	Ancien site de campement / Old camp site
	Prise d'eau potable projetée / Future water intake
	Prise d'eau potable actuelle / Current water intake
	Site potentiel de fraie / Potential spawning area
	Aire de fraie / Spawning area
	Site de pêche au filet / Gillnet fishing site
	Ancien site de pêche au filet / Former gillnet fishing site

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Variantes du point de rejet pour l'effluent minier / Site alternatives for the mine effluent discharge point

ROCHE

Carte de base : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier : 61470_EIES_Minier_111213.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.7

Table 3.2.9 Assessment Results of the Site Alternatives for the Mine Effluent Final Discharge Point

Alternatives evaluation criteria	Criteria weighting[1]	Position of the discharge point with respect to the criteria		Value for criterion parameters		Result for each evaluation criterion for the alternative mine effluent discharge points			
		Direction	Score (pts)	Class	Score (pts)	1	2	3	4
Technical Criteria									
Length of the pipeline between the R-65 sedimentation pond and the final mine effluent discharge point	1.00	N/A	N/A	>2 000 m	1	160 m	890 m	2470 m	1340 m
				500 ≥ 2 000 m	2	**3.0**	**2.0**	**1.0**	**2.0**
				< 500 m	3				
					Sub-total	**3.0**	**2.0**	**1.0**	**2.0**
Physical Criteria									
Maximum water depth near the discharge point	0.36	N/A	N/A	<1 m	1	5.5 m	11.2 m	8 m	12,7 m
				1 ≥ 10 m	2	**0.72**	**1.08**	**0.72**	**1.08**
				> 10 m	3				
Distance of a tributary that can favour the dispersion and diliution of the mine effluent	0.20	N/A	N/A	> 1000 m	1	120 m	520 m	200 m	380 m
				500 ≥ 1 000 m	2	**0.59**	**0.40**	**0.59**	**0.59**
				< 500 m	3				
Type of substrate[2]	0.11	N/A	N/A	Unconsolidated sediment (Om)	1	Om	Om	Om	Om
				Rock	2	**0.11**	**0.11**	**0.11**	**0.11**
				Sand	3				
				Gravel	4				
				Blocks and large blocks	5				
Current in the area	0.23	N/A	N/A	Weakest (+)	1	+	++	++	+++
				Moderate (++)	2	**0.23**	**0.45**	**0.45**	**0.68**
				Strongest (+++)	3				
Exposure to prevailing winds (west)	0.10	N/A	N/A	Downwash (DW)	1	DW	DP	DW	DP
				Dispersion (DP)	2	**0.10**	**0.21**	**0.10**	**0.21**
					Sub-total	**1.75**	**2.24**	**1.98**	**2.67**
Biological Criteria									
Distance from a known spawning ground	0.5	Upstream	1	< 1000 m	1	2160 m	1280 m	760 m	760 m
		Downstream	2	≥ 1000 m	2	**1.0**	**1.0**	**0.5**	**0.5**
Distance from a known rearing area	0.5	Upstream	1	< 1000 m	1	>1000 m	>1000 m	760 m	760 m
		Downstream	2	≥ 1000 m	2	**1.0**	**1.0**	**0.5**	**0.5**
					Sub-total	**2.0**	**2.0**	**1.0**	**1.0**
Human Criteria									
Distance from an existing fishing site	0.5	Upstream	1	< 500 m	1	690 m	> 1000 m	750 m	1170 m
		Downstream	2	500 ≥ 1 000 m	2	**1.0**	**1.5**	**2.0**	**1.5**
				>1000 m	3				
Distance from the planned drinking water intake	0.5	Upstream	1	< 500 m	1	920 m	1220 m	3480 m	1730 m
		Downstream	2	500 ≥ 1 000 m	2	**1.0**	**1.5**	**3.0**	**3.0**
				>1 000 m	3				
					Sub-total	**2.0**	**3.0**	**5.0**	**4.5**
					Total	**8.75**	**9.24**	**8.98**	**10.17**
					Rank	**4**	**2**	**3**	**1**

Notes
N/A : Not applicable

[1]Weighting was done using the multi-criteria hierarchy method (MHM) (CCI software): http://www.cci-icc.gc.ca/tools/ahp/index_e.aspx.

[2]Relationship between the type of substrate and the preferred spawning substrate for whitefish, brook trout, and lake trout:
Rocks (potential fraying substrate for whitefish)
Sand (potential fraying substrate for whitefish)
Gravel (potential fraying substrate for brook trout and whitefish)
Blocks and large blocks (potential fraying substrate for lake trout and whitefish)

Discharge point #3 description

Site #3 favours the dispersion of the treated effluent in Lake Lagopede because the discharge point is located at the periphery of a pool with an approximate maximum depth of 10 m. However, the direction of the prevailing winds favours pushing the surface water back to the shore located less than 50 m from the mine effluent discharge point. The main tributary in this area is the F3300V stream which flows into *Baie Est* (East Bay), and the mouth of the stream is located near discharge point #3. The stream's discharge would likely favour dispersion and dilution of the mine effluent in this area. However, the total distance between the R-65 catch basin and site #3 is considerable (2.5 km).

Discharge point #4 description

Site #4 is characterized by higher current velocities and is located less than 500 m downstream from the main tributary (F3294) of Lake Lagopede which allows a maximum dispersion and dilution of the effluent in the lake. In addition, site #4 is the deepest (12.7 m) of the four alternatives studied and is located downstream and a good distance (more than 1 km) from the drinking water intake. Site #4 is considered the best site for the treated mine effluent outfall because it presents the most advantages of the four alternatives studied.

Selected site for the treated mine effluent discharge point

The comparative analysis for the mine effluent discharge point alternatives (Table 3.2.9) illustrates that site #4 is the most advantageous option (1st place, weighted score of 10.17).

3.2.4.5 Confinement Alternatives for Material resulting from Mining Operations

Material from mining operations includes the overburden stockpile, the waste rock stockpile, the ore (kimberlite), and the processed kimberlite (fine and coarse fractions of kimberlite after ore processing).

- *WASTE ROCK STOCKPILE*

Waste rock generated on-site and not used for backfill, construction, or stabilization will be taken to a stockpile. This stockpile will contain waste rock from underground extraction and/or open pit extraction.

Two alternative locations for the waste rock stockpile (F and G, Map 3.2.8) were considered. Since the waste rock does not present any particular environmental issues (see Section 3.6.5), it can be used as stabilization or construction material. Based on this premise and other technical, environmental, and economic considerations, it was decided that the distance between the stockpile and the pits constituted the most important factor for the selection of the stockpile location. In fact, not only will the waste rock be transported from the extraction pits to the stockpile but it will also then be returned to the underground workings via surface openings from the R-2/R-3 pits.

From this perspective, alternative F on Map 3.2.8 was selected. This site was clearly superior to alternative G in terms of the environmental criteria evaluated, some of which are as follows:

- Proximity to the processed kimberlite confinement area where waste rock will be used for slope stabilization;
- Shorter waste rock transport distance thereby reducing greenhouse gas production;
- Same watershed as the processed kimberlite confinement area, the overburden stockpile, and the ore stockpile;
- Less water and runoff management;
- Smaller impacted area;
- Lower road construction and maintenance costs.

However, the two sites are similar in terms of fish and wildlife habitat loss as well as archeological potential.

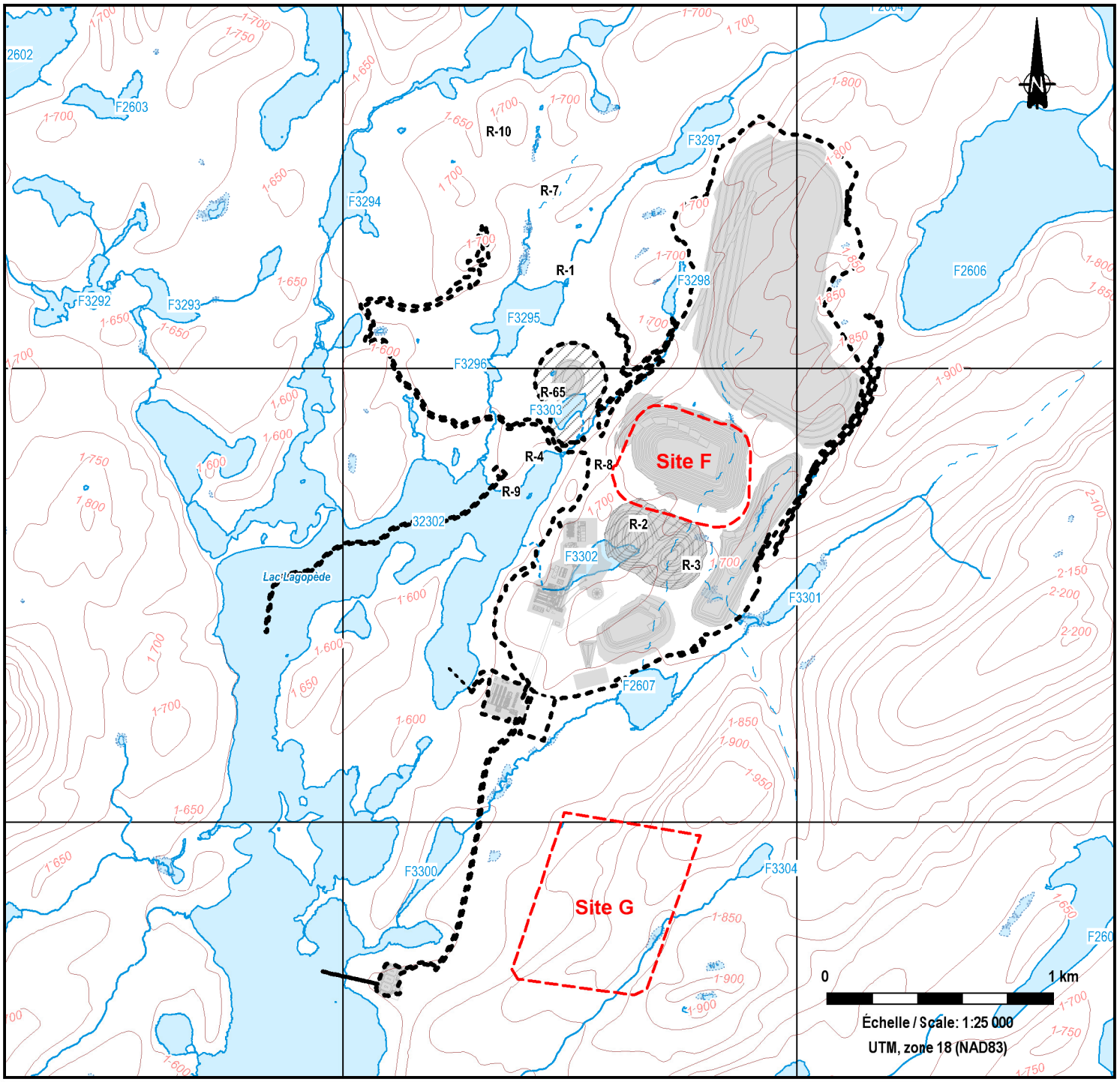
➢ *PROCESSED KIMBERLITE CONFINEMENT (PKC) AREA*

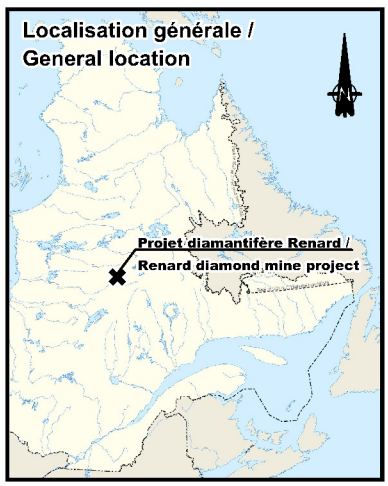
As required by Guideline 019, the selection of the processed kimberlite confinement area was the subject of a formal and thorough site selection process.

Preliminary analysis for site alternatives

In 2008, Roche, Ltd. (Roche, 2008) conducted a first analysis of the possible alternatives for storage of the three types of mine waste that will be produced during mining: the slimes fraction, the coarse and grits fractions, and waste rock. The management approach initially proposed aimed at a joint management of the waste rock and the coarse PKC downstream from the fines PK confinement site in order to optimize the wastewater management. The preliminary test results for initial leachability suggested that there was leachability potential for the combined materials. It is important to note that the kinetic tests carried out in 2011 showed that the combined materials did not generate acid and did not leach contaminants in concentrations likely to affect aquatic life (see Section 3.6.5).

The preliminary analysis of site alternative covered ten potential sites which were compared on the basis of environmental, social, operational, and economic criteria. This study showed that a valley located to the east of Lake Lagopede had the most advantages. However, the samples collected and the surveys carried out in 2010 as part of the environmental baseline study revealed that this valley had a certain value in terms of fish habitat, forest stands, and potential use by wildlife.





Emprise du projet / Project footprint (26/10/2011)

Fosse d'extraction à ciel ouvert / Open pit

Variante de site / Site alternative

F3293 Numéro d'identifiant de lac de CEHQ / CEHQ lake ID number

Courbe topographique(intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Analyse des variantes de la halde de roches stériles / Assessment of site alternatives for the waste rock stockpile

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_VariantesKimberlite_111220.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.8

Final analysis for site alternatives

A new site selection analysis was carried out in 2010 by the firm Golder Associates, Ltd. (Golder, 2010; Appendix 3.2.1). Although this study was conducted prior to the *Guidelines for the Assessment of Alternatives for Mine Waste Disposal* (Environment Canada, September 2011), the site selection analysis done by Golder took into account the majority of the selection criteria suggested by Environment Canada.

In Golder's study of site alternatives, tailings management was modified by taking into consideration the non-leachability of the material. The management approach included the layout of a combined PKC confinement area and a separate stockpile for the waste rock, which can also be used for construction purposes.

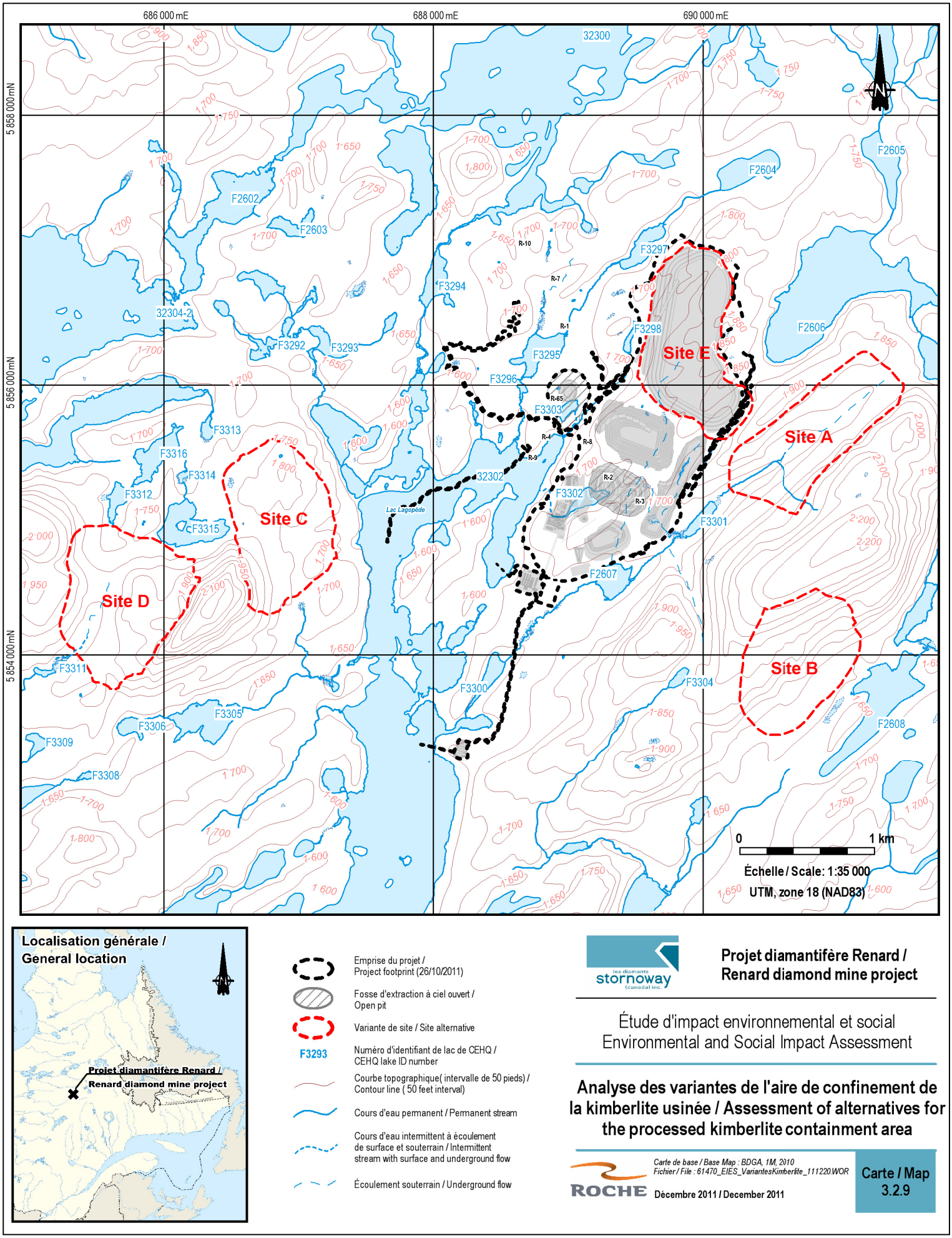
In an area covering a radius of approximately 10 km around the future mineral processing plant, five potential sites (A to E, see Map 3.2.9) were identified and studied, including the site initially proposed by Roche, Ltd. to the east of Lake Lagopede (site A).

Potential site identification

In order to identify sites where the PK could potentially be stored, it was assumed the PK did not show environmental issues that would require sealing measures to the site (low risk waste according to the definition in Guideline 019). The kinetic tests performed in 2011 validated this hypothesis.

The first selection criterion for the potential sites is the capacity to meet the storage needs for the two types of kimberlite. The first type is the coarse and grits fractions of the processed kimberlite that resembles gravel and accounts for 84% of the volume of the PK (-6.0 mm to 0.125 mm). The second type of PK is composed of a finer fraction (slimes fraction) resembling fine beach sand and accounts for 16% of the volume of the PK (-0.1215). In total, a volume of 22.1 Mm^3 (44.3 million metric tonnes) will be required for a twenty-year operation.

A 3D model was used to determine the storage capacity for the five alternative sites. A Golder Associates employee then went to the field to confirm the potential of these sites. During this visit, constraints related to the presence of several water bodies (rivers and lakes) and the topography were identified. In the field, it was also observed that the overburden of the sites is thin and consists of a moraine type granular material. Therefore, the sites essentially lay directly on the bedrock.



Emprise du projet / Project footprint (26/10/2011)

Fosse d'extraction à ciel ouvert / Open pit

Variante de site / Site alternative

F3293 Numéro d'identifiant de lac de CEHQ / CEHQ lake ID number

Courbe topographique(intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Analyse des variantes de l'aire de confinement de la kimberlite usinée / Assessment of alternatives for the processed kimberlite containment area

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_VariantesKimberlite_111220.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.9

Site comparison methodology

To compare the sites, the GoldSET software application developed by the firm Golder Associates was used. This tool can compare the sites based on site specific qualitative or quantitative comparison indicators and can attribute a weighting to the indicators as a function of environmental, social, and economic constraints correlated the valuation of the area or its resources by its users.

Each indicator is evaluated on a quantitative or qualitative scale. The scale is considered regressive if a decrease of the value corresponds to a favourable situation and progressive if an increase of the value corresponds to a favourable situation. In order to use the same base for the quantitative indicators, the values are normalized on a scale of 0 to 100. A weighting is done to account for the relative weight between indicators, and the indicators are attributed a value that varies between 1 and 3 (a value of 1 indicates that the indicator is less important).

Each of the five identified sites was evaluated as a function of 18 environmental indicators, six social indicators, and nine technical-economic indicators based on information available during the analysis. Tables 3.2.10 to 3.2.12 present the selected indicators as well as the weighting attributed to each environmental, social, and economic indicator.

Table 3.2.10 Environmental Indicators Used to Compare the PK Confinement Sites

Indicator Description	Scoring Scheme	Weighting
Proportion of Watershed Affected	Quantitative (%) / Regressive	3
Number of Watersheds Affected	Qualitative 0: > to 3 Watersheds Affected; 20: 2 Watersheds Affected; 100: 1 Watershed Affected	3
Location in the Watershed	Qualitative 0: Upstream Section of the Watershed; 50: Middle Section of the Watershed; 100: Downstream Section of the Watershed	3
Actual Distance from Water Body	Quantitative (m) / Progressive	2
Stream Diversion	Quantitative Binary 0: Yes; 100: No	2
Stream Crossing by Road/Pipeline	Quantitative (No. of Crossings) / Regressive	1
Presence of Fish Habitat on the Site	Qualitative 0: Yes; 50: Unknown; 100: No	3
Presence of Fish Habitat Downstream	Quantitative (m) / Progressive	2
Distance from a Spawning Ground	Qualitative 0: Spawning Ground Less than 1 km Downstream; 50: Unknown; 100: No Spawning Ground Less than 1 km Downstream	3
Presence of Wetlands on the Site	Quantitative (m^2) / Regressive	3
Presence of Wetlands Downstream	Quantitative (m) / Progressive	1
Deforestation Required	Quantitative (m^2) / Regressive	2
Plant Community or Presence of Habitat of Interest on the Site	Qualitative 0: Yes; 50: Unknown; 100: No	2
Distance from a Natural Park, Protected Habitat or High-value Habitat	Quantitative (km) / Progressive	2
Presence of Special-status Plant Species within the Confinement Area Footprint	Qualitative 0: Confirmed Presence; 50 Uncertain or Potential Presence; 100: Unlikely Presence	3
Presence of Special-Status Wildlife Species	Qualitative 0: Confirmed Habitat; 25: Potential Habitat; 50: Potential or Confirmed Transit Site; 100: Unlikely Presence	3
Presence of Waterfowl	Qualitative Binary 0: Yes; 100: No	2
Road or Pipeline Distance to Confinement Area	Quantitative (km) / Regressive	2

Table 3.2.11 Social Indicators Used to Compare the PK Confinement Sites

Indicator Description	Scoring Scheme	Weighting
Visual Impact	Qualitative 0: Always Visible (Populated Area, Resort Area, or Road); 20: Partially Visible (Populated Area) 40: Sometimes Visible (Populated Area, Resort Area or Road); 100: Not Visible from a Populated Area, Resort Area, or Road	1
Traditional Cree Activity Area	Qualitative 0: Valued Area; 50: Used but not as a Valued Area; 100: No Activity	3
Land Tenure	Qualitative Binary: 0: Private; 100: Public	1
Recreational Tourism Activities and Infrastructures and Vacation Area Nearby	Qualitative 0: Activities Impossible; 25: Activity Strongly Impacted (e.g.: displacement of a trail); 75: Activity Slightly Impacted (annoyance); 100: Activity Not Impacted	1
Archaeological Site, Cultural or Heritage Asset	Qualitative 0: Presence of an archaeological site, a cultural asset, or a patrimonial asset on the site; 25: Presence of an archaeological site, a cultural asset, or a heritage asset nearby, which integrity and value are affected; 50: Potential presence of an archaeological site, a cultural asset, or a heritage asset nearby, which integrity and value are affected; 100: No archaeological site, cultural asset, or heritage asset on the site or nearby	3

Table 3.2.12 Economic Indicators Used to Compare the PK Confinement Sites

Indicator Description	Scale	Weighting
Controlled Backfill Volume	Quantitative (m^3) / Regressive	3
Dyke Height	Quantitative (m) / Regressive	3
Site Area	Quantitative (km^2) / Regressive	3
Possibility of Expansion	Quantitative 0: No possibility; 25: Possibility with major restrictions; 50: Possibility with moderate restrictions; 75: Possibility with minimal restrictions; 100: Possibility with no restriction	3
Diversion/Compensation	Qualitative 0: Diversion unfeasible; 25: Diversion possible but very complex; 50: Diversion possible but moderately complex; 75: Diversion possible with minimal restrictions; 100: No diversion needed	3
Maximum elevation change between the concentrator and the site	Quantitative (m) / Regressive	2
Length of Main or Trucking Distance	Quantitative (km) / Regressive	2
Site Accessibility	Quantitative (km) / Regressive	1
Consequence of a Dyke/Confinement Failure	Qualitative 0: Considerable; 20: Very Important; 40: Important; 60: Moderate; 80: Low; 100: Minimal	3

Comparative analysis results

Table 3.2.14 presents the results of the comparative analysis for the environmental, social, and economic indicators. In the Golder Associates report, the results are presented based on the information available at the time (2010). The results were updated to take into account the field work done in 2011.

Site Alternative selection

Table 3.2.13 presents the results of the comparative analysis of the site alternatives for each indicator considered.

Table 3.2.13 General Results of the Site Alternatives Comparative Analysis for the Processed Kimberlite Confinement Area

Indicator Description	Site A	Site B	Site C	Site D	Site E
Environmental Dimension (%)	45	68	35	35	58
Social Dimension (%)	77	60	60	57	77
Economic Dimension (%)	58	44	48	65	61
Average	**60.0**	**57.3**	**47.7**	**52.3**	**65.3**

Concerning the environmental aspect, site B obtained the best score. The advantages of site B include the absence of water body within the footprint area (therefore no loss of fish habitat) and a short distance from the process plant. Site E came in second place. According to the information available, site E also does not contain any fish habitat and has been optimized to only affect one watershed. The distance from the process plant is also short.

Concerning the social aspect, sites A and E obtained the best scores. They are set apart from the other sites by a greater distance from places of interest for the Cree, notably moose hunting grounds and snowmobile trails.

Concerning the economic aspect, site D obtained the best score, followed by site E. These two sites would be the most advantageous in terms of setup and operation.

In general, site E represents the best choice for PK confinement, and it is also the site that was favoured by the M11 area tallymen at a meeting held on March 15, 2011.

Table 3.2.14 Evaluation Results for the Processed Kimberlite Confinement Area Site Alternatives

Indicator Description	Explanation	Site A	Site B	Site C	Site D	Site E
Environmental Aspect						
Proportion of watersheds affected	A=43 %, B=22 %, C=40%, D=40%, E=27%	0	100	14	14	76
Number of watersheds affected	A=1, B=2, C=3, D=3, E=2	100	20	0	0	20
Position in the watershed	All in the upstream portion of the watershed	0	0	0	0	0
Actual distance from body of water (river or lake) in m	A=0, B=98, C=27, D=22, E=0 The distances are calculated as straight line distances (as the bird flies). The site E groundwater thalwegs were considered since the latter will also be affected by the layout.	0	100	28	22	0
Watercourse diversion	A=Yes, B=No, C=No, D=Yes, E=Yes	100	100	100	100	100
Stream crossing by road/pipeline	A=2, B=2, C=5, D=6, E=2.	100	100	25	0	100
Presence of fish habitat on the site	A= Yes, B= No, C= No, D= Yes, E= No	0	100	100	0	100
Presence of fish downstream Distance in m	A=160, B=100, C=27, D=22, E=66. Where data is unavailable for certain sites, the distances are calculated as straight line distances towards the closest lake.	100	57	4	0	32
Distance from a spawning ground	A=less than one km, B= unknown, C= less than one km, D= unknown, E=unknown. B, D, and E are unknown because the bodies of water had not been inventoried when Golder Associated ltd, (Feb. 2011) did the study.	0	50	0	50	0
Area of wetland on the site in m^2	A=5,590 B=2,223 C=11,475 D=95, E=2,400.	52	81	0	100	80
Distance from a downstream wetland in m	A=0, B=25, C=0, D=0, E=77. The distances are calculated as straight line distances towards the closest wetland.	0	32	0	0	100
Deforestation required (in m)	A=711 187, B=674 540, C=728 178, D=719 977, E=729 791;	34	100	3	18	0
Plant population or presence of a habitat of interest on the site	Information was unavailable when Golder did the study (Feb. 2011)	50	50	50	50	50
Distance from a park, a protected habitat, or a high value habitat	No protected area or regulated wildlife habitat in proximity. These sites are more than 50 km away, such as the planned Albanel-Temiscamie-Otish National Park. However, a swallow biodiversity reserve project exists about 30 km east of Lagopede Camp.	50	50	50	50	50
Presence of special status	Up to the present, no special status species were discovered in the	100	100	100	100	100

Table 3.2.14 Evaluation Results for the Processed Kimberlite Confinement Area Site Alternatives

Indicator Description	Explanation	Site A	Site B	Site C	Site D	Site E
flower species within the confinement area footprint	Renard Project study area.					
Presence of special status wildlife species	A=Yes, B=Potential habitat, C= Potential habitat, D=Yes, E= Potential habitat. Brook trout, a species of interest and subsistence according to the MDDEP at sites A and D, and the Cooper Lemming Campagnol (*Synaptomus coopen*), a species likely to be designated threatened or vulnerable according to the Quebec Threatened and Vulnerable Species Law at site D. "Potential habitat" for the other sites because these sites have not been inventoried.	0	25	25	0	25
Waterfowl presence	Information unavailable at the time of the Golder study (Feb., 2011) or no lake likely to house the waterfowl nesting sites on the project site.	100	100	100	100	100
Length of road or pipeline (footprint) in m	A=2,306 B=2,503 C=4,832 D= 5,658 E=2,986.	94	88	23	0	100
	Environmental aspect score (%)	**45**	**68**	**35**	**35**	**58**
Social aspect						
Visual impact	The sites will always be partially visible from the ski-doo trails	40	40	40	40	40
Traditional activity area (Cree)	A=In proximity, B=On the site, C=On the site, D=On the site, E=In proximity. Sites B, C, and D are in a moose hunting ground and/or a trapline.	50	0	0	0	50
Recreational tourist activities and infrastructures and vacation area nearby	A=Activity not impacted, B= Activity not impacted, C= Activity not impacted, D=Activity slightly impacted, E=Activity not impacted. It is considered that the ski-doo trial in the site D area will be slightly impacted because the trail goes around the site. The trail can be easily moved without disrupting the activity to a significant degree. The other sites do not interfere with the ski-doo trails or other types of activities.	100	100	100	75	100
Land tenure	All on crown land	100	100	100	100	100
Archeological site, cultural or patrimonial asset	No archeological site within the limits of the sites	100	100	100	100	100
	Social aspect score (%)	**77**	**60**	**60**	**57**	**77**
Economic aspect						
Volume of dykes	A=13.8 Mm^3 B=14.5 Mm^3 C=15.9 Mm^3 D=15.0 Mm^3 E= 16.6 Mm^3	100	77	27	59	0
Stockpile height	A=88 m, B=136 m, C=89 m, D=77m, E=91 m	81	0	80	100	76

Table 3.2.14 Evaluation Results for the Processed Kimberlite Confinement Area Site Alternatives

Indicator Description	Explanation	Site A	Site B	Site C	Site D	Site E
Stockpile area (cover, liner)	A=0.815 Mm^3 B=0.855 Mm^3 C=0.808 Mm^3 D=0.677 Mm^3 E= 0.65 Mm^3	22	0	26	100	50
Possibility of expansion	A=No possibility – significant lakes to the north and south, and topographical limits to the east and west; B=Possibility of minor expansion to the west; C=Possibility to the north and south despite few rivers/streams; D=Possibility to the southwest, limited by lakes; E=Major possibility to the northeast.	0	25	50	25	75
Deviation/Compensation	A=One or two simple deviations, moderate compensation required; B=No deviation or compensation required; C=No deviation possible but major compensation; D=No deviation possible but minor compensation required; E=No deviation possible but moderate compensation required.	75	100	25	75	25
Maximum elevation change between the concentrator and the output point	A=-44 m B=-64 m C=-36.5 m D=-46.6 m E=-46.5 m	73	0	100	64	64
Length of main or trucking distance	A=2.37 km B=2.48 km C=4.99 km D=5.75 km E=2.09 km	92	89	21	0	100
Site accessibility	A=2.37 km B=2.48 km C=1.0 km D=1.6 km E=1.12 km	8	0	100	59	92
Consequence of a dyke/containment failure	In all cases, no population is at risk and there will be no loss of infrastructure. For the environment A=Loss or deterioration of a major part of the fish or wildlife habitat; B=No significant loss or deterioration of the fish or wildlife habitat; C=Loss or deterioration of a major part of the fish or wildlife habitat; D=No significant loss or deterioration of the fish or wildlife habitat; E: No long-term loss.	50	75	50	75	100
	Economic aspect score (%)	**58**	**44**	**48**	**65**	**61**

3.2.5 Power Supply Alternatives

➢ *JUSTIFICATION OF POWER SUPPLY NEEDS*

The average annual power needs of the mine is estimated at 9,500 kW and 13,560 kW at peak periods (maximum simultaneous demand) (SNC-Lavalin, 2011g) based on a possible extraction scenario of 7,000 tonnes per day (tpd). The main mine activities that will require power supply include those related to the underground mining (including shaft, air compressor, and ventilation system operation), the operation of the crusher, and the process plant and ancillary facilities (Table 3.2.15).

Table 3.2.15 Ventilated Power Needs by Mining Activity

Equipment	Maximum Simultaneous Demand (kW)	Average Annual Demand (kW)
Primary Crusher and Plant	5,677	5,393
Production Headframe	2,600	672
Ancillary Headframe	240	44
Mine Shafts (surface infrastructure)	310	186
Ancillary Infrastructures	1,265	1,139
Open Pits	353	88
Air Compressors	880	440
Ventilation	627	564
Pit Dewatering	428	257
Mobile Power Generation System	1,180	708
Total	13,560	9,491

Source: SNC-Lavalin, 2011g

➢ *DESCRIPTION OF POWER SUPPLY ALTERNATIVES*

Various electrical power supply alternatives were studied for the mine in order to meet its power supply needs:

- Diesel generator set;
- High-voltage power line;
- Combination of power generating sets and power line;
- Small-scale hydropower plant;
- Wind power;
- Solar power.

The first alternative analyzed is the installation of on-site, diesel power generating sets. The main power generating set would consist of 10 power generating sets of 1,800 kW each plus 2 reserve gen-sets for a total capacity of 21,600 kW to supply the necessary power during current fluctuations and peak periods.

The second alternative consists of the construction of a 161 kV power line of approximately 165 km in length connecting the Renard Project site to the Nikamo substation located near Hydro Quebec's Laforge 1 generating station, to the north-northwest of the Foxtrot property. Another connection option would have been to run a power line from the south but this alternative was not considered in the analysis. Connecting to the existing Hydro Quebec network would imply the construction of various infrastructures, notably the installation of two power transformers, a grounding transformer, high-tension circuit breakers, reactive power compensation equipment, and high-tension surge arrestors (SNC-Lavalin, 2011). Stornoway began discussions with Hydro Quebec to build a line from the north.

The third alternative is a combination of the first two alternatives; that is, the installation of a diesel power generating set for the first two years, followed by a connection to the Hydro Quebec network (Stornoway memorandum, November 15, 2010).

The fourth alternative considered is the construction a small-scale hydropower plant (Scott Wilson Mining, 2010). Finally, the use of wind power and solar power were also studied in the alternative analyses for the mine's power supply.

- *ECONOMIC ANALYSIS*

An economic analysis of the power supply for the mine was conducted for the following alternatives: power with diesel power generating sets; high-voltage power line connecting to Hydro-Quebec's network; the combined option of diesel power generating sets followed by a power line connecting to Hydro-Quebec's network (Stornoway, 2010). This economic analysis took into account the estimates for the increase in diesel price (based on crude oil prices) as well as the financing options for the installation of a high-voltage power line. The analysis revealed that the power line alternative could be advantageous and economically viable since it would protect the project against fuel price fluctuations, fuel that is required for diesel powered operations. Certain costs related the alternatives of connecting to Hydro-Quebec's network could be lower than initially evaluated in the preliminary assessment if hosting facilities are shared between the mining clients and Hydro-Quebec (Hydro-Quebec, 2009). And the study recommends carrying out a technical feasibility study for a Hydro-Quebec power line in order to examine the cost details and attempt to negotiate more advantageous terms with Hydro-Quebec. The cost of the installation of a connecting network is indeed very high, i.e. more than CAD$155 M including a substation at the Renard Project site.

➢ *GHG EMISSION ANALYSIS*

The main greenhouse gas (GHG) emissions were calculated for the various alternatives for the mine's power supply (with the exception of the hydropower plant[1]). For each alternative, the emissions associated with the construction and the installation of the facilities as well as those associated with their operation were considered in the analysis. The results of the analysis are presented in Table 3.2.16.

To compare the various alternatives, the following hypotheses were used:

- Required supply of 134,983,636 kWh/yr;
- Average distance for material procurement: 500 km;
- Life of the mine: 20 years.

Diesel power generating sets

The main source of emissions associated to the installation of the diesel power generating sets is the construction of the building that houses the power generating sets, and transport and consumption of the diesel.

According to FEEMA[2], the CO_2e emissions for an industrial building made of cement with a floor area of 1,300 m^2 should be approximately 325 tonnes. By adding the emissions due to the transport of material, the construction of a building represents a total of approximately 346 tonnes of CO_2e emissions, which is very little. However, diesel consumption produces much more GHG. By using an energy conversion factor, the annual quantity of diesel required to generate the electrical power necessary to power a mine is estimated at 12,562,105 litres. According to the emission factors of the Canadian GHG Inventory (Environment Canada, 2010), the combustion of all this fossil fuel generates 35,046 tonnes of CO_2e.. In addition, assuming 500 km of transportation for the trucks containing 30,000 litres and that consume approximately 35 litres per 100 km themselves, the diesel procurement would, in fact, generate approximately 172 tonnes of CO_2e per year. Thus, over 20 years the total of GHG emissions would be approximately 704,707 tonnes of CO_2e.

[1] It was not possible to calculate the GHG emissions for a small-scale hydro-electric plant due to the lack of information for this alternative (e.g.: potential placement, type of dyke). It was estimated that this alternative would be susceptible to generate average GHG emission values (50-500 million tonnes of CO_2e class, Table 3.2.16).

[2] In January 2011, the French Environment and Energy Management Agency (FEEMA) published a guide entitled, "Bilan carbone appliqué au bâtiment" (ADEME, 2011) that gives a series of emission factors that take into consideration the building materials used and the use of the building.

Table 3.2.16 GHG Emission Estimates for Electric Power Supply Alternatives for the Renard Project

Alternatives	Source of the Emission	Annual Emissions (tonnes of CO2e /year)	Total Emissions (tonnes of CO2e)
Power Generating Sets	Plant Construction	-	346
	Diesel Consumption	35,046	700,913
	Diesel Transport	172	3,448
	Total	**704,707 tonnes of CO_2e**	
Connection to Hydro Quebec's Network	Construction of a High-voltage Power Line	-	13,586
	Substation Modification	-	263
	Power Consumption from the HQ Grid	810	16,198
	Total	**30,047 tonnes of CO_2e**	
Diesel Power Generating Sets and Connection to Hydro Quebec's Network	Construction of a building for power generating sets (including material transport)	-	346
	Diesel Consumption (for 2 years)	35,046	70,092
	Diesel Transport (for 2 years)	172	344
	Construction of a High-voltage Power Line	-	13,586
	Substation Modification	-	263
	Power Consumption from the HQ Grid (for 18 years)	810	14,578
	Total	**99,209 tonnes of CO_2e**	
Solar Power	Construction, Installation, and Maintenance of Solar Panels	2,430	48,594
	Transport of Solar Panels	-	823
	Total	**49,417 tonnes of CO_2e**	
Wind Power	Construction, Installation, and Maintenance of Wind Turbines	3,240	64,792
	Transport of Wind Turbines	-	1,647
	Total	**66 439 tonnes of CO_2e**	

Hydro-Quebec network connection

The main source of emissions for connecting to the Hydro-Quebec network includes the construction of the high-voltage power line and the consumption of electricity from the Hydro-Quebec network.

Estimates were made based on the impact assessment for the construction of high-voltage power lines for the Romaine Project (Hydro-Quebec TransEnergy, 2009). This same data was used to evaluate the GHG emissions. The high-voltage power line to be built between the Romaine 4 station and the (existing) Montagnais substation will be similar in length to the line built between the Nikamo substation and the Renard Project site (178 km for Romaine vs. 165 km for the Renard Project). In both cases, the existing station must be modified and telecommunication and supply stations must be built. Using the numbers from the Romaine impact assessment, it is estimated that a total of 13,586 tonnes of CO_2 would be emitted during the construction of the Nikamo-Renard line and 263 tonnes for the modification of the existing substation and the construction of a transformer substation on the project site. These data include the necessary equipment for roads building, stringing of the lines, material transport, and the use of cement for the construction of the sites.

The power consumption produced by the hydroelectric network will not generate very much GHG itself. The Canadian GHG Inventory stipulates that the average emission factor for energy consumption in Quebec is 6 g/kWh GHG since nearly 96% of electricity comes from the hydroelectric network. The total annual energy consumption from a connection to the Hydro-Quebec network would emit810 tonnes of GHG yearly, which equates to total GHG emissions of 30,047 CO_2e over twenty years.

Combination of power generating sets and power line

The hypotheses considered to estimate the GHG emissions for this alternative are the same as for the previous two alternatives. That is, the respective emissions will be added together: construction of a building to house the diesel powered generating sets including the transport of construction material (346 tonnes of CO_2e), construction of a high-voltage power line (13,586 tonnes of CO_2e), and the modification of the Nikamo or de Tilly substation (263 tonnes of CO_2e).

The two years annual diesel transportation (172 tonnes of CO_2e/yr) and combustion (35,046 tonnes of CO_2e/yr) emissions are added together as well as the emissions generated by the power consumption of the Hydro Quebec network (810 tonnes of CO_2e/yr) over the remaining period of 18 years. Thus, the calculated total emissions are approximately 99,209 tonnes of GHG over a twenty year period.

Small-scale hydropower plant

The GHG emission calculation could not be calculated for the small-scale hydropower plant alternative due to a lack of information on this alternative (e.g.: location, type of plant selected). Therefore, an "average" GHG emission value (between 50,000 and 500,000 tonnes of CO_2e) was used for the comparative analysis of the alternatives (see Table 3.2.17).

Solar power

For the installation of the solar panels, the main sources of GHG emissions are panel transportation, installation, construction, and maintenance.

For construction, the available data indicate an amortization of the emissions over the lifespan of the panels as a function of the supplied energy. In the documentation, an average of 15 g CO_2e/kWh is estimated, and a contingency factor of 1.2 is recommended in the calculation of the desired power output. Therefore, the estimated annual emissions are 2,430 tonnes of CO_2e per year for the use of the panels.

For installation, it is estimated that 1,000 trips of an average distance of 1,000 km are needed. The emissions relative to fuel consumption for these trips are estimated at 823 tonnes of CO_2e.

Over a period of 20 years, the total emissions from the use of solar panels would be 49,417 tonnes of CO_2e[3].

Wind power

For the installation of wind turbines, the main sources of GHG emissions are turbine transportation, installation, construction, and maintenance.

For construction, the available data indicate an amortization of the emissions over the lifetime of the turbines as a function of the supplied power. In the documentation, an average of 20 g CO_2e/kWh is estimated, and a contingency factor of 1.2 is recommended in the calculation of the desired power output. Therefore, the estimated annual emissions are 3,240 tonnes of CO_2e per year for the use of wind turbines. For installation, it is estimated that 2,000 trips of an average distance of 1,000 km are needed. The emissions relative to fuel consumption for these trips are estimated at 1,647 tonnes of CO_2e.

Over a period of 20 years, the total emissions from the use of wind turbines to supply the Renard site with power would be 66,439 tonnes of CO_2e[3].

Table 3.2.16 illustrates that, for GHG emissions, the alternative that generates the least amount of emission is the connection to the Hydro Quebec network via the construction of a high-voltage power line.

- *COMPARISON OF POWER SUPPLY ALTERNATIVES*

The comparison of the power supply alternatives for the Renard Project was done following a weighted point system. The three main criteria in choosing the best alternative are: technical feasibility, environmental indicators, and socio-economic indicators. Each groups a set of sub-criteria for which a

[3] This estimate does not take into account the installation of collectors required to store the energy that would be used at night or during cloudy periods for solar power and for less windy periods for wind power.

weighting was attributed based on Saaty's multi-criteria hierarchy analysis method (1980)[4]. This method allows the evaluation of various criteria and prioritizes them based on relative importance (hierarchical structure) by assigning a relative weighting factor to them. The model also includes a consistency ratio that indicates the consistency of the comparative criteria evaluation[5]. Each alternative was evaluated for each of the sub-criteria based on a score from 1 to 3, where 1 was the least favourable and 3 was the most favourable. The score for each alternative was then multiplied by the pre-established weighting. Finally, the total for each alternative was added up for each category of criteria (technical, environmental, socio-economic) in order to establish the rank for each alternative, the highest score (1st place) to the lowest score (6th place).

The sub-criteria for each criteria category are presented in Table 3.2.17. The technical feasibility is essentially the capability to produce sustained power.

The significant power needs of the mine require a reliable and continuous source in order to supply the required energy in a sustained manner. The other technical feasibility sub-criteria include the risk of a power outage due to weather conditions (e.g.: freezing rain, forest fire), the duration of construction, the level of difficulty in obtaining environmental authorizations, the transport of components and material, and the maintenance and operation requirements (time and manpower). The environmental indicators include greenhouse gas (GHG) emissions, the use of renewable energy, and the impact on wildlife and water habitats. Among the socio-economic indicator sub-criteria, those with the most weight in this category include the initial capital investment cost, the operation costs, and the risks related to the fluctuations in fuel cost.

The comparative analysis of the power supply alternatives (Table 3.2.17 and Figure 3.2.10) reveals that the construction of a power line is the most advantageous alternative (1st place, weighted score=7.35), notably from the technical feasibility and socio-economic indicator perspectives where it obtained the highest weighted score. The main advantages of this alternative include a continuous power supply, lower operation costs than the other alternatives, and insensibility to fuel cost fluctuations. A power line is also advantageous from an environmental perspective due to low GHG[6] emissions and the use of renewable energy (water – connection to the Laforge 1 hydro-electric dam). However, taking into account the important difference between the initial construction costs of the power line and the diesel power generating sets, the option selected by the project for this phase is the use of the diesel power generating sets. If, during the project start-up, there are changes to the cost of fuel or if the cost sharing of the power line construction makes this alternative economically viable, then the project could eventually opt for this alternative.

[4] The calculations were done using software from the Canadian Conservation Institute: http://www.cci-icc.gc.ca/tools/ahp/index_e.aspx.

[5] A low value indicates good consistency (≤ 0.1) while a value > 1 requires a revision of the criteria hierarchy analysis before compiling the weightings.

[6] Total GHG emissions estimated at 32,679 tonnes of CO_2e over 20 years.

Table 3.2.17 Power Supply Alternatives Comparison

Criteria	Weighting (2)	Score	Justification	Weighted Score for each Alternative[3]					
				Diesel Power Set	High-tension Power Line	Diesel Power Set + High-tension Power Line	Small-scale Hydro-electric Plant	Wind Power	Solar Power
Technical Aspects									
Capacity to produce continuous electricity	47%	1	Low	1.42	1.42	1.42	1.42	0.47	0.47
		2	Moderate						
		3	High						
Risk of service interruption due to climatic conditions (e.g.: freezing rain, forest fire)	9%	1	High	0.19	0.28	0.19	0.28	0.28	0.09
		2	Moderate						
		3	Low						
Duration of construction	10%	1	Long	0.21	0.10	0.10	0.10	0.10	0.21
		2	Moderate						
		3	Short						
Obtention of environmental authorizations	4%	1	Difficult	0.04	0.04	0.04	0.04	0.04	0.04
		2	Moderately Difficult						
		3	Relatively Difficult						
Component transportation	11%	1	Complex and Costly	0.21	0.21	0.21	0.21	0.11	0.21
		2	Moderate Complexity/Costs						
		3	Simple and low cost						
Maintenance	11%	1	Frequent/Costly	0.21	0.21	0.21	0.21	0.21	0.11
		2	Infrequent/Low Cost						
		3	Minimal						
Operational demand (time and manpower)	7%	1	High	0.07	0.22	0.07	0.15	0.22	0.22
		2	Moderate						
		3	Low						
			TOTAL	**2.36**	**2.49**	**2.25**	**2.42**	**1.44**	**1.36**
Environmental Aspects									
GHG Emissions over 20 years	17%	1	High Value (> 500 000 t CO_2 eq)	0.17	0.50	0.33	0.33	0.33	0.17
		2	Moderate Value (50,000 - 500,000 t CO_2 eq)						
		3	Low Value (< 50,000 t CO_2 eq)						
Renewable energy source	17%	1	No	0.17	0.50	0.33	0.50	0.50	0.50
		2	Partial						
		3	Yes						
Impact on terrestial habitats	33%	1	High	1.00	0.67	0.67	0.33	0.67	1.00
		2	Moderate						
		3	Low						
Impact on aquatic habitats	33%	1	High	1.00	1.00	0.67	0.33	0.67	1.00
		2	Moderate						
		3	Low						
			TOTAL	**2.33**	**2.67**	**2.00**	**1.50**	**2.17**	**2.67**
Socio-economiques Aspects									
Anticipated public acceptation	14%	1	Unfavourable	0.42	0.42	0.42	0.42	0.42	0.42
		2	Partially Favourable						
		3	Favourable						
Impact on sound and visual environment	9%	1	High	0.19	0.19	0.19	0.19	0.19	0.19
		2	Moderate						
		3	Low						
Area footprint	9%	1	Large	0.19	0.09	0.19	0.09	0.09	0.19
		2	Moderate						
		3	Small						
Possibility to connect to network by a third party	3%	1	No	0.03	0.09	0.06	0.06	0.03	0.03
		2	Possible						
		3	Yes						
Sustainable development	4%	1	Unlikely	0.04	0.12	0.12	0.08	0.12	0.08
		2	Probable						
		3	Highly Probable						
Initial capital costs	27%	1	High	0.53	0.27	0.27	0.27	0.27	0.27
		2	Moderate						
		3	Low						
General operational costs[1]	17%	1	High	0.35	0.52	0.35	0.35	0.17	0.17
		2	Moderate						
		3	Low						
Risk of fuel price fluctuations	17%	1	High	0.17	0.50	0.33	0.50	0.50	0.50
		2	Moderate						
		3	Low to None						
			TOTAL	**1.91**	**2.19**	**1.91**	**1.95**	**1.78**	**1.84**
			GRAND TOTAL	**6.60**	**7.35**	**6.17**	**5.87**	**5.39**	**5.86**
			Rank	**2**	**1**	**3**	**4**	**6**	**5**

Notes

(1): Based on, among other things, a high crude oil price ($US120 per barrel) (Stornoway, 2010)

(2): The weighting of criteria was done based on Saaty's multi-criteria hierarchy method (MHM) (1980) of analysis using software from the Canadian Conservation Institute (http://www.cci-icc.gc.ca/tools/ahp/index_e.aspx).

(3): The weighted score was calculated by multiplying the score attribute (3rd column) and the respective criteria weighting.

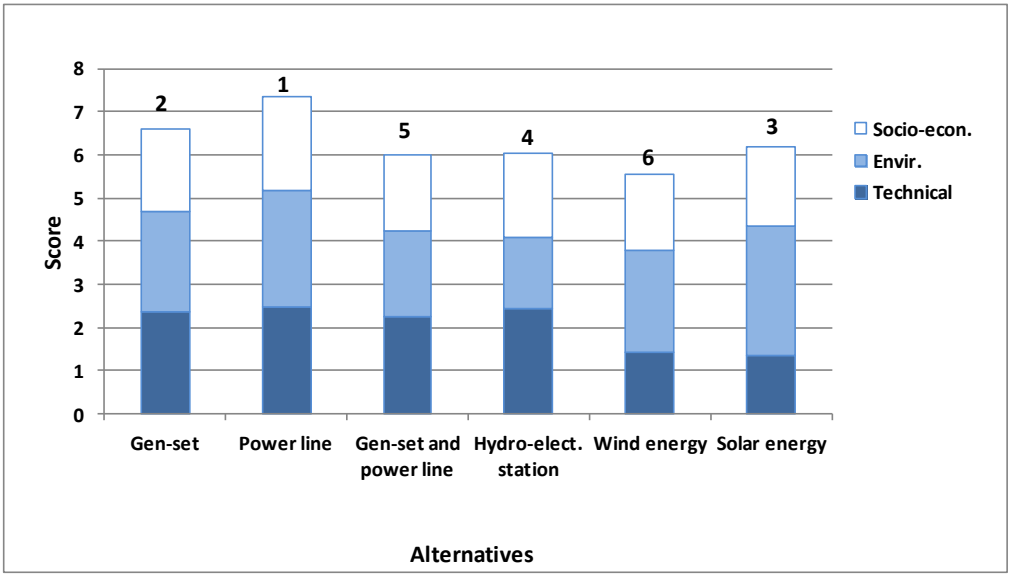


Figure 3.2.10 Comparative Analysis of the Power Supply Alternatives as a Function of Technical, Environmental, and Socio-economic Criteria

The power generating sets ranks 2nd (6.60 weighted score) in the analysis, mainly because of a sustained supply of energy and initial costs lower than the other alternatives; nonetheless, it remains susceptible to the high risks related to fuel cost fluctuations. This alternative is also a disadvantage from an environmental point of vue due to high GHG emission levels (704,707 tonnes of CO_2e) and only partially renewable energy.

The alternative combining the diesel power generating sets and the connection to the Hydro-Quebec network (3rd place, 6.17 weighted score) has few advantages since it includes unfavourable elements from the diesel generating sets (risk associated with fuel costs, environmental disadvantages) and those related to connecting to the Hydro-Quebec network (high initial cost).

The small-scale hydropower station comes in 4th place (5.87 weighted score). Although it is relatively interesting in terms of technical feasibility (sustained power supply) and socio-economic perspectives, the installation of an hydropower plant would likely have a more important impact on wildlife and aquatic habitats than the other alternatives.

The solar power alternative is clearly advantageous from environmental (the highest score) and socio-economic (e.g.: no risk related to fuel costs) perspectives. However, and this applies to wind power too, this type of energy cannot produce a continuous supply and sufficient output. Indeed, these types of power supplies depend on the availability of a resource that can be variable (e.g.: period with no wind for wind power; cloudy periods and winter with shorter periods of daylight for solar power). Wind turbines are a disadvantage in terms of the complexity of transporting the energy to this isolated region (e.g.: the road must meet certain curve standards for the transport of the blades) and of the suspected

impacts on wildlife and aquatic habitats due to the construction of access roads to the wind turbines. For all of these reasons, solar power and wind power are relegated to 5th and 6th spots respectively in the alternative analyses in spite of the positive aspect of wind and solar power from an environmental perspective (average greenhouse gas emission[7], renewable energy).

Ultimately, although the diesel power generating sets ranked 2nd in the analysis, this alternative was selected because of much lower initial costs than the installation of a power line connecting to the Hydro-Quebec network (Scott Wilson report, 2010). However, considering the life of the mine, negotiations with Hydro-Quebec could continue and lead to a significant reduction in costs. Based on past agreements, Hydro-Quebec has, in fact, proposed to some of its clients the possibility to recover a significant part of their capital investment (70-75%), based on the energy consumption throughout the life of the project (Scott Wilson report, 2010). The construction of a power line would also be more advantageous from environmental and social perspectives (see Table 3.2.17).

3.2.6 Accommodation and Services Complex Alternatives

Various alternatives were considered before finalizing the selected layout for the accommodation and services complex. To begin with, the accommodation complex will be modular to facilitate dismantling and future reuse and it will be located away from the buildings related to the mine operations. The modular, prefabricated construction was selected for the accommodation complex because of cost considerations, the quality of the construction, and the ease of installation and dismantling. The material selected for the accommodation and services complex was chosen based on heat retention and easy recycling or dismantling. The site initially selected for the accommodation complex was moved further north to tighten the project footprint and avoid the deforestation of a peninsula, which did not need to be affected by the project. Also, the accommodation complex was designed as a two-storey building instead of a single storey thereby minimizing its footprint.

3.2.7 Solid Waste Management Alternatives

3.2.7.1 Justification for waste management alternatives

The Renard Project will generate various solid waste material and hazardous material. This waste will be generated during the construction phase, the operation phase, or during the closure and site rehabilitation phase. The operation of the site will generate approximately 575 tonnes of solid waste per year (SNC-Lavalin, 2011h). This quantity includes waste that will be recovered and recycled; therefore, it is estimated that a total of 276 tonnes of solid waste will be eliminated while close to 300 tonnes will be recovered and recycled. The relative importance of each category of waste could vary according to the phase of the project but all the categories must be considered in the alternatives analysis.

[7] Total GHG emissions of 49,017 tonnes of CO_2e and 66,439 tonnes of CO_2e for solar and wind power respectively.

3.2.7.2 Hierarchy of management strategies

Given the anticipated large variety of solid waste, various strategies (including their technical, financial, and human resource aspects) must be used to manage the waste. Five framework strategies can be considered for the management of solid waste for the Renard Project. All five are based on the "4R-D" waste strategy priorities: reduce, reuse, recycle, repurpose, and dispose. For the Renard Project this means the following: 1) reduce at the source, 2) reuse certain waste, 3) implementation of a recycling program for some waste, 4) repurpose value-added waste, and finally 5) responsible disposal of waste, often called ultimate waste. The following sections present these strategies in order of decreasing priority.

- *REDUCE*

The first strategy consists of minimizing, at the source, the volume of goods brought to the mining site in order to reduce the quantity of garbage produced since most of the waste will eventually be recycled or disposed of. This management strategy equates to the adoption of a responsible procurement policy that eliminates or reduces, at the source, some supply material. The procurement policy can equally favour suppliers who reduce packaging at the source, by, for example, charging a refundable deposit for packaging. Furthermore, this strategy favours the acquisition of modular buildings designed and built to reduce their environmental footprint not only through the choice of construction material but also through the ease of reuse of this material at the end of the Renard Project.

- *REUSE*

The second strategy targets the reuse of certain products likely to generate waste. To cite a few examples: the reuse of wood pallets on-site, the purchase of filtering equipment to filter oil and grease so it can be reused in other processes, reuse of barrels and pails as garbage cans and containers, the use of cutlery and tablecloths, the use of printed paper as draft paper, etc.

- *RECYCLE*

The third strategy aims at collecting, preparing, and transporting recyclable waste. Certain waste with highly recyclable potential will thus bypass the last two steps (repurpose and disposal) in favour of a more responsible use of resources.

- *REPURPOSE*

The fourth waste management strategy to consider for the project is to repurpose and treat waste generated on-site in the local facilities by, among other ways, composting putrescible waste and incinerating ultimate waste. This equipment and infrastructure will not only decrease the quantity of ultimate waste disposed of at an authorized landfill site, whether the site is located in proximity of the project site or not but also create new resources that could be used in the scope of the Renard Project.

Namely, composting will produce organic soil conditioner that will be used for the progressive restoration work of the processed kimberlite confinement area or other areas temporarily exposed to erosion.

- *DISPOSAL*

The last strategy consists of waste disposal in an authorized site while minimizing the environmental impact of this activity. Although according to the proposed hierarchy, disposal is the last strategy to be used, it is important to keep it in the analysis because, today it is unrealistic to think that the Renard Project, not unlike society in general, could avoid using this strategy.

In the same vein, it is important to provide equipment that will collect and transfer hazardous waste and all other waste that cannot, by law, be taken to a landfill. It is mandatory that this waste is disposed of at an authorized site; therefore, it is important to ensure proper waste management.

3.2.7.3 Management strategy alternatives analysis

There are several alternatives for each of the aforementioned strategies. Also, it is possible that some alternatives be used in parallel (thus partially) based on the analysis results. The elements of each management strategy must be considered to guarantee sound waste management.

Table 3.2.18 presents a summary of the advantages and inconveniences of each management strategy and the related implementation measures.

The analysis of the results in Table 3.2.18 leads to the following two findings:

- The reduction, reuse, recycling, and recovery measures are not mutually exclusive. Since their costs vary from low to average, it is possible to use strategies simultaneously to allow the ultimate decrease of costs associated to disposal;
- It is essential to select a waste disposal system for solid waste that does not require treatment by alternative methods. To this effect, the three alternatives presented are mutually exclusive since their respective costs are high; and it would not be technically nor economically feasible to simultaneously deploy two of these alternatives.

3.2.7.4 Disposal alternatives analysis

Three alternatives are presented for ultimate waste disposal:

- On-site incineration;
- Waste transportation to an authorized technical landfill site (TLS) (e.g.: Chibougamau, Amos, etc.);
- Construction of an on-site landfill site.

These three alternatives each have specific advantages and inconveniences. An analysis of alternatives was done by SNC-Lavalin and AMEC (SNC-Lavalin, 2011h) and included environmental, social, economic, and technical criteria.

Table 3.2.19 presents the main advantages and inconveniences of the three waste disposal alternatives.

The analysis illustrates that landfill is the best alternative.

3.2.7.5 Landfill site alternatives analysis

As illustrated above, the Renard Project requires a landfill site for ultimate waste disposal. The implementation site for this landfill area depends on several factors that are influenced by, among other things, the type of landfill site selected. To this end, the following four alternatives were considered:

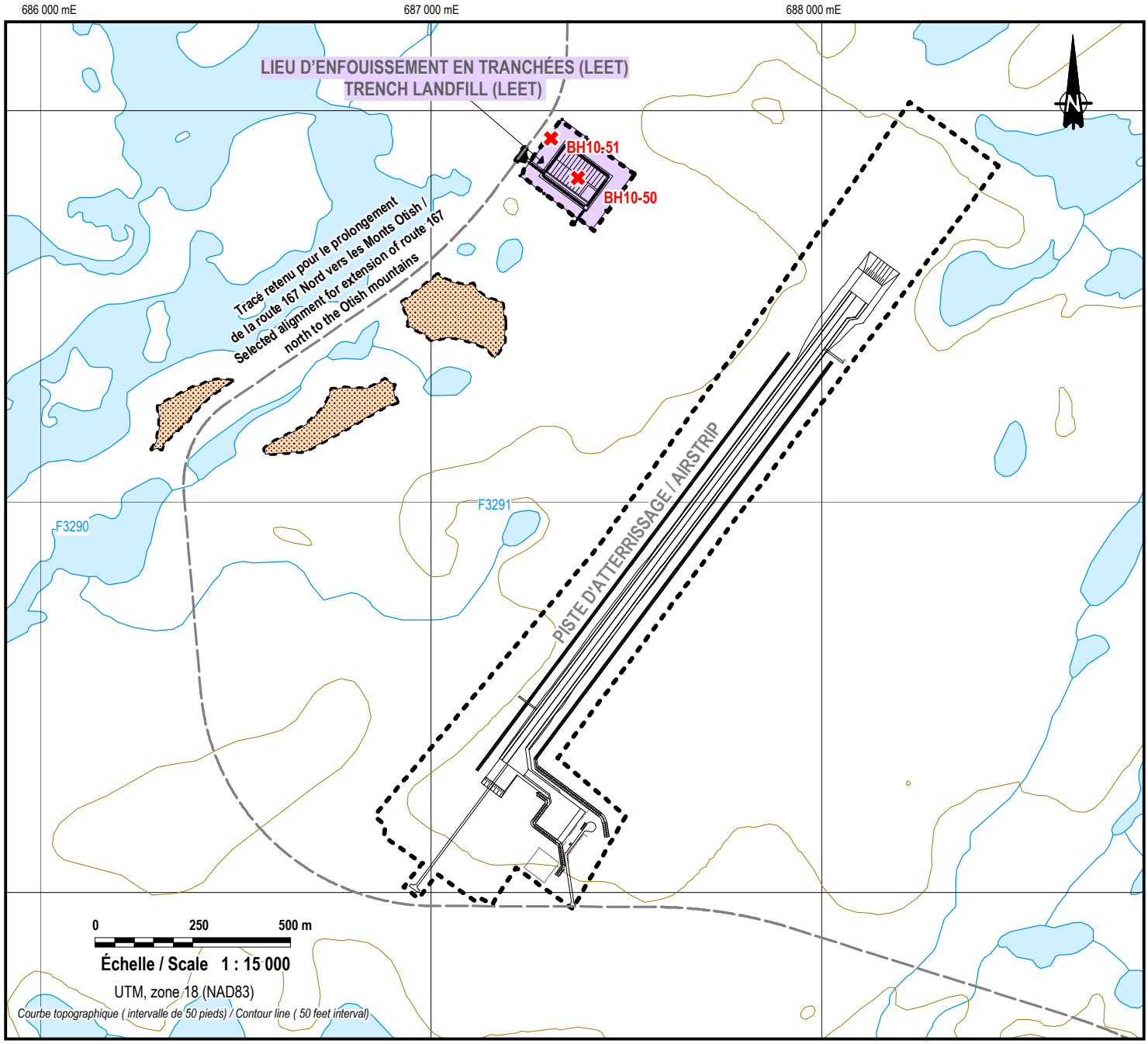
- **Technical landfill site (TLS)**: This type is the most common in the south of the province. The TLS is very safe and equipped with landfill liners (geomembrane) to collect water that is treated before being returned to the environment;
- **Trench landfill site (TLFS)**: This type is adapted to isolated and remote areas. It allows for more flexible use and does not require leachate treatment;
- **Northern area landfill site (NALS)**: This type is adapted to northern communities. It is simply a pit that is covered and re-covered throughout the operation. Open burning may also be authorized for this type of landfill;
- **Isolated area landfill site (IALS)**: This type is adapted to sites inaccessible by road and occupied sporadically. It is an area where it is authorized to dig holes and bury waste.

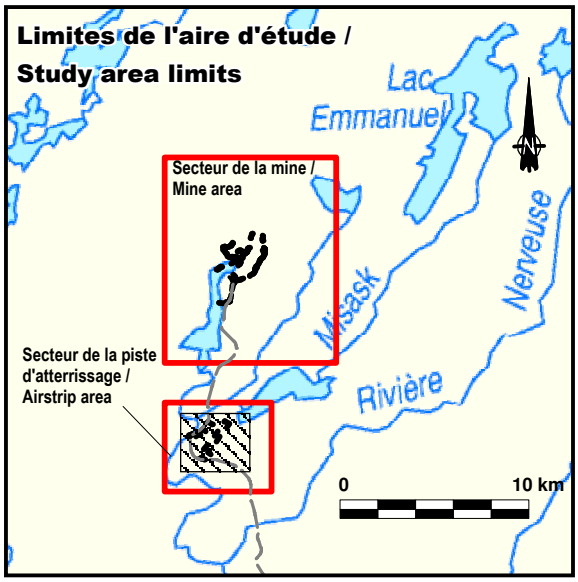
Table 3.2.20 presents a comparison summary of the four alternatives based on the pertinent regulatory, technical, environmental, and socio-economic criteria.

Based on this analysis, the TLFS is selected. This type of landfill site consists in excavating trenches in the ground, filling them with waste, and covering them with the excavated earth. A site that uses this process becomes spread out since the trenches are made with a mechanical shovel and thus cannot be very deep. The trenches must also be more than one metre from the surface of the highest level of the water table and more than 150 m from any free ground water. Given the projected waste volume during the operation phase of the mine (25,000 m^3), only a single area within the proximity of the mine fits the criteria. The area is located parallel to the MTQ's planned road, near the airstrip. The area is identified on Map 3.2.10.

Table 3.2.18 Summary of the Advantages and Disadvantages of the Various Waste Management Strategies and the Necessary Implementation Measures

Approach	Implementation Measure	Impact or Action	Technical Feasibility	Environmental	Socio-economical
Reduce	Responsible procurement policy	Reduction of material brought on site (and therefore RM)	Improved planning of material requirements and other resources	Resource optimization, less GHG associated with transportation	Less transportation
		Use of consigned material (pallets, batteries, etc.)	When purchasing, verify if the supplier has a used equipment recovery program	Less natural resources for manufacturing	Reduces costs associated with disposal
		Favour bulk purchasing	Request for interim handling not always possible	Reduction in packaging	Initial cost is higher for on-site handling. Other cost reduced.
		Prohibit the presence of certain material	Some products do not have substitutes	Presence of lower risk material	Costs for certain substitutes can be higher.
	Raising employees awareness	More efficient management when employees are engaged Improved quality when sorting at the source	Very easy	No risks	Must be done while respecting employees
Reuse	Outdoor and indoor storage sites	Certain parts or pieces (wood, steel, equipment) can be temporarily stored and reused later elsewhere on the site	Easy, but some materials may corrode or deteriorate over time	Material likely to generate contaminants must be securely stored	Avoids transportation, reduces costs by not purchasing
	Oil filtering	After being filtered, hydraulic and transmission oils can be reused	Feasible but requires initial investment for filtration equipment	Reduces oil disposal, but the local filtering process may generate pollution	Economical after a certain volume is met
	Cutlery and tablecloths	The use of reusable tablecloths will be required	Often standard practice in the field; easy to implement	Reduces amount of waste	Economical over the long term
	Other	Paper used on one side only can be used as draft paper before being recycled	Very easy	No risks	No cost, only savings
Recycle	Set up of a recyclable material collection system	Certain strategic points that generate residual waste with a high potential for recycling (e.g.: paper) will have a two-tiered collection system	Easy, the problem resides with the transportation of the material	Reduces disposal	Requires two levels of residual waste management
Recycle	Ecocentre	Storage of recyclable material (wood, ferrous metal, non-ferrous metal) before it is transported	Easy to set up, just need minimal equipment and landscaping	Reduces disposal	Can be economical if the price of metal is high
Recycle/Reduce volume	Transfer center with compactor	Necessary to compact and store recyclable materials (paper, cardboard, glass, plastic) before shipping them	Request for standard equipment and part of a building	Improved use of resources	Essential for proper recycling and will allow to significantly reduce the amount of RM generated
Repurpose/Reduce volume	Industrial composter	Plan for part of the building to house the composter	The technology exists and is accessible	Reduces odours	Reduces humidity of the remaining ultimate waste that must be managed (respect of MDDEP objectives)
		Plan for part of the building for storage in case the equipment breaks down	The average temperature is approximately -5°C	Wildlife management (bear, fox, etc.)	Creates a good quality substrate with a high concentration of organic matter for use during the site rehabilitation phase
	Drying bed/freeze-thaw cycle	Non-mechanical sludge drying with a high organic concentration coming from Lagopede Lake before being repurposed for the site	Request for the area and runoff water collection	Can be used for progressive site rehabilitation	Will reduce costs by avoiding transportation
	Centrifuge system for sludge from the water treatment system	Will increase sludge dryness so it can be used in compost or incinerated	Mobile unit available for pond cleaning or purchase of a small unit to treat a continuous volume if a bio-disc treatment system is selected	Can be used for progressive site rehabilitation	Equipment is expensive
Disposal/Reduce volume	Incinerator	Potential source of heat	Ad-hoc use = stress of material and useful life possibly shortened	Fossil resource consumption	Equipment is expensive
		Reduces volume and weight of RM sent to the landfill site		Requires ash disposal	Complex maintenance
Disposal	Landfill area	Required to have an ultimate waste disposal area in the vicinity of the site Minimizes the transportation of non-productive material Ensures control of disposal	Relatively easy to set up and use	Reduces transportation Becomes a source of water table contamination	Reduces disposal costs compared to shipping or incineration
Disposal	Controlled burn area	Required for explosive and explosive's packaging disposal	Easy to build and use	Emits smoke	Very inexpensive





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Bancs d'emprunt potentiels / Potential borrow pits

Forage et piézomètre / Drilling holes observation wells

Localisation du lieu d'enfouissement en tranchées (LEET) et des zones potentielles de banc d'emprunt / Trench landfill and location of potential borrow pits

ROCHE

Carte de base / Base Map : BNDT50, 33A16
Fichier / File : 61470_EIES_Leet_111220.WOR

Décembre 2011 / December 2011

Carte / Map 3.2.10

Table 3.2.19 Advantages and Disadvantages of Three Waste Disposal Alternatives

Evaluation Criteria	Criteria Weighting	Value for criterion parameters		Result for each evaluation criterion for the different alternatives		
		Class	Weighting (pts)	Incinerator	Landfill	Transportation
Economic						
Planned implementation costs	8	> $1,000,000	1	$ 1 020 000.00	$ 211 000.00	$ 210 000.00
		$1 M $ ≥ $100,000	2	**8**	**16**	**16**
		< $100,000	3			
Planned operations cost	5	> $100,000/yr	1	$40,000/yr	$56,000/yr	$102,908/yr
		$100,000/yr ≥ $50,000/yr	2	**15**	**10**	**5**
		< $50,000/yr	3			
Total cost over a 20 year lifecycle	5	> $2,000,000	1	$ 1 820 000.00	$ 1 331 000.00	$ 2 268 160.00
		$2,000,000 ≥ $1,500,000	2	**10**	**15**	**5**
		< $1,500,000	3			
Need financial guarantee for operations	1	Yes	1		x	
		No	2	**2**	**1**	**2**
Technical and Administrative						
Maintenance equipment related constraints	3	High	1	High	Medium	Medium
		Medium	2	**3**	**6**	**6**
		Low	3			
Equipment is reusable at the end of development	2	No	1	Off site	On-site	Off site
		Only on-site	2	**6**	**4**	**6**
		Off site	3			
Degree of environmental monitoring	4	High	1	High	Moderate	Low
		Moderate	2	**4**	**8**	**12**
		Low	3			
Extent of site closure activities	1	Dismantling and monitoring	1	Dismant.	Dismant. + monit.	None
		Dismantling	2	**2**	**1**	**3**
		No activity	3			
Post-closure monitoring required	1	Yes	1		x	
		No	2	**2**	**1**	**2**
Possibility to use as of the construction phase	5	No	1		x	
		Yes	2	**5**	**10**	**5**
Interferes with mining activities	3	Yes	1			
		No	2	**6**	**6**	**6**
Environmental						
Major risk to impact the water table	2	Yes	1		x	
		No	2	**4**	**2**	**4**
Generates air pollution	2	Yes	1	x		x
		No	2	**2**	**4**	**2**
GHG emissions	2	No	1	x	x	x
		Yes	2	**4**	**4**	**4**
Extent of encroachment on the area	2	Major	1	Low	Major	Moderate
		Moderate	2	**6**	**2**	**4**
		Low	3			
Social						
Increase in road traffic	2	Major	1	Low	Moderate	Major
		Moderate	2	**6**	**4**	**2**
		Low	3			
Offers local employment opportunity	3	No	1	x	x	
		Yes	2	**6**	**6**	**3**
Obstructs the freedom of those who use the area	2	Yes	1		x	
		No	2	**4**	**2**	**4**
			Total	**80**	**92**	**86**

Table 3.2.20 Comparison of the Four Landfill Site Alternatives for the Renard Project

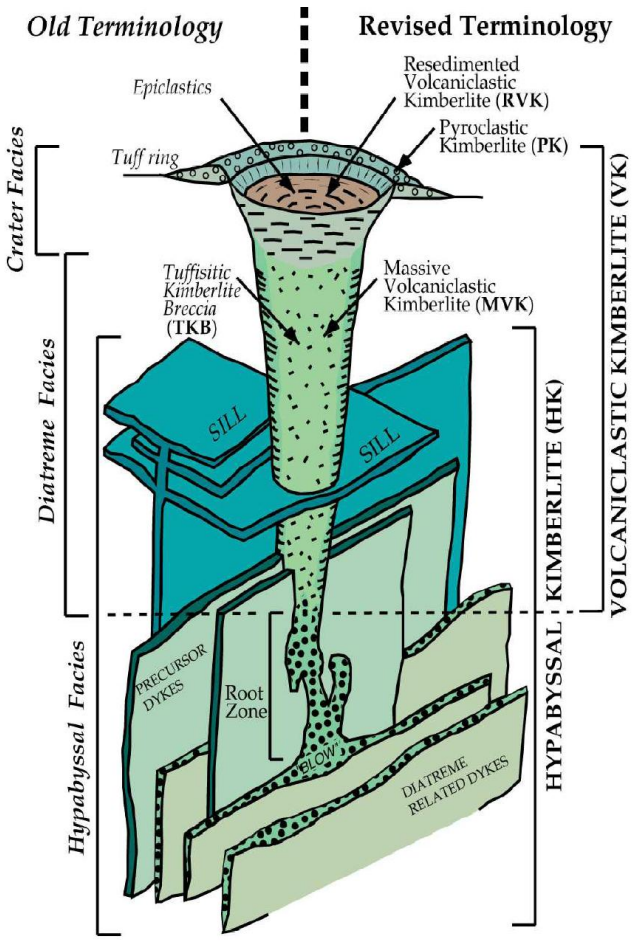
Evaluation Criteria	Criteria Weighting	Value for criterion parameters		Result for each evaluation criterion for the different alternatives			
		Class	Weighting (pts)	TLS	TLFS	NALS	IALS
Regulatory							
Regulatory plan admissibility	5	No	0	x	x		
		Yes	2	**10**	**10**	**0**	**0**
Technical							
Site dimensions	2	Insufficient	0	Sufficient	Sufficient	Sufficient	Insufficient
		Sufficient	2	**4**	**4**	**4**	**0**
Maintenance and monitoring constraints	1	Major	1	Major	Moderate	Low	Low
		Moderate	2	**1**	**2**	**3**	**3**
		Low	3				
Extent of environmental monitoring	1	Major	1	Major	Moderate	Low	Low
		Moderate	2	**1**	**2**	**3**	**3**
		Low	3				
Environmental							
Risk of water table contamination	2	Major	1	Low	Moderate	Major	Major
		Moderate	2	**6**	**4**	**2**	**2**
		Low	3				
Risk to contaminate area	2	Major	1	Low	Moderate	Major	Major
		Moderate	2	**6**	**4**	**2**	**2**
		Low	3				
Extent of encroachment on the area	1	Major	1	Major	Moderate	Low	Low
		Moderate	2	**1**	**2**	**3**	**3**
		Low	3				
Socio-economic							
Cost of equipment	5	Major	1	Major	Moderate	Low	Low
		Moderate	2	**5**	**10**	**15**	**15**
		Low	3				
			Total	**34**	**38**	**32**	**28**

3.3 General Description of the Deposit and the Mining Project

3.3.1 Description of the Deposit and its Mineral Characteristics

The geology of the project area is characterized by ancient rock from the Precambrian age (approximately 2.7 billion years). The rock is traversed in places by ancient volcanic “chimneys” that have transported a mixture of molten magma with rock and mineral fragments toward the surface from great depths. Part of this mixture then consolidated in the vertical channels of the chimneys, producing rock formations that show varied petrographic and mineral characteristics.

The volcanic chimneys observed in the Renard Project region are typical of the South African model. They present three distinct facies: the hypabyssal facies found at the base of feeder dykes; the diatreme facies, often brecciated, forming the cone; and the crater facies showing volcaniclastic and epiclastic rocks (Jébrack and Marcoux, 2008). Figure 3.3.1 illustrates an example of a chimney and the main characteristics associated with it.



Source: *Taken from Kjarsgaard (1996) and modified according to Mitchell (1986);* [*http://www.futura-sciences.com/fr/doc/t/geologie/d/diamants-sur-canape_772/c3/221/p4/*](http://www.futura-sciences.com/fr/doc/t/geologie/d/diamants-sur-canape_772/c3/221/p4/) (French only)

Figure 3.3.1 Example of a Volcanic Pipe

The volcanic chimneys in the region contain rock formations known as kimberlites. Kimberlite is a volcanic, ultrabasic, potassic rock poor in silica (SiO_2 <45%) and rich in magnesium and volatile elements (H_2O, CO_2). The richness in volatiles along with the magmatic breccia suggests a highly explosive origin of the kimberlitic magma deposit Figure 3.3.2 illustrates an example of a kimberlite sample.



Source: *http://www.stornowaydiamonds.com/mining_fundamentals/genesis_of_diamonds/types/*

Figure 3.3.2 Renard Project Kimberlite with Diamond Presence Taken From a Drilling Sample

Five episodes of kimberlite-type volcanism would have occurred in northern Quebec. The Renard Project is associated to the volcanic episode having given birth to the Otish Mountains. This dates back to approximately 640.5 ± 2.8 Ma. The episode would have produced at least 12 volcanic chimneys.

Several of the kimberlite chimneys identified in the region of the Renard Project offer similar geological characteristics. The presence of diamonds is typically associated with kimberlite formations that contributed to their transport to the surface. Indeed, diamonds form in conditions of very high pressure and at very deep depths, often more than 150 km below the surface. The type of deposit found in the Renard project kimberlites is considered *primary* since the diamonds remained in the matrix, whereas a *secondary* deposit type results from the erosion of the kimberlite that concentrates the diamonds in marine and alluvial sediments.

The rough diamonds from the Renard deposit are of various colour, shape, size, and quality. Although the diamond content varies from one pipe to another, all the chimneys contain diamonds, which makes for an economically viable site. Indeed, the project proposes on average an indicated mineral resource of 23 million carats, an inferred resource of 17 million carats, and a potential resource evaluated between 24 and 49 million carats (GeoStrat Consulting Services, 2011).

3.3.2 Deposit plans and profiles

Around nine kimberlite chimneys were identified over a 2 km^2 zone in the Renard Project assessment area. These kimberlites are known as Renard 1 to 10 (Renard 5 and 6 being a single kimberlite were named R-65). The kimberlite chimneys appear at the surface as irregular and elliptic bodies. Their size varies between 0.1 and 2.0 ha, and they are generally spaced between 50 and 500 m apart. The linear dyke systems (Hibou and Lynx) associated with the kimberlites also present an interesting resource development. Figure 3.3 illustrates the location of the main kimberlites and the associated dykes. Figure 3.3.4 illustrates a cross-sectional view of a kimberlite chimney.

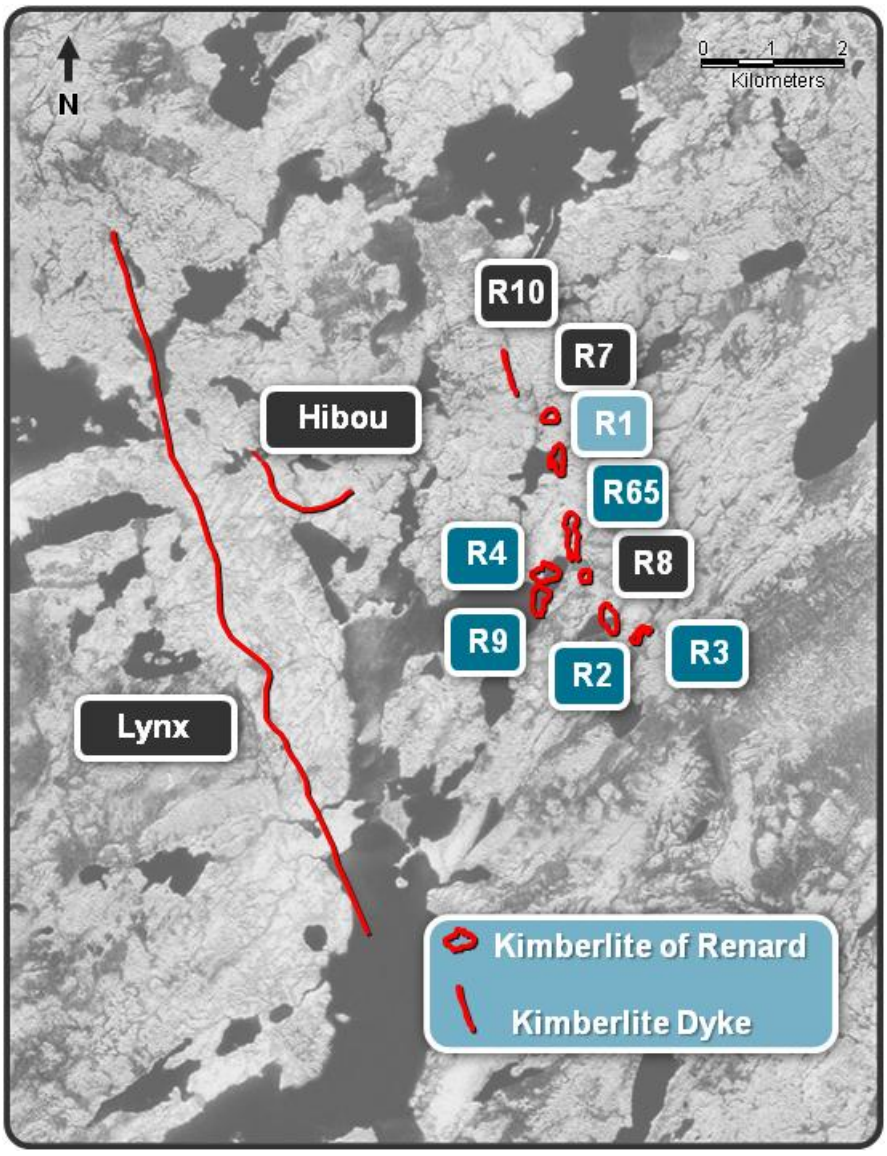
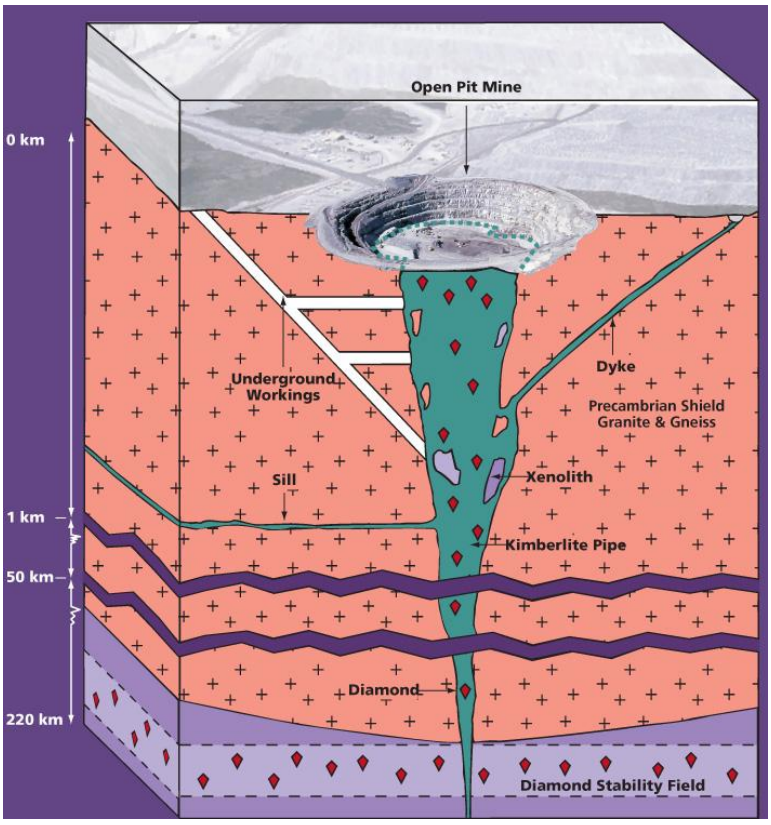


Figure 3.3.3 Renard Project Main Kimberlites and Dykes



Source: http://geoscape.nrcan.gc.ca/nwt/diamonds_e.php

Figure 3.3.4 Main Components of a Kimberlite Pipe Mine

Only a few of the kimberlite pipes have been, up until now, the object of intensive exploration activities. The R-2, R-3, R-4, R-9, and R-65 kimberlite pipes as well as the Hibou and Lynx dyke systems present diamond counts of potential economic interest. Some of their characteristics are shown in Table 3.3.1.

Table 3.3.1 Main Characteristics of a Kimberlite System

System	Surface Size (ha)	Modelled Vertical Extent (m)	Mining Potential	Comments
Renard 2	0.8	688	Remains open at depth	Irregular kimberlite diatreme zone near the surface. Laying slightly on a north-south axis near the surface. The extent of the kimberlite portion in the chimneys increases with depth. Partly covered by a lake.
Renard 3	0.3	395	Remains open at depth	Irregular root zone in the kimberlite chimneys.
Renard 4	1.0	380	Remains open at depth	Generally regular kimberlite diatreme zone. Laying slightly on an east-west axis, subcircular near the surface. Partially covered by a shallow lake (0.4 ha).
Renard 9	0.5	380	Remains open at depth	Kimberlite zone from the base of the diatreme to the root zone. Laying on a north-south axis near the surface with an elliptical shape. The body dips eastward with depth. Covered entirely by lake 2-4 m deep.
Renard 65	1.7	280	Remains open at depth	Kimberlite diatreme zone. Laying slightly on a north-south axis near the surface with an irregular shape.
Hibou	N/A	92	Remains open along the length and dip	East-west dyke direction. Weak 10° N-NE dip.
Lynx	N/A	95	Remains open along the length and dip	North-northwest dyke direction. Variant dip of 10° to 50° to the east.

Source: Adapted from Scott Wilson, 2009.

3.3.3 Mineral Resources and Project Lifespan

The evaluation of the mineral resources was conducted in March 2011 by GeoStrat Consulting Services Inc. The indicated mineral resources were rated at 23.8 million carats (26.6 million tonnes at 89.2 carats per 100 tonnes of ore). The presumed mineral resources were rated at 17.5 million carats (31.1 million tonnes at 56.1 carats per 100 tonnes of ore). As well, 23.5 million to 48.5 million carats were classified as “potential mineral deposit.”

The project is based on the production and treatment of 44.3 million tonnes (Mt) of ore. At a nominal treatment rate of approximately 2.6 Mt/year, the resources should allow for a mining operation lifespan of about 20 years. However, several indicators suggest that the resources could support a longer mine life because all the kimberlites remain open to their depth.

3.3.4 Mine Plan

The mine plan calls for the exploitation of several deposits (also called kimberlite chimneys). Table 3.3.2 shows the extraction chronology of the different deposits and the tonnages of overburden, waste rock and ore involved. The locations of stockpiles for the overburden, waste rock and ore are illustrated on Map 3.2.5 (in pocket insert at the end of this document).

The construction phase will take place in 2013 and 2014 (before the beginning of ore processing). This phase will include the following activities:

- Land clearing and surface levelling;
- Construction of access roads;
- Construction of various buildings and infrastructure;
- Setting up of components of the water management system (ditches, culverts, treatment systems, etc.);
- Extraction of overburden, waste rock and ore in pits R-65 and R-2/R-3.

The operation phase will be conducted from 2015 to 2033.

In 2013 and 2014, overburden, waste rock and ore will be extracted from pit R-65. The waste rock will be used for construction purposes, while the ore and overburden will be taken to their respective stockpiles. The extraction activities in pit R-65 will be interrupted in 2015 and 2016 but will re-start in 2017 until the completion of the project in 2033.

The extraction activities in pits R-2/R-3 will begin in 2014. The same material management methods will be used as for pit R-65 during construction, however, extraction activities at pits R-2/R-3 will cease in 2016.

The access ramps to underground worksites at R-2/R-3 will be dug beginning in 2013. There will be no overburden to remove and the waste rock will be taken to its dedicated storage area. Mining activities at the underground worksites R-2/R-3 will continue until 2028.

Underground worksites R-4 and R-9 will be operated from 2021 to the end of the project's activities in 2033. From 2021 to 2024, however, the work will concern access to the resources and no minerals will be extracted.

It is noteworthy that all waste rock will be used for construction or underground backfilling or will be returned to the pits. Some of the overburden will be used for site rehabilitation.

3.3.5 Mining Methods and Required Infrastructures

As previously mentioned, open pit mining will first be used to mine the Renard Project deposits followed by underground mining. These deposits in R-65, R-2 and R-3 chimneys were selected to be mined first. The mining of R-4 and R-9 chimneyswill begin during the second half of the extraction operations in years 11 and 12. These deposits are located within approximately a one kilometre radius. Figure 3.3.5 illustrates the configuration of the deposits and the proposed development infrastructures.

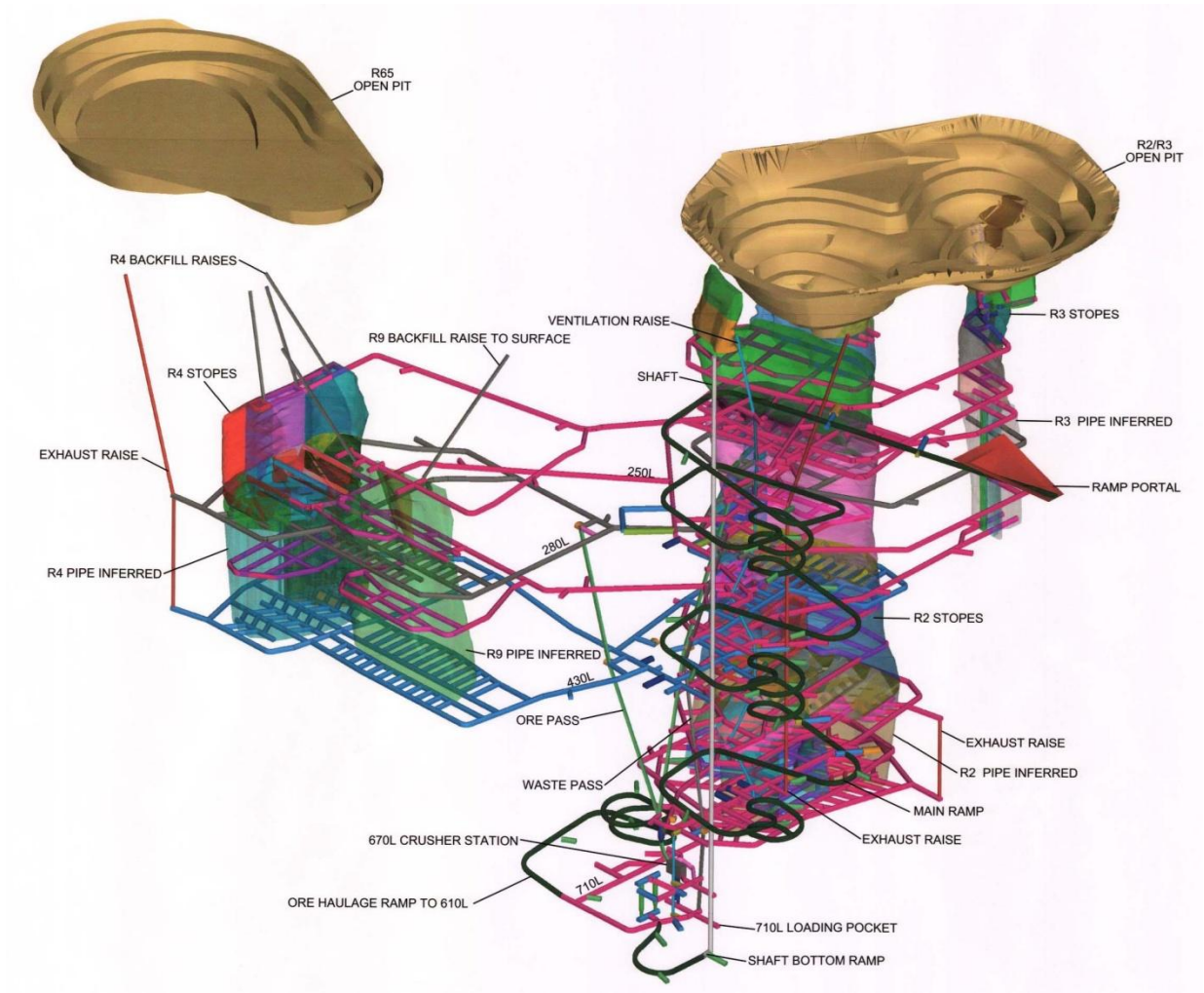


Figure 3.3.5 Mining Operations for R-2, R-3, R-4 and R-65 Deposits

Table 3.3.2 **Chronology of the Mining Activities and Overburden, Waste Rock, and Ore Tonnage (x1000 t)**

Deposit/Materials	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
R-65 (pit)																						
Overburden	810	81	-	-	382	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1 273**
Waste Rock	835	182	-	-	995	1 185	1 185	1 185	790	807	790	790	790	790	790	790	790	790	790	790	424	**15 488**
Ore	106	37	-	-	322	395	395	395	395	403	395	395	395	395	395	395	395	395	395	395	212	**6 609**
R-2/R-3 (Pits)																						
Overburden	-	2 259	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2 277**
Waste Rock	-	2 559	4 746	552	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**7 857**
Ore	-	192	1 237	606	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2 035**
R-2/R-3 (Underground)																						
Waste Rock	74	220	282	273	164	213	74	41	55	55	55	41	-	-	-	-	-	-	-	-	-	**1 547**
Ore	-	-	51	463	2 160	2 160	2 160	2 160	2 160	2 152	2 160	2 160	2 143	2 022	921	464	-	-	-	-	-	**23 335**
R-4 (Underground)																						
Waste Rock	-	-	-	-	-	-	-	-	15	74	42	-	55	55	55	55	-	-	-	-	-	**351**
Ore	-	-	-	-	-	-	-	-	-	-	-	-	11	90	807	1 105	1 406	1 406	1 406	1 406	737	**8 374**
R-9 (Underground)																						
Waste Rock	-	-	-	-	-	-	-	-	55	55	55	55	-	-	-	-	-	-	-	-	-	**219**
Ore	-	-	-	-	-	-	-	-	-	-	-	-	6	48	432	592	754	754	754	754	422	**4 515**

The site operation activities include the following:

- Stripping and management of the overburden;
- Excavation and management of the rock (waste rock, ore);
- Ore processing;
- Management of the processed kimberlite confinement area;
- Water supply;
- Water management, recycling, and treatment;
- Solid waste management.

The detailed plans of the main infrastructures planned for the project site can be found on Map 3.2.5 in the pocket insert of Volume 3. Figure 3.3.6 is a 3D visual simulation of the operation phase of the site.

Thus, the main infrastructures that will be required for the operation of the mine include the following elements:

- Open pits for mining five kimberlite chimneys (R-2, R-3, R-4, R-9 and R-65);
- A 740-metre deep shaft and adits to allow underground extraction of the kimberlite chimneys (R-2, R-3, R-4, R-9 and possibly R-65);
- An access ramp to the underground mine;
- A ore processing plant;
- A processed kimberlite confinement area;
- A waste rock stockpile and a pre-production ore stockpile;
- A water management system with sedimentation ponds;
- An industrial wastewater treatment plant;
- An accommodation and services complex;
- A drinking water supply system;
- A domestic wastewater treatment plant;
- An airstrip for the transport of personnel;
- A quarry and borrow pits;
- An area for storage, management and recycling of solid waste and hazardous materials;
- A trench landfill site for the management of solid waste;
- A storage area for explosives;
- Secondary roads on the site;
- Power generating sets and a heat recovery system for industrial heating;
- A fuel storage area and filling stations.

3.4 Ore Extraction, Handling, and Storage

In the context of the Renard Project, the mining of the diamond-bearing resources is subdivided into three main steps: extraction, mineral processing, and final sorting. For the first step, extraction, the sizes and the shapes of the different volcanic kimberlite chimneys led to the development of two distinct extraction methods: open pit mining and underground mining.

3.4.1 Open Pit Mining

In the initial operation phase, topsoil stripping will be undertaken at the sites of deposits R-65 and R-2/R-3 (Photo 3.4.1). This first step allows access to the different diamond deposits located near the surface by removing the overburden. The kimberlite chimneys will then be excavated, using explosives, at the same time as benches are built by which the ore and waste rock may be brought to the surface by truck and transported to the processing plant (or a pre-production ore stockpile) or to the waste rock stockpile. The open pit mining of the R-2 and R-3 pits will take place over about three years and will be followed by underground extraction. The R-65 deposit will be mined only by the open pit method.

The combined R-2/R-3 pit will have a surface area of 8.8 ha and a depth of about 115 metres. The combined R-65 pit will have a surface area of 13.6 ha and a depth of about 120 metres. A sedimentation pond will be installed in the R-65 pit to settle particulates upstream of the mine wastewater treatment plant.

The presence of streams and water bodies nearly the deposits will involve the diversion of certain rivers and streams, the dewatering of two small lakes, and the development of a drainage system in order to access the resource in a safe manner (see Section 3.10 for details).



Photo 3.4.1 Open Pit Mining



Figure 3.3.6 3D Visual Simulation of the Operation Phase of the Renard Project Site

3.4.2 Underground Mining

A 740-metre deep vertical shaft will be developed to access deposits R-2, R-3, R-4 and R-9. Initially, an access ramp will be built in the R-2 deposit area down to the 250-metre level and will later reach the bottom of the mine, providing access to R-2, R-3, R-4 and R-9. The extraction method chosen for the underground deposits R-2 and R-3 is known as blasthole shrink stoppage (Figure 3.4.1, Photo 3.4.2), which is characterized by drilling vertical holes in the ore from one level of the mine to another. The drilling is conducted from small production chambers dug in the deposit. Insertion of explosives in the drill holes allows for successive blasting of ore in the chambers where it can then be drawn out by gravity at the blast site.

During the blasting phase, the ore is left in place to avoid collapsing of the chamber walls. Given that blasted ore occupies a larger volume than rock left in place, approximately 35% of the ore will be regularly removed to ensure an adequate workspace.

Backfilling work will then be completed to fill the void left by complete extraction of the blasted ore. This operation consists of transporting waste rock by truck and dumping it from the surface. The use of this fill material serves to eliminate the waste rock stockpiles during the operation of the mine.

Finally, the ore will be crushed before being taken to the surface.

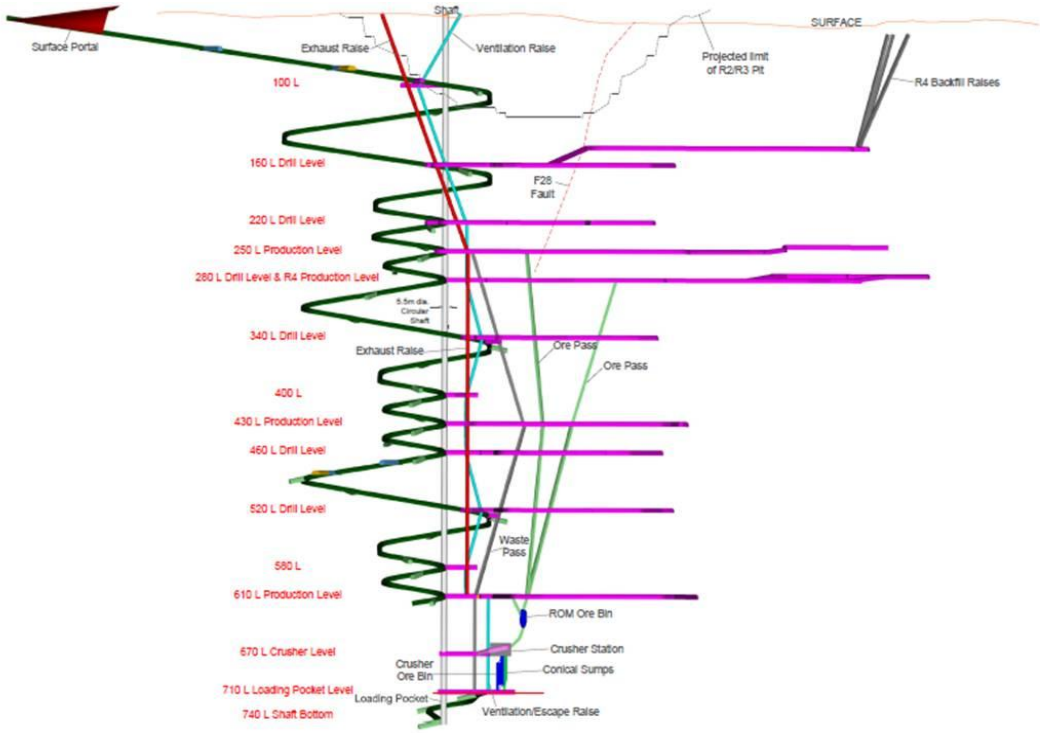


Figure 3.4.1 Cross-sectional View of Underground Infrastructures



Photo 3.4.2 Blasthole Shrinkage Mining Method

3.4.3 Ore Storage

A pre-production ore stockpile will be set up south of the R-2/R-3 extraction pits. The ore extracted during site preparation (years -2, -1 and beginning of year 1) will be stored there before being transported to the process plant. The pre-production ore stockpile area will contain approximately 1 Mt of ore at the beginning of year 1. All the stockpiled ore will already have been processed once the processing activities are terminated (middle of year 19).

3.5 Equipment Use and Maintenance and Road Traffic

The heavy equipment is separated into two groups based on their main functions:

- Heavy equipment used for underground mining;
- Heavy equipment used for open pit mining.

A secondary vehicle fleet used to support operations has been added to the major support equipment fleet.

3.5.1 Underground Mine Equipment

This category (Photo 3.5.1) includes all the equipment and machinery used for the underground mining activities during the development and production phases. In total, 50 vehicles will be used, including

22 secondary vehicles (support equipment), during the two phases of underground operations. This number includes approximately 15 vehicles that will be used beginning in 2016 for the operation phase.



Photo 3.5.1 Type of Underground Mining Vehicles

3.5.2 Open Pit Mine Equipment

This category (Photo 3.5.2) includes vehicles mainly related to excavation, pumping, loading, and transport operations. In 2013, approximately 35 vehicles will be used for these operations including a support vehicle fleet. The list of production vehicles includes 2 blasting drills, an emulsion re-pump truck, 4 rigid-body haul trucks (60t) (Photo 3.5.2) and 3 articulated haul trucks (40t) used to transport material (waste rock, ore, overburden, processed kimberlite) to their respective stockpiles or confinement area. In addition, two load vehicles a 6 m^3 hydraulic excavator (Photo 3.5.2) and a wheel loader with an 8.6 m^3 bucket are added to this fleet.



Photo 3.5.2 Various Types of Load and Transport Vehicles

3.5.2.1 Support Equipment

This type of equipment is used to support the mining operations and, therefore, includes vehicles to transport fuel, water, tools, etc. around the site to the various facilities. In this category, there are also vehicles used for the maintenance and management of the processed kimberlite confinement area, for the construction and maintenance of the mining roads as well as for grading access roads and ramps, etc.

In 2013, the machinery fleet that will be used to do surface work includes a total of 14 support equipment vehicles. The fleet will be equipped with 3 track dozers, a compactor will be required for 4-5 months per year for maintenance and construction purposes, a tool carrier, a motor grader, a fleet of 3 service trucks, including a fuel and lube truck, a water truck, and a service truck, a 3 m^3 hydraulic excavator for maintenance, and 8 service trucks for employee transport.

Due to the small size of the fleet, it will be managed by the foremen and superintendent.

3.5.3 Heavy Equipment Maintenance

The heavy equipment maintenance will be performed by an owner maintenance team. The maintenance department will be responsible for repairing and maintaining all the mine equipment, be it underground or open pit. Specialized mechanics and mobile equipment foreman will be on site during the open pit production periods. All major repairs to equipment (underground or surface) will be done at ground level in a garage specifically designed for this purpose. This garage and other workshops required for the

maintenance and repair of all the heavy and light mine equipment will be grouped together in one building of approximately 2,423 m^2. However, two underground repair areas will be provided at two different levels in the mine for all minor repairs.

3.5.4 On-site Road Traffic

The on-site road network that connects all the mine facilities has a total length of approximately 2.2 km, excluding the MTQ road. The network provides access to the various mine facilities including the open pits, the underground ramp access, the explosives storage area, the crusher, the process plant, the processed kimberlite confinement area, the waste rock and overburden stockpiles, the ore stockpile, the water treatment plants, the accommodation and services complex, etc.

The network consists of three types of roads:

- Heavy-load roads with a roadway width of 15 m and 1.5 m shoulders;
- Light vehicle roads with a roadway width of 7 m and 1.5 m shoulders;
- Access roads with a roadway width of 6 m and no shoulders.

The access roads will connect the main site, the management water pumping station, the domestic and mine wastewater treatment stations, the solid waste management site, and provide access to several ditches.

The heavy-load roads are designed for Caterpillar 775F trucks.

The ramps inside the pits are 21.8 m in width and are designed for double lane traffic. This corresponds to 3.5 times the width of the 60 t trucks with a security berm of 1.1 m and also include an allowance for a drainage ditch. The maximum ramp gradient is 10%. The single lane ramps have a designed width of 13.7 m and will be used to access the bottom of the open pits.

3.6 Ore Processing

The ore processing system will extract diamonds, by an established order of magnitude (cut-off point), of grain sizes above 1 mm and with a recovery rate of at least 97%. The kimberlite processing plant (Photo 3.6.1) will contain the following equipment: crushers, screening (sieving), scrubbing-cleaning, dense media separation circuit, and sorting circuit. Figure 3.6.1 illustrates the general mineral process for the Renard Project.

3.6.1 Type of Processing

Crushing

The crushed ore (-600 mm) from the underground mine or the open pits will be temporarily stockpiled or sent directly to the crushing circuit. This circuit frees the diamond from the gangue (kimberlite) with various equipment and mechanical processes (primary, secondary, tertiary) (Photo 3.6.1). As such, conveyors and jaw crushers are part of the primary circuit. The ore grain size at this step is below

250 mm. The secondary step involves an ore screening step that separates the diamond ore between 50 mm and 30 mm in order to send this ore to the coarse diamond recovery circuit. The screened ore exceeding 50 mm will loop back to the cone crusher and is returned to screening. The screened ore less than 30 mm is sent directly to the high pressure grinding rolls. The diamond ore between 30 and 50 mm is also sent toward the grinding rolls while waiting to be redirected to a future coarse diamond recovery circuit.



Photo 3.6.1 Kimberlite Processing Plant

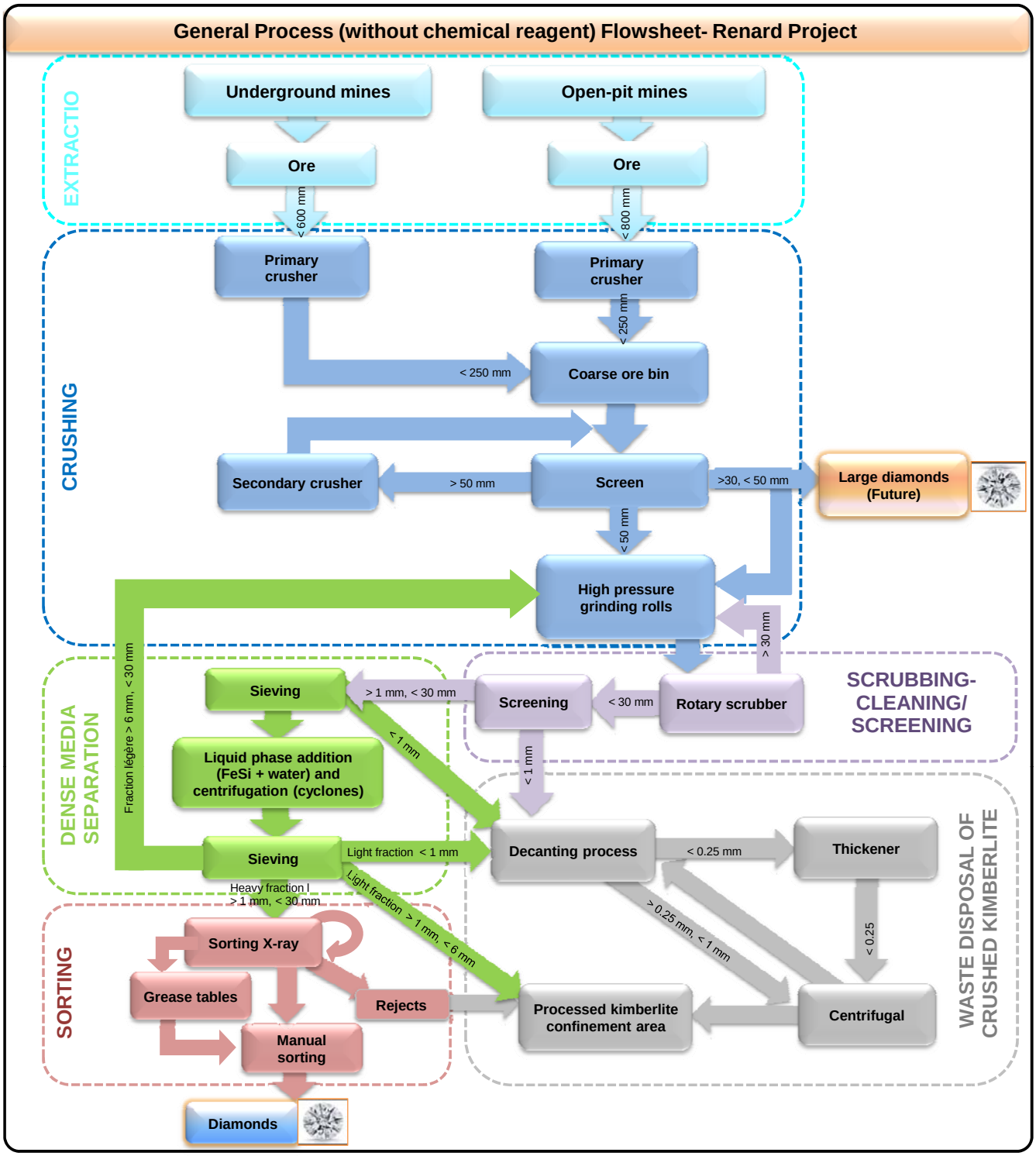


Figure 3.6.1 Overall Processing Flow

Scrubbing-Cleaning/Screening

The ore coming from tertiary crushing next moves to the scrubbing-cleaning step inside a rotary scrubber (photo 3.6.2). This operation disaggregates the sludge or gangue stuck on the diamonds. The scrubbed ore exceeding 30 mm is returned to the crushing circuit. The scrubbed ore with a diameter less than 30 mm goes to the screening step and is classed between 1 mm and 30 mm. The washed grains are then sent to the dense media separation circuit (DMS). However, the grains with a diameter less than 1 mm will be, after the thickening and degritting process, sent to the processed kimberlite confinement area. The water used in the process will be recycled and reused.



Photo 3.6.2 Rotary Scrubber

Dense media separation (DMS)

This technique separates the constituents in the ore by specific density (3.51 gm/cm^3 diamond density) by combining them with an intermediate density liquid phase. The separation process begins by adding to the crushed ore (1 mm to 30 mm) a mixture of ferrosilicon (FeSi) and water (2.55-2.65 gm/cm^3 pulp). The media slurry (non-toxic, non-flammable, and chemically stable) is then pumped into the cyclones of the Dense Media Separation (DMS) (Photo 3.6.3). The centrifugal force exerted on the mixture separates the different density materials. This mixture, forming the dense media between the gangue and the diamond, will then allow one fraction to float and the other to sink. After the sifting, the lighter fraction containing the gangue will generate two different diameter ores. The first, with a grain size varying between 6 mm and 30 mm, is sent back to the tertiary crushing, scrubbing-cleaning, and screening circuits. The second, with a diameter between 1 mm and 6 mm, is discharged from the floats screen and convoyed to the processed kimberlite confinement area. The heavy fraction of the processed kimberlite, called the DMS concentrate, containing diamonds, is first sieved and fed into a hopper then transported by pipeline to the recovery plant where it is sorted. A FeSi magnetic separation recovery circuit is included in the DMS plant.



Photo 3.6.3 Cyclones Used in the Dense Media Separation Process

Sorting

The unique physical properties of diamonds are useful in their recovery. These properties include sensitivity to magnetism and luminescence to x-rays. In addition, diamonds are lipophilic, which means they are insoluble (repel water) and they have an affinity to adhere to fats like grease. The grease table technique will also be used as a complementary process to x-rays (Figure 3.6.2).

When x-rays pass through the DMS concentrate, the diamonds absorb the energy and give off light. This luminescence specific to diamonds allows them to be detected and sorted. First, the screening process divides the DMS concentrate with a grain size of between 1 mm and 30 mm into three different size fractions. These fractions are sent to an initial round of sorting by x-ray. From here, one part is directed to the grease tables and a second part is dried and demagnetized by a magnetic separation process. Only the non-magnetic fraction is sorted by x-ray. These are then removed from the process flow. The diamond concentrate from the grease tables, previously degreased, and diamonds from the final round of x-ray sorting are left in the process. These diamonds end up in a diamond room where they are hand sorted in secure glove boxes, weighed, and cleaned before being sent to a secure area. The non-diamond rejects associated with the sorting process are sent to the processed kimberlite confinement area.

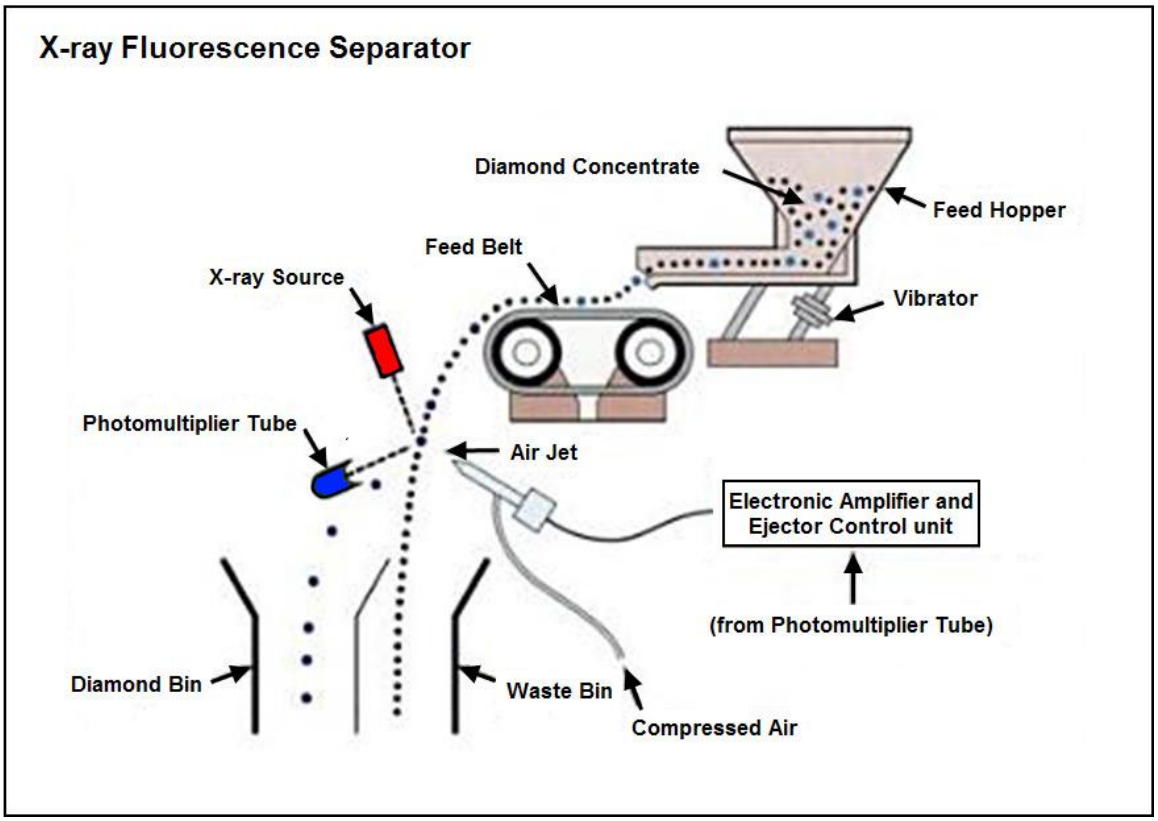


Figure 3.6.2 X-ray Sorting Process Diamcor Mining Inc

3.6.2 Processing Rate

The ore processing plant plans to process 6,000 tons per day over the first year of operation and will increase quickly to 7,000 t/d. In the first few years, the ore will come only from the open pit mines. The underground mines will then take over the depletion of pits R-2 and R-3; the production will be 6,000 t/d from the underground operations and 1,000 t/d from the R-65 pit.

3.6.3 Secure Storage and Delivery

The chemicals used at the ore processing plant include anionic polymer, ferrosilicon, caustic soda, hydrochloric acid, and greases. Table 3.6.1 details their chemical composition, use, and storage conditions. Information on storage and hazardous material management, including combustibles, is presented in Section 3.12. Hazardous material management will be made in accordance with the *Hazardous Materials Regulations* (R.S.Q., c. Q-2, r. 15.2). The transport of hazardous material will meet the *Transportation of Dangerous Goods Regulations* (R.S.Q., c. C-24.2, a. 622, par. 1 to 8). The management of petroleum equipment and products will follow the *Petroleum Products and Equipment Act* (R.S.Q., chapter P-29.1) and the *Petroleum Products Act* (R.S.Q. c. P-29.1, r.3).

Heavy equipment and other mobile equipment traffic will be limited to the right-of-way access roads and pre-identified work areas. Vehicle traffic should be at low speeds respecting the speed limit of 30 km/h on-site and 50 km/h on secondary roads.

For the propane storage facilities:

- The facilities will comply with the CSA B-149.2-05 standard (Code for propane storage and handling);
- The propane suppliers will be qualified;
- The area around the propane containers will be free of combustible material, vegetation, and debris;
- The ground surface under the containers will have a 1% slope toward the periphery to avoid combustible liquid accumulation in the event of an accidental leak;
- The containers will be protected by bollards to prevent vehicle collisions;
- Portable fire extinguishers will be on hand;
- The emergency water network and emergency vehicles for fire will be available.

Prevention procedures for risk of spillage and accidental leakage will be implemented as well as an emergency response plan (e.g.: confinement structures, treatment of runoff in areas of fuel storage and handling, etc.) (see Chapter 12).

An emergency kit for the recovery of petroleum products and hazardous material, complete, permanent, easily accessible at all times will be available at each refueling stations on the worksite. An absorbent material will be used to hold the waste oil. The soiled absorbent material will be disposed of in a secure manner.

All accidental spillage or leakage will be immediately reported to the person responsible for the emergency response plan. If a spillage occurs, the response plan will be deployed quickly and rigorously.

3.6.4 Required Chemicals and Annual Consumption

Unlike metal mines, diamond mines do not require the use of any reagents. This is because the operation is based on physical processes rather than chemical.

Table 3.6.1 lists the products used as well as their usage rate. All products used by the Renard Project show a very low potential for environmental contamination.

3.6.5 Characterization of Solid, Liquid, and Gas Wastes

Golder Associates conducted characterization of excavated mine waste material in 2010 and 2011. The characterization examined overburden, waste rock, kimberlite, and processed kimberlite samples.

The methodology used and the detailed results are presented in the report entitled, *Static and Kinetic Testing of Waste Rock, Kimberlite and Processed Kimberlite Renard Project*, Golder Associates Ltd. (2011b, c). This report is available in Appendix 3.6.1.

Table 3.6.1 List of Required Chemical Products Used in the Operation Phase

Chemical Product	Location of Use/Use	Annual Consumption (kg), (L)	Type of Storage		Aquatic Environment Toxicity (Ecological Information section in the Material Safety Data Sheet)
			Site	Container/Confinement	
Explosives					
Emulsion explosives		1,080,000 kg/yr	Emulsion storage site to the north of the actual camp	20,000 kg, ISO surface container compliant to federal standards; also 40 truckloads of 1,500 kg will be transported underground; two depots are located underground.	
Packaged explosives		120,000 kg/yr	Explosives storage site to the north of the actual camp	Depot with a capacity for 40,000 kg of explosives compliant to provincial standards. Depot with a capacity for 10,000 kg of detonators (100,000 detonators). Type 4 and Category I depot built to the standards in Appendix 5 of the *Regulation under the Act respecting explosives* .	
Various Chemical Products					
$Fe_2(SO_3)_4$ - Ferric sulphate (concentration: 30-60% ferric sulphate and 0.1 to 1% sulphuric acid)	Water treatment plant - used as a coagulant	119,920 kg/yr	Mine wastewater treatment plant site	Chemical storage tanks and supply systems made of appropriate construction material and taking into account the dangers of chemical products	Not available. Low-level concentrations of the product may be harmful to aquatic life. The toxicity is mainly due to the pH. Toxic sulphate concentration of short duration in an aquatic environment: 500 mg/L (MDDEP, 2011).
Polymer	Water treatment plant - used as a flocculent	8,570 kg/yr	Mine wastewater treatment plant site		
Ferro silicon (FeSi) Ferrosilicon composed of Iron (70-80%) and Silica (10-20%)	Ore processing plant	432,000 kg/yr	Stored inside the ore processing plant (Concentrator - DMS) in a dry area	2 t flexible containers	N/A It is important to note that this product contains 70-80 % (w/w) iron, 10-20 % silicon, 5-10% titanium, 1-5 % aluminum.
Flocculent (Floerger AN 923 VHM) - Ionic polymer soluble in water	Ore processing plant	7590 kg/yr	Stored inside the ore processing plant (Concentrator - DMS) in a dry area	Flexible containers	• Fish: LC50: Fat-head minnow: 96 hrs: > 1000 mg/l • Seaweed: EC50: *Selenastrum capricornutum* : 96 hrs: > 500 mg/l
Caustic soda (NaOH)	Ore processing plant	3 t/yr	Cleaning room for diamonds from the concentrator - DMS	25 kg barrels	The toxicity is mainly due to the pH. This product may be toxic to aquatic life. LC50 = 25 ppm (brook trout) (24 hrs) LC50 = 33 to 100 ppm (shrimp) (48 hrs) LC50 = 220 to 1,000 ppm (cockle) (48 hrs)
Hydrochloric acid (HCl)	Ore processing plant (recovery plant) for cleaning diamonds	1,830 litres	Stored in the cleaning room for diamonds from the concentrator - DMS	Acid cabinet	Toxic for aquatic life. The toxicity is mainly due to the pH. • TLm = 282 ppm (larvivorous fish, fresh water), 96 hrs • LC50 = 100 to 330 ppm (shrimp, salt water), 48 hrs
Grease (Engen collector DB; will also be used to adjust the texture of the grease: Microwax 2528 + Tekniwax petrolatum)	Ore processing plant - Grease table	3,460 L/yr	Concentrator - DMS - recovery area	210 L steel barrels	N/A It is important to note that this product contains 70-80 % (w/w) iron, 10-20 % silicon, 5-10% titanium, 1-5 % aluminum.
Chlorine - Sodium hypochlorite 12% NaOCl (Bleach)	Drinking water treatment system	100 L/yr			• LC50 (Fat-head minnow) = 5.9 mg/l, 96 hrs • LC50 (Rainbow trout) = 0.07 mg/l, 48 hrs
Alum (construction phase)	Domestic wastewater treatment plant - phosphate removal from the treatment ponds	44.7 L/yr Liquid alum and 2.82T/yr Dry alum	Domestic wastewater treatment plant		Low levels of the product (Aluminum sulphate/Alum, solid) may be harmful to aquatic life. The presence of this product may acidify the soil. The toxic heavy metal concentrations in the soil and surface water could reach above normal levels. • 72 hrs LC50 (Goldfish) = 100 mg/l (3)
Alum (operation phase)		214 L/yr Liquid alum and 1.36 T/yr Dry alum			
Polypropylene glycol or propylene glycol	Airstrip - de-icing of planes	250 gallons/yr	Airport	One 500 gallon tank is planned; Mobile system designed for de-icing a Dash 8-300 and transported by a light vehicle. In compliance with the 2010-2 Canadian Aviation Regulations, Transport Canada, and the 622.11 Ground Icing Operations standard.	Low acute toxicity aquatic organisms. • EC50: 48 hrs (*Daphnie magna*) = 4,850 - 34,000 mg/l • LC50: 96 hrs (Rainbow trout) = 44,000 - 51,600 mg/l
Hydrocarbons (other than grease for the grease table)					
Jet fuel (kerosene)	Airstrip	100,000 L/yr	Airport	25,000 L, above-ground, double-lined tank in compliance with the Quebec Construction Code, Section VIII	
Gasoline	Garage/for the generator at the emulsion site	100,000 L/yr	Garage - Gasoline tank 25 m from the garage.	ISO container	
	Fuel station		Plant site (mill)	16 double-lined, 50,000 L tanks; sealed containment pond; 57m x 38 m x 0.5m dyke with Solmax Texel Hazgard 1,000 sealed membrane or equivalent	
Diesel	Fuel station	2,181,640 L/month			
	Airstrip		Airport	12,500 L double-lined, above-ground tank	
Oil	Machinery (surface, underground mine, ore processing plant, etc.)	18,256 L/month		ISO Cube (1,000 L), motor oil (bulk 4,000 L), hydraulic oil (bulk 3,000 L), Toyota Axle Oil (500 containers of 5 gallons), etc.	
Propane	Plant site (mill) - Underground mine heating	193,056 L/10 days for 5 months	Propane tank storage area	Three, 113,560 L (30,000 USWG) tanks	
	Kitchen,laundry room	19,801 L/10 days		Two, 18,927 L (5,000 USWG) tanks	

N/A: Not Available

3.6.5.1 Metal content in solid mine wastes

The metal content was determined by Method MA200 Met 1.1 from the *Centre d'expertise en analyses environnementale du Québec* (CEAEQ) of the MDDEP. All the overburden, waste rock, kimberlite, and processed kimberlite samples showed chromium levels higher than Criteria A of the *Politique de protection des sols et de réhabilitation des terrains contaminés* for the Superior geologica province" (Table 3.6.2). All the samples of kimberlite and processed kimberlite showed nickel levels exceeding Criteria A and the majority of samples showed barium and cobalt levels exceeding corresponding criteria. The majority of the waste rock samples also showed nickel levels greater than criteria A.

Table 3.6.2 Number of Samples Showing Metal Content Exceeding Criteria A of the *Politique de protection des sols et de réhabilitation des terrains contaminés*

Material	Number of Samples	Ba	Co	Cr	Cu	Mo	Ni	Zn
Overburden	6	0	0	6	0	0	0	0
Kimberlite	46	41	30	46	1	0	46	0
Processed kimberlite	18	17	15	18	0	1	18	0
Waste rock	190	15	1	190	8	8	138	4

3.6.5.2 Acid Mine Drainage Potential

Acid mine drainage potential was determined using MA. 110-PGA 1.0 method, (*Centre d'expertise en analyses environnementale du Québec* (CEAEQ)) of the MDDEP. Nearly all samples of overburden, waste rock, kimberlite, and processed kimberlite showed total sulfur, sulphates and sulphide levels of low to nil, therefore having a low acidification potential (AP). The neutralization potential (NP) of the great majority of samples exceeded the acid generation potential.

In fact, only one waste rock sample showed total sulfur content higher than 0.3 %, which is 0.48%. The 0.3% limit for the Guideline 019, defines the sulfur content necessary for a given sample to show acid generation potential. However, for the sample in question, 0.22% of the sulfur was in the form of sulphate, a form much less reactive so that the NP exceeds the AP generated from sulphide oxidation.

Table 3.6.3 Acid Generation Potential

Material	Number of Samples	Total Sulfur (%)	Acidification Potential (AP) kg $CaCO_3$/t	Neutralization Potential (NP) kg $CaCO_3$/t	NP-AP kg $CaCO_3$/t	NP/AP Ratio
Overburden	6	0.005	0.16	4.9	48	31
Kimberlite	46	0.042	1.9	67.6	65.7	61
Processed kimberlite	18	0.01	0.7	69.4	68.7	196
Waste rock	190	0.041	2.7	12.2	9.5	8.3

3.6.5.3 Leachability potential (static tests)

Leaching tests TCLP (USEPA-1311), SPLP (USEPA-1312) and CTEU-9 (Environment Canada) were conducted on all samples using Quebec Method MA.100-Lix.com.1 (MDDEP).

The TCLP test (USEPA-1311) is used to classify mine tailings (which includes, by definition, waste rock) consistent with Guideline 019 and to determine the reclamation potential for waste in compliance with the *Guide de valorisation des matières résiduelles inorganiques non dangereuses de source industrielle comme matériau de construction.* The SPLP (USEPA-1312) and CTEU-9 (Environment Canada) tests are used only to evaluate the reclamation potential.

- *TCLP LEACHING TEST (USEPA-1311)*

As required by Guideline 019 for the classification of mine tailings (including, by definition, waste rock), the concentrations measured in the leachate obtained by the TCLP test were compared with corresponding criteria for protection of groundwater. These criteria are shown in the *Politique de protection des sols et de réhabilitation des terrains contaminés.* They apply to resurgence of groundwater in surface water and correspond to the criteria of acute toxicity for the protection of aquatic life. Because for many parameters toxicity varies with the hardness of the water, a hardness value of 10 mg/L was used to calculate the criteria.

Table 3.6.4 shows, for a variety of parameters, the number of samples for which the content exceeds the criteria A of the policy and the concentration in the leachate exceeding the criteria for groundwater protection criteria.

No sample of overburden exceeded the criteria. All the samples of kimberlite and processed kimberlite showed nickel concentrations exceeding the protection criteria while the majority of the samples also showed concentrations exceeding the criteria for barium. A few samples also showed chromium concentrations exceeding the groundwater protection criteria.

Several samples of waste rock also showed nickel concentrations exceeding the protection criteria. Few samples also showed concentrations of barium, copper, and zinc exceeding the protection criteria.

Metal concentrations in the leachate were, however ten times lower than the standards of *Regulation respecting the quality of drinking water*.

Table 3.6.4 Number of Samples Showing Leachate Exceeding the Groundwater Protection Criteria – TCLP test (EPA-1311)

Material	Number of Samples	Ba	Cr	Cu	Ni	Zn
Overburden	6	0	0	0	0	0
Kimberlite	46	41	11	1	46	0
Processed Kimberlite	18	17	4	0	18	0
Waste Rock	190	15	1	8	86	4
Groundwater Protection Criteria (mg/L)	-	0.11	0.016	0.002	0.067	0.017

- *SPLP LEACHING TEST (USEPA-1312)*

For many samples, leachates obtained using the SPLP test showed concentrations greater than the groundwater protection criteria for several parameters including aluminum, barium, cadmium, copper, lead, silver, and zinc. The concentrations observed were generally lower than those obtained using the TCLP leaching test.

Concentrations of manganese and nickel in the leachate were also ten times greater than the standards of the *Regulation respecting the quality of drinking water*.

- *CTEU-9 LEACHING TEST (ENVIRONMENT CANADA)*

For many samples, leachates obtained with the CTEU-9 test showed concentrations exceeding the groundwater protection criteria for several parameters including barium, copper, lead, nickel, silver, and zinc. It was also the case for aluminum, beryllium, cadmium, chromium, and fluoride. The concentrations observed were generally lower than those obtained with the TCLP leaching test, except for a few samples which showed higher concentrations of aluminum.

For many samples of waste rock, the concentrations of molybdenum and fluoride in the leachate exceed the standards of the *Regulation respecting the quality of drinking water*.

- *STATIC TEST CONCLUSIONS*

The results for the static tests indicate that nearly all the samples, including the waste rock, kimberlite, and processed kimberlite, are classified as non-acid generating, but are leachable according to the mine waste classification presented in Guideline 019. However, the overburden is classified as low-risk mine material.

Static tests conducted over short term have a limited capacity to reproduce the anticipated drainage water quality conditions after percolation through the waste material due to acid solutions used for the TCLP and SPLP leaching tests (the waste materials do not show a potential for production of acid and the acidic conditions will not develop in the stockpiles).

Regarding the classification of the waste materials for reuse, the *Guide de valorisation des matières résiduelles inorganiques non dangereuses de source industrielle comme matériau de construction* states that waste can be used for construction if the concentration in the leachate obtained with the TCLP and SPLP tests is ten times lower than the standards of the *Regulation respecting the quality of drinking water* and one time lower than the CTEU-9 test. Only the leachates obtained from the SPLP test meet these requirements.

Thus, only the waste rock will be classified as Category III, that is, if encapsulated without direct contact with the soil.

3.6.5.4 Potential for Leaching (kinetic testing)

To confirm or reject the static test results, a serie of kinetic leaching tests were conducted using a sub-set of samples used for the static tests. The tests were conducted over a period of 20 weeks. This long study period allowed a better simulation of the real conditions observed on site.

Four samples of waste rock, four samples kimberlite, and four samples of processed kimberlite were selected to conduct the tests using the humidity cell test method D5744-96 (American Society for Testing and Materials, 2001) and for mineralogical analysis by x-ray diffraction (XRD with Ritveld refinement). The selection of the samples was based on the potential of acid mine drainage and metal leaching potential as well as to obtain a proportional representation of the relative importance of the various waste material sub-types.

All the samples submitted to kinetic test produced neutral to alkaline leachate. The test results for pH, alkalinity, and sulphate are consistent with the predictions from the static tests, i.e, the samples show no acid mine drainage potential given their low sulfur content. The mineralogical observations corroborate these results by the absence of sulfide in the samples.

The samples of kimberlite which typically present a higher neutralization potential than waste rock and the processed kimberlite show higher pH values, frequently greater than the Quebec groundwater protection criteria (>9.0) and closer to the discharge criteria (9.5).

Among the parameters for which the criteria for groundwater protection were exceeded in static leaching tests (Al, Ba, Cd, Cu, Mn, Ni, Pb, Zn) none exceeded these criteria in kinetic tests. Initial leaching is regularly observed at the beginning of the test. In this initial leaching, soluble salts and fine particles present on the surface of the loaded material are released. This phenomenon was observed for sulphates, calcium, chlorides, magnesium, potassium, sodium, and strontium during the first cycle of testing. Following this, however, all measured concentrations remained very low (see Appendix D figures of the Golder Associates report (2011b, c) and Appendix 3.6.1 of this document).

- *KINETIC TEST CONCLUSIONS*

Table 3.6.5 presents a summary of the results obtained from static tests and kinetic tests. Based on these results, waste rock, kimberlite, and processed kimberlite constitute low-risk material according to Guideline 019 on the mining industry. In fact, none of these waste materials present a potential to generate acid mine drainage, and their leachate shows concentrations well below the groundwater protection criteria.

It should be noted that some parameters are present naturally in site waters, sometimes at concentrations higher than those observed with the kinetic tests (see Appendix D figures in the Golder Associates report (2011c) and Appendix 3.6.1 of this document) and even greater than groundwater protection criteria (Table 3.6.5). Given the results obtained with the kinetic tests, no groundwater protection measure is required to comply with Guideline 019 requirements.

Potential use of waste rock for construction is presented in the *Guide de valorisation des matières inorganiques non dangereuses de source industrielle comme matériau de construction* (MDDEP, 2002). The waste rock shows element contents below the Criteria C of the *Politique de protection des sols et de réhabilitation des terrains contaminés*, and the leachate obtained from the kinetic tests showed results ten times lower than the criteria for drinking water (Table 3.6.6). The results obtained with all the leaching tests and the potential for acid mine drainage allow the waste rock to be classified as Category I. Therefore, the waste rock can be used for construction purposes without any restriction. Table 3.6.7 presents a list of possible uses for each category of waste material.

Table 3.6.5 Summary of Static and Kinetic Test Results

Material	Leachability classification under TCLP test	Leachability classification under SPLP and CTEU9 tests	Level exceeding groundwater protection criteria for kinetic tests		Background exceeding groundwater protection criteria
			Weeks 0 to 4	At the end of tests	
Waste Rock	Ba, Cu, Cr, Ni, Zn	pH (>9.0), Ag, Al, Ba, Be, Cd, Cu, F, Pb, Zn	pH>9.0, Cd	N/E	pH (< 6.5), Ba, Cu, Pb, Zn
Kimberlite	Ba, Cr, Cu, Ni	pH (>9.0), Ag, Al, Ba, Be, Cd, Cr, Cu, F, Ni, Pb, Zn	pH>9.0	N/E	
Processed Kimberlite	Ba, Cr, Ni	Ag, Al, Ba, Cd, Cu, Pb, Zn	N/E	N/E	

N/E.: No Exceedence

Table 3.6.6 Summary of Waste Material Classification for Use in Construction

Tests	Compliance	Justification
Waste with high-risk	**Yes**	Results obtained with TCLP test meet the criteria presented in Table 1 in the appendix II of the *Règlement sur les matières dangereuses*
Grain size	**Yes**	Crushed waste rock and all crushed materials will have a grain size greater than 2.5 mm
Alteration	**Yes**	Material meets abrasion and Micro-Deval test standards
Total organic content	**Yes**	Not applicable to this type of material
Neutralization Potential	**Yes**	The Acid Base Accounting test showed high potential for neutralization and the pH of the ore pulp is generally greater than 9.0
Sulphur content	**Yes**	The great majority of samples showed sulphur content less than 0.2%
Chemical content	**Yes**	Chemical contents are less than Criteria C of the *Politique de protection des sols et de rehabilitation des terrains contaminés*
Leachability	**Yes**	The leachates obtained with the kinetic tests showed concentrations ten times lower than the criteria for drinking water

Table 3.6.7 Permitted Uses for Categories of Materials

USE	CATEGORIES OF MATERIALS		
	I	II	III
1. Construction and repair of highways and roads (including those in residential areas)			
Sub-foundation	Yes	Yes	
Foundation: paved highways	Yes	Yes	
Foundation: unpaved highways	Yes		
Paved shoulders	Yes	Yes	
Unpaved shoulders	Yes		
Borrow material for backfilling and cushioning	Yes	Yes	
Filtering layer	Yes	Yes	
Anti-contaminant layer	Yes	Yes	
Screening	Yes	Yes	
Mineral filler	Yes	Yes	Yes
Surface treatment	Yes	Yes	Yes
Hot mix	Yes	Yes	Yes
Cold mix	Yes	Yes	Yes
Aggregate for sealants	Yes	Yes	Yes
Lean-mix concrete	Yes	Yes	Yes
2. Aggregates for winter abrasives	Yes		
3. Construction on residential lands			
Automobile laneways (additional restriction: granulometry >5 mm)	Yes		
4. Construction on commercial and industrial lands	Yes		
5. Construction of snow storage area*	Yes	Yes	
6. Production of concrete	Yes	Yes	Yes
7. Primary material for production of clinker	Yes	Yes	Yes
8. Material for daily covering of sanitary landfill or monthly covering of dry disposal site**	Yes	Yes	Yes
9. Infrastructure material (roads) for sanitary landfill	Yes	Yes	
10. Cleaning material (sanding) of concrete and steel	Yes	Yes	Yes
11. Railway line ballast	Yes		

Taken from: *Guide de valorisation des matières résiduelles inorganiques non dangereuses de source industrielle comme matériau de construction* (MDDEP, 2002)

3.6.6 Sources of Noise and Nuisance

3.6.6.1 Sources of noise

During the construction phase, noise will be generated mainly by activities related to the preparation and development of the sites such as blasting operations, excavation, and bulk material transportation (Table 3.6.8). Surface blasting will mainly occur during the construction phase and open-pit blasting will occur during the first two years of the operation phase. This source of noise is intermittent, and noise levels for blasting are typically between 110 to 130 dB. Subsequently, blasting will be much less frequent and the noise level will be mostly attenuated by the pit walls. The noise from blasting, although present at higher levels, will have little effect on the equivalent noise level (LAeq, 1hr) due to the short duration of the noise event. The main sources of permanent noise during the construction phase will be generated by the mobile machinery used on-site; mobile machinery includes drills, graders, loaders, etc. All the equipment will generate noise with levels in the order of 95 dBA at 15 m.

Table 3.6.8 Main Noise Source Characteristics

Source of Noise	Coordinates (UTM Nad83, zone 18)		Technical Specifications			
	mE	mN	Noise Level	Phase	Permanent/Intermittent	Notes
Generators (5210)	688 970	5 855 100	<70 dB	Construction and Operation	Permanent	When installed in a separate building, in terms of acoustic conditions, the noise level is <70 dB at 7 m from the building
Dynamiting (1210)	689 360	5 855 220	110 to 130 dBa	Construction and Operation	Intermittent	
Dynamiting (R-65)	689 000	5 855 940				
Rockbreakers on the surface (3210)	689 050	5 855 030	85 dB	Construction and Operation	Intermittent	Noise outside of the building mainly caused by the primary crusher; very rarely used; used to break blocks >1000 mm
Conveyors and crushers in the ore processing plant (3110)	688 930	5 855 000	<70 dBa	Operation	Permanent	Noise measured outside of the building and the drifts; noise generated at the transfer point; noise level is influenced by the height of the chute and the particle size. All the conveyors are installed inside the processing plant and the drifts.
Mine ventilation system (2060)	689 030	5 855 130	Negligible	Operation	Permanent	The mine ventilation system will not be operated at high speed or high pressure; the noise level outside will therefore be negligible.
Ore processing plant ventilation system (3110)	688 930	5 855 000	<70 dBa	Operation	Permanent	Installed on a separate roof and designed to operate at low speed
Air compressor system (5610)	688 980	5 855 220	90 - 100 dBa inside the building <80 dBa outside the building	Operation	Permanent	The compressors will be equipped with a muffler
Wastewater treatment plant suppressors (5831)	688 190	5 853 300		Operation	Permanent	The suppressors will be equipped with an acoustic cover
Ore and mining waste transport	Several locations throughout the mine site		Operator: 79 dB(A)	Construction and Operation	Permanent	Based on ANSI/SAEJ1166 OCT 98, for Caterpillar cabs, when properly installed, maintained, and tested with doors
			Outside: 89 dB(A)	Construction and Operation	Permanent	Average, outdoor sound pressure based on the "SAE J88Apr95 - Constant Speed Moving Test"; Measures taken at a distance of 15 m with engine running forward and average speed

The most important noise levels will be encountered early in the open-pit mining phase (first 2 years) when the equipment will be located on the surface of the extraction area. As mining progresses, the noise level will be reduced because the pit walls will effectively shield the noise. During underground mining, the noise will be generated by the surface facilities, the mine ventilation systems, the transportation of aggregates, etc. The noise levels will be lower than those during the construction phase.

During the operation phase, the main sources of noise will be related to the development and operation of the open pit and borrow pit (blasting, excavation, rock crushing, etc.), heavy equipment traffic (ore and waste rock transport) between the extraction zones and the stockpile areas, gen-sets, processing plant and underground mine ventilation systems, compressed air systems, and wastewater treatment station suppressors.

At the beginning of mine operation, the equipment will be positioned at the highest point of the rock surface. The noise levels in the service areas will be at their maximum. The noise will mainly be generated by drilling and aggregate handling and transport. The main sources of noise will be concentrated around the open pit mines, at the primary crusher unload point, and at the various stockpile areas.

During underground mine operations, the noise will mainly be generated by the transport of agglomerates on the site and by the low tonnage of ore extracted from the R-65 pit, the only pit in operation at that point, and also by the crushing activities on the surface related to the R-65 extraction activities. During this operation phase, the stockpiles will be high enough to reduce noise propagation.

The rock breaker will be used only to break blocks larger than 1,000 mm, which are not frequent. The rock breaker will be installed in a building with an outside sound level in the order of 85 dB mainly associated with the primary crusher. The conveyors should not constitute an important noise source except at transfer points where the noise level will be influenced by the height of the unload point and the particle size.

To reduce noise, the power generating sets will be installed in buildings with soundproofing, which will reduce the noise level to 70 dB at 7 m from the building. Thus, in general the power generating sets and compressors will constitute secondary noise sources given that they will be installed inside buildings. As such, they will have no effect on the noise level in the accommodation and services complex.

The suppressors in the wastewater treatment station will be equipped with soundproofing. The off-road, 60 trucks used to transport the ore will be equipped with resonators. To attenuate the noise, the conveyors will be installed inside the ore processing plant and the drifts. The ore processing plant ventilation system will be soundproofed and designed to work at low velocity generating a noise level generally under 70 dB. The air compressor will be equipped with a muffler and will generate noise levels

inside the building of approximately 90 to 10 dB. Outside the building, the noise level should not exceed 80 dB.

Finally, during the closure phase, the vehicle fleet required to ensure the dismantling and rehabilitation of the site will be reduced. In this phase, the main noise sources will be:

- Trucks (40 t) used to transport the overburden and the waste rock to the processed kimberlite confinement (PKC) area to prepare for hydroseeding;
- Dismantling activities (mechanical shovels, jackhammers for cement surfaces, trucks, etc.);
- Road and airstrip scarification (grading) activities;
- Ditch digging to restore the water network (shovel excavator (dipper dredge), trucks).

The noise level from this machinery will be lower than during the operation phase and should be in the order of 90 dB at 15 m from the equipment.

3.6.6.2 Atmospheric contaminant sources

During the construction phase, the main emission sources of air contaminants will be related to the following:

- Site preparation and development work (including the mine and airstrip areas);
  - Deforestation of approximately 300 ha;
  - Grubbing;
  - Overburden stripping;
  - Overburden transportation to stockpile areas;
- Site excavation and grading over approximately 100 ha;
- Blast hole drilling;
- Blasting;
- Quarry operations (R-65);
- Sandpit operations near the airstrip;
- Road construction;
- Raw material transportation;
- Power supply by diesel power generating sets.

Surface blasting activities will occur mainly during the construction phase and the first two years of open pit mining (R-2/R-3 and R-65). The emissions from blasting will consist mainly of suspended particles, dust particles, and nitrogen oxides.

Air contaminants emitted during the construction phase will consist mainly of dust, generated from the operations mentioned above, and exhaust gas (nitrogen oxide (NO_x), sulfur dioxide (SO_2), and carbon monoxide (CO)) generated from the machinery (power generating sets, drills, graders, loaders, transportation trucks, etc.).

During the operation phase, the main sources of nitrogen oxide (NO_x), sulfur dioxide (SO_2), and carbon monoxide (CO) emissions will be the diesel power generating sets used to supply power to the mine,

followed by emissions generated from the machinery (ore and processed kimberlite transport trucks, drilling, loaders, etc.) and the underground mine ventilation system.

The fine dust emissions during the operation phase will be generated from the following sources:

- Equipment for drilling and surface blasting during the first two years of operation;
- Ore processing plant equipment (breaking of rock, grinding and crushing);
- Underground mining machinery (stone breakers, transportation equipment, crushers);
- Fugitive emissions generated by ore transportation to the stockpile areas, processed kimberlite transportation to its confinement area, and wind erosion of the processed kimberlite confinement area.

When the underground mining phase will begin, dust emissions from the R-2/R-3 open pit will be greatly reduced. The mining technique selected for the underground mine, blasthole shrink stoppage will confine dust emissions to the underground mine, thereby minimizing the dust emissions in the ambient air.

The processed kimberlite confinement area will be gradually revegetated that will limit wind erosion. Table 3.6.9 presents the main sources of air pollution emissions and their location.

The processing equipment (crushing and grinding) will be equipped with dust collectors that will limit the dust emissions to less than 30 mg/Nm³.

CAT 775 trucks will be used to transport the ore. Their emissions will come from the exhaust gas (greenhouse gas, nitrogen oxide (NO_x), carbon monoxide (CO), and sulfur dioxide (SO_2)) and dust recirculated by their passage. The use of dust supressants will limit the dust emission in this latter case.

Emissions will also be generated by site supply trucks (diesel, gas, food, mine operation material, and maintenance of equipment) when they are on the mine roadways. These emissions will consist of exhaust gas and vehicle traffic dust.

Finally, during the closure phase, the vehicle fleet required to ensure the dismantling and rehabilitation of the site will be reduced. During this phase, the main emission sources will be:

- Trucks (40 t) used to transport the overburden and the waste rock to the processed kimberlite confinement (PKC) area to prepare the hydroseeding;
- Trucks used to transport backfill material for the mined kimberlite pipes;
- Dismantling activities (mechanical shovels, jackhammers for cement surfaces, trucks, demolition equipment, etc.);
- Road and airstrip scarification (grading) activities;
- Ditch digging to restore the water network (shovel excavator (dipper dredge), trucks).

The emissions from this machinery will consist of exhaust gas and equipment traffic dust. Since fewer vehicles will be required, the air emissions will be reduced during the closure phase.

Table 3.6.9 Characteristics of the Main Sources of Atmospheric Emissions

Source of Noise	Coordinates (UTM Nad83, zone 18)		Technical Specifications			
	mE	mN	Emitted Contaminants	Phase	Permanent/Intermittent	Notes
Generators (5210)	688 970	5 855 100	Fine particles ($PM_{2.5}$), nitrogen oxides (NO_x), sulphur dioxide (SO_2)	Construction and Operation	Permanent	
Dynamiting (1210)	689 360	5 855 220	Suspended particles, fine particles ($PM_{2.5}$), nitrogen oxides	Construction and Operation	Intermittent	
Dynamiting (R-65)	689 000	5 855 940				
Rockbreakers on the surface (3210)	689 050	5 855 030	Suspended particles, fine particles ($PM_{2.5}$)	Construction and Operation	Intermittent	Equipped with dust filters that limit emissions to 30 mg/m³
Conveyors and crushers in the ore processing plant (3110)	688 930	5 855 000	Suspended particles, fine particles ($PM_{2.5}$)	Operation	Permanent	Equipped with dust filters that limit emissions to 30 mg/m³
Mine ventilation system (2060), underground workings stone crusher (1130)	689 030	5 855 130	Fine particles ($PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NO_x)	Operation	Permanent	The underground mine emission sources are equipped with dust filters that limit emission to 30 mg/m³
Boiler (5310)	688 900	5 854 950	Carbon monoxide (CO), nitrogen oxides (NO_x)	Operation	Permanent	Negligible source of emission
Fugitive emissions from vehicle and machinery traffic	Several locations throughout the mine site		Fine particles (PM2.5)	Construction and Operation	Permanent	
Fugitive emissions from wind erosion of the processed kimberlite containment area	Large surface area located between 689,600 mE and 690,300 mE and between 5,855,700 mN and 5,857,000 mN		Fine particles (PM2.5)	Operation	Permanent	Progressive revegetation
Ore and mine waste transport – CAT 775 truck	Several locations throughout the mine site		Fine particles ($PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NO_x)	Construction and Operation	Permanent	

3.7 Mine Waste Management

3.7.1 Overburden Management

Approximately 1.4 Mt and 2.3 Mt of overburden will be removed for the R-65 and R-2/R-3 pits respectively. All of the overburden will be transported to a stockpile located east of the R-2/R-3 pit. Part of the overburden will be used for progressive and final revegetation of the site, which includes the waste rock stockpile area, the ore stockpile area, and the processed kimberlite confinement area.

3.7.2 Waste Rock Management

The open pit and underground mining will generate 23.3 Mt and 1.5 Mt respectively, for a total of 24.8 Mt. Approximately 23 Mt of material or waste rock will be used to backfill drifts. The foundation of the ore stockpile will require 1.1 Mt of waste rock. Approximately 1.8 Mt of waste rock will be used for various construction purposes from 2013 to 2014. Finally, 1.2 Mt of waste rock will be used to stabilize the slopes of the processed kimberlite confinement area.

Because the requirements of the underground backfilling will follow the development of the open pits, some of the waste rock will be temporarily stored in a stockpile located north of the R-2/R-3 pit. The stockpile will contain approximately 9 Mt near the beginning of 2018.

However, at the end of the operation, the waste rock stockpile will be emptied because all the waste rock will have been sent to the R-2/R-3 pit as backfill for the underground mining operations.

3.7.3 Processed Kimberlite Management

The process of diamond mining generates a by-product (processed kimberlite) that must be disposed of in compliance with Quebec Guideline 019. To this end, a confinement area is planned to store all processed kimberlite. The facility was designed by the firm Golder Associates (Golder, 2011d; report in Appendix 3.7.1).

The processed kimberlite will be generated in three sizes: coarse particles (-6.0 mm to 1.0 mm), fine particles (-1.0 mm to 0.125 mm), and slime fractions (-0.125 mm). Approximately 44.9 Mt of processed kimberlite will be stored. The relative importance (weight) of the different types of kimberlite will be approximately 84% for the coarse and fine fractions and 16% for the slime fractions. The slime fractions will be subject to centrifugation at the processing plant. The three fractions will then be combined and will have a solid content of approximately 85% by weight. The material will then be transported by 60 t trucks to the confinement area.

In 2010, a geotechnical investigation was performed by Golder Associates at the selected site for the processed kimberlite confinement area. Five (5) boreholes were drilled at the proposed area to evaluate the thickness and characteristics of the surface deposits. Monitoring wells were also installed. A series of laboratory tests were performed on the soil samples to determine the geotechnical properties of the site.

The data indicate generally a thin surface layer of silty sand with organic matter over a loose sandy layer to a depth of approximately 1 m. Also, a dense gravelly (till) and silty sand layer between 1.1 m and 5.7 m thick overlays the bedrock.

Bedrock was encountered at depth 1.4 m to 9.1 m below the surface, and groundwater level vary between 0.9 m and 3.6 m below the ground surface. Hydraulic conductivity values ranging between 2.5×10^{-6} m/s for the till and 1.7×10^{-9} m/s for the bedrock were measured *in situ* in the monitoring wells.

For design purposes, the dry density for the processed kimberlite is estimated at 2.00 t/m^3. Based on the estimated density, the storage capacity for the processed kimberlite is evaluated close to 22.1 Mm^3.

During the site preparation and development, the organic matter and overburden layer will be transported to a storage area for future use, notably for the rehabilitation of the confinement area.

The confinement area will be progressively filled to ensure long-term stability. Fill placement will occur from west to east and on several levels. Berms of five (5) m in width will be built at all level of 10 m benches. There will be a total of 9 benches of 10 m. The berms will permit erosion control and progressive revegetation operations. The sideslopes will be 2.5H:1V and covered with a 0.5 m layer of coarse material (waste rock) to control erosion.

The confinement area will not be lined with a sealed membrane given the characteristics of the processed kimberlite (non-leachable and non-acid generating) and estimated seepage rates.

The elevation of the confinement area foundation is 510 m. The storage capacity is designed to reach a maximum elevation of 600 m, but could also accommodate storage up to an elevation of 610 m. In fact, it is expected that the height of the stack can reach 90 m.

A two-way haul road will be built for trucks traveling between the process plant and the confinement area. The road will have a width of 25 m for safe traffic flow.

No special measures are planned for dust control measures during the operation of the site because experience acquired from other Canadian diamond mines leads to the conclusion that it is unlikely to encounter such problem due to the coarseness of the processed kimberlite.

The confinement area was also designed to limit water infiltration and favour runoff. Although the processed kimberlite is relatively dry, a contact water management plan including control structures consisting of ditches and sedimentation ponds will be established. Three rock drains of 2 m depth and 11 m wide will be built around the perimeter of the confinement area to facilitate drainage of the confinement area.

An instrumentation monitoring system will be used at the confinement area during the development and progressive closure of the site to verify design assumptions and ensure the performance of the facility during operation and after site closure. The system includes piezometers (to monitor the water level

surface and pore pressures), thermistors (to monitor temperature in the deposited processed kimberlite), and stationary tags (to monitor movement inside the processed kimberlite mass). The instrumentation will be installed in the foundation of the facility and within the PK pile.

3.8 Quarries and Borrow Pits

3.8.1 Use

The civil engineering work related to the planned infrastructures of the Renard mine requires a large quantity of granular material (mainly sand and gravel or crushed stone). These materials must have the specific geotechnical properties for specific use to which they are intended.

Natural aggragates (sand and gravel) or artificial (crushed stone) are required for the following:

- As a natural filter for the processed kimberlite confinement area;
- The construction of the airstrip;
- The construction of the foundations of buildings and other facilities;
- The construction and maintenance of mining roads;
- Cement making;
- As backfill.

3.8.2 Raw Materials

The regional geomorphological context of the study area is characterized by a strong geographic disparity of the quality and quantity of unconsolidated natural source material. This variability is attributable to the unequal distribution in the region in the characteristics of the raw materials of interest for the development of borrow pits[8]. The potential sources of material in the region come essentially from the eskers. Eskers contain mostly sand and gravel, and often, to a less degree, finer sediments (e.g.: silt). In fact, according to manual core sampling performed in 2010 on the summit or sides of the eskers near the mine site, the first metre of deposit contains a silt ratio of up to 30%, which is relatively high for eskers. Glaciofluvial outwash plains could also be of interest; however, they occur rarely in the area of the Foxtrot site. An alternative source of raw material could come from thick, sporadic till[9] accumulations that often contains coarse aggregates (gravel, pebble, and blocks) but has the disadvantage to contain sometimes an excessive proportion of fine particles (silt and clay) or even large boulders.

3.8.2.1 Potential borrow pit areas

Two potential borrow pit sites were identified near the Renard mine by Roche (2003). In 2010, these two sites were the subject of on-site characterization and a grain size distribution analysis by means of manual core drilling on the first top metre of soil. Furthermore, a third potential borrow pit site was identified in the area of the planned airstrip. This site is most likely to be selected by Stornoway because

[8] A borrow pit is an area where natural, unconsolidated material is extracted notably for construction purposes.
[9] Heterogeneous, natural, loose particles, generally ranging from clay to block.

it is located near Route 167 and the planned airstrip. It could be oparated jointly by MTQ and Stornoway.

In the planned area for the mine, the largest potential site has an area of approximately 60 ha and is located about 4 km directly east of the mine. The area, generally well-drained, is mostly covered by black-spruce lichen woodland. Surface samples analyzed within this deposit are silty sand with traces of gravel and presence of boulders. This potential borrow pit area is crossed by at least one stream, and contains at least one peatland pond, and is bordered to the southeast by an unnamed lake. A second, more restrained and elongated area of about 3 ha, is located approximately 2.5 km directly north-northwest of the present mine site. Containing mostly sand and gravel, this site is partly well-drained and contains young, black-spruce lichen woodland and a small wetland. This site is crossed by at least one stream and is bordered by a lake (Lake 32300). A raw material sample was taken in 2010 from these two potential borrow pits. Laboratory analysis performed on these two samples indicated that the materials do not meet minimum standards for aggregate used in cement.

A third potential borrow pit site is located near the planned airstrip, on the edge of the Misask River. This esker, although discontinuous, stretches along a southwest-northwest axis over several kilometres. The project alignment for MTQ's Route 167 passes along the summit of the esker over a short distance, to the north of the airstrip. The MTQ plans to use a borrow pit not far from the alignment on the same esker. The site for the MTQ's borrow pit has not been decided yet (as of November 2011). Consequently, the implementation of Stornoway's planned borrow pit could be modified should a conflict arise with the use of MTQ's borrow pit. On the other hand, Stornoway and MTQ could agree to use the same borrow pit thereby reducing environmental impact of granular surface material development.

To build the airstrip, Stornoway evaluated that 40,000 m³ of MG-112 type (fine sand) material and 26,000 m³ of MG-20 (0-3/4'' gravel) will be needed. By adding 30 % more to the required amount of MG-20 for contingency and to account for a potential lower quality material, a total amount of 73,800 m³ is obtained. The surface area that could be affected by the excavation of approximately 73,800 m³ of material varies as a function of the excavated thickness of the deposit. Without detailed topographical information and drilling results from the MTQ studies for the Route 167 project, it is not possible at this time to know with any precision the thickness that can be excavated. However, based on the hypothesis of average excavated thickness of 5 m, an area of 1.47 ha would be required. If the thickness is 2 m, then an area of 3.69 ha would be required for this activity, for a total of approximately 5.15 ha.

While identifying potential sites along the esker, a strip of 75 m was allowed for around streams and water bodies in accordance with Article 14 of the *Regulation on quarries and sandpits*. The area located outside of this protection strip is equal to about 6.9 ha and is included in the project footprint. This area is adequate since it compensates for slightly higher requirements if certain aggregates are not available or if the MTQ would want to use part of the 6.9 ha. Based on the data known at this time, the sites of interest are located near Route 167 and Stornoway's trench landfill area.

3.8.3 Granular Material Produced from the Waste Rock

The building and mining of the open pits and underground drifts will generate a significant amount of country rock (waste rock) that must be disposed of. The reuse of this rock for the production of granular material known as “artificial” (by crushing and screening) is planned. As such, the rock from the excavation of the R-65 pit will be used as crushed rock for construction, thereby recycling a good portion of this material. According to analyses performed in 2010 on country rock samples, this material meets the standards and requirements for cement. The availability of this material inherent in the extraction of the ore makes it, *a priori*, unnecessary to build an additional quarry just for the production of aggregates for cement solely. No other use of the granular material from the excavation of the R-65 pit is planned.

3.9 Water Supply

3.9.1 Drinking Water

Lake Lagopede will supply the water supply necessary for the drinking water for the workers. The drinking water supply system includes a water supply intake, a water supply pumping system, a treatment plant, an underground reservoir for drinking water, and drinking water pumps and distribution lines (Map 3.9.1). The system will supply drinking water 24 hr/d, 365 d/y.

The drinking water requirements during the construction and operation phases are presented in Table 3.9.1. During construction, approximately 500 workers will be on-site while this number is estimated to be around 230 during the operation phase. In spite of the lower numbers of workers during the operation phase, the drinking water needs will be higher because of the different working conditions while mining (SNC-Lavalin, 2011).

Table 3.9.1 Drinking Water Requirements during the Construction and Operation Phases

	Construction Phase	Operation Phase
Number of Workers	500	230
Average Consumption	300 L/pers./d	400 L/pers./d
Maximum Consumption	400 L/pers./d	800 L/pers./d
Peak Flow	0.83 L/pers./min	1.11 L/pers./min

Station des eaux usées minières /
Industrial wastewater treatment plant

1 650

1 700

1 700

Prise d'eau brute /
Raw water intake

Station de traitement de l'eau potable et réservoir / Potable water treatment plant

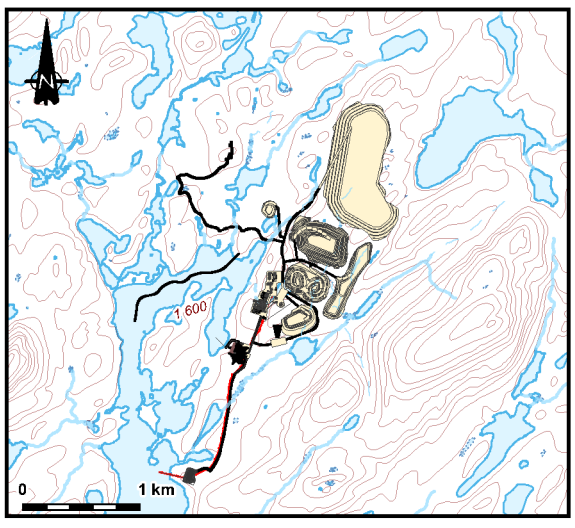
Usine de traitement de l'eau potable /
Potable water treatment plant

Station de pompage /
Pump house

0 100 m

Échelle / Scale 1 : 5 000

UTM, zone 18 (NAD 83)



Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Conduites de distribution /
Water distribution network

Bornes d'incendie /
Fire hydrants

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Système de traitement et d'approvisionnement en eau potable et système de protection contre les incendies / Drinking water treatment system and distribution network and fire protection system

ROCHE

Carte de base : Canvec, 1: 50 000, 33A16-33A09, RNCan, 2010 et fond hydrographique fourni par Stornoway le 12 novembre 2010.
Fichier : 61470_conduites_distribution_111220.WOR

Décembre 2011 / December 2011

Carte / Map 3.9.1

It is important to note that the fire protection system will use the same network as the drinking water distribution system. Several fire hydrants will be strategically placed throughout the mine site. Thus, the total drinking water reserve includes the mine camp needs and a fire reserve. The drinking water and fire protection supply will use the same network so as to reduce the risk of freezing lines (continuous circulation of water in the network). An independent network for fire protection without permanent water circulation would have a high risk of freezing and would also be costly to build (SNC-Lavalin, 2011).

The water used to control dust emissions will come from Lake Lagopede.

- *WATER SUPPLY INTAKE AND PUMP SYSTEM*

The water intake and pumping station are located near the mine camp facilities. The water which will be treated for drinking water supply comes from Lake Lagopede. The option to use Lake Poisson (F2606) for the water supply intake remains a possibility. The water intake will be located in the South Bay, 130 m from the shore. A heated cable will be installed to prevent system stoppage should frazil accumulate. The water intake will use a 200 mm diameter HDPE pipe covered with polyurethane foam and will have an intake screen at the end. The water intake will be 3 m deep to protect it from freezing and ice.

The average water supply flow rate will be 173 m³/d during the construction phase and 106 m³/d during the operation phase. These values include an additional flow rate of 15% to the average consumption to account for loss relate to leaks (5%) and water used for treatment (e.g.: washing filters) (10%).

The water supply will be pumped to the treatment station by a pump system located in a pre-fabricated, heated and insulated pump house located near the lake (see Figure 3.9.1). The water supply pump house will contain 2 electrical turbine pumps powered via the camp's power lines. The electrical input will be designed to connect a portable, emergency generator should the power supply be interrupted.

- *TREATMENT SYSTEM AND RESERVOIR*

The quality of the drinking water produced will meet the requirements of the *Regulation on the quality of drinking water* (RQDW).

The quality of the water from Lake Lagopede is similar to that of lakes in northern Quebec. The main treatment parameters to control are a slightly acid pH, the presence of total and fecal coliforms, a high true colour (varies between 18 and 25 UCV), and a high total organic carbon concentration (average of 4.4 COT/L). Removing the organic matter at the beginning of the treatment avoids the production of by-products (e.g.: organochlorinates, THM) after the chlorination treatment.

The treatment system will consist of two units with a maximum daily total flow rate of 210 m^3/d (105 m^3/d per unit) that will ensure a drinking water supply equivalent to 100% of the average daily requirements

in case one of the two units breaks down. Based on the chemical composition of the water supply, the treatment process will consist of the following steps:

- Sand and anthracite filtering;
- Ionic exchange;
- Active carbon filtering;
- pH re-adjustments;
- Ultraviolet ray disinfection.

A granular filtration will be installed ahead of the main filtration system to remove particles of sedimentation that could be in the pumped water supply during spring flood.

The water supply treatment will generate wastewater containing mainly water from filter washing. If the wastewater is the result of regenerated resins, it could contain sodium chloride. This wastewater will be managed according to the requirements in Article 5.3 of the MDDEP's "*Guide de conception de petites installations de production d'eau potable* " (*Small plant design guide for drinking water)* (Ellis, 2009) (SNC-Lavalin, 2011).

Various methods of wastewater management could be considered. Currently, it is noted that the sewage could be directed to the domestic wastewater treatment station.

The drinking water reservoir will have a total capacity of 530 m^3 and will be installed under the water supply treatment system. It will include an emergency reserve of drinking water and a reserve for fire protection. The 50 m^3 emergency reserve for drinking water will be used should unforeseen circumstances arise (e.g.: pump or water main break) and will provide an average daily consumption for a period of 12 hours. The fire protection reserve is 430 m^3 and will provide sufficient water supply to fight a fire for 2 hours with a 60 l/s flow which complies with the recommendations in the « *Guide relatif à la réalisation des réseaux d'eaux au fins de la protection contre les incendies* » (Water Supply for Public Fire Protection, a Guide to Recommended Practice), (SIAL, 1999).

➢ *DRINKING WATER DISTRIBUTION NETWORK*

Two electric pumps, an emergency pump, and a drinking water distribution network will ensure the drinking water distribution to the accommodation and services complex and mine facilities. A diesel motor pump is also planned for fire protection purposes.

The harsh climate was taken into account when designing the drinking water distribution network. Thus, all the network components (pipes, valves, fire hydrants, couplers, etc.) were designed to be protected during severe weather conditions in the region, notably by using insulation and heating elements.

The distribution network will use HDPE pipes (150 mm to 200 mm in diameter) buried 1 m deep and insulated with rigid polyurethane. The pipes will have heated cable along their length to protect them against freezing. At the end of the distribution network, continuous water recirculation will be ensured by a 20 mm diameter insulated pipe that will be installed parallel to the main line in the same trench and

will act as a drinking water return line back to the reservoir. This will serve as an additional safety measure against freezing.

A water well will supply water to the airstrip terminal and maintenance garage. Bottled water will be available as drinking water.

3.9.2 Mine Water

The water required for the kimberlite processing plant will come entirely from the recirculation of water from the percolation through the processed kimberlite, runoff from the ore pile, and from part of the mine water, e.g.: water accumulated in the open pits, the shafts, and ramp (see Section 3.10.3 Water Balance for details).

3.10 Water Management

3.10.1 Domestic Wastewater

During the preliminary construction phase, the domestic wastewater will be managed by a temporary bio-disc or bio-ditch treatment system. Temporary toilets (dry or chemical) will be installed throughout the site. The wastewater and solid waste will be redirected towards the temporary treatment system which will also manage other domestic wastewater (e.g.: water from showers) generated on-site.

During the main construction phase and the operation phase, the mine camp activities will generate domestic wastewater that will be managed by a wastewater management system with the following components: a collection network, a pumping station, a main waterline, a wastewater treatment plant, and a treated wastewater outfall into Lake Lagopede (Map 3.10.1).

The number of workers on site during construction will be approximately 500 and around 230 during the operation phase. During construction phase, the average daily domestic wastewater flow to be treated is evaluated at 165 m^3/d and a peak flow rate of 458 L/min. During the operation phase, the inflow to be treated will average approximately 101 m^3/d with a peak flow rate estimated at 281 L/min.

The domestic wastewater generated at the airstrip will be treated there by a septic tank system and a fully compliant, modified seepage bed[10].

- *DOMESTIC WASTEWATER COLLECTION NETWORK*

Domestic wastewater generated to buildings supplied with drinking water will be captured in high-density polyurethane (HDPE) pipes of 200 mm in diameter and will have a capacity of 1,380 L/min at a 5 % slope; the design flow is 458 L/min. These buildings include the accommodation and services complex, the garage, the ore process plant, and the mine offices (Map 3.10.1).

[10] A system similar to a classic seepage bed but without trenches and that uses three times less area.

The collection network will be adapted to the region's severe climatic conditions. To protect the network from the risk of freezing, the HDPE pipes will be insulated with 50 mm polyurethane and buried at least 1 m in the ground. To avoid freezing, the manholes will also be insulated. The collected domestic wastewater will thus flow to the pumping station by gravity.

Before being sent to the collection network, the wastewater from the cafeteria and the vehicle maintenance building will be pre-treated using fatty waste traps and water-oil interceptors.

- *WASTEWATER PUMPING STATION AND MAIN WATER LINE*

The wastewater at the pumping station will be sent to the domestic wastewater treatment plant, located south of the camp, via the main water line which covers a total distance of 1,311 m. This 100 mm diameter line will be wrapped with 50 mm polyurethane to prevent freezing; a heated cable will also be laid alongside the main line.

The pumping station will consist of a pumping well with two, 76 L/s submersible pumps. Only one pump will operate at a time. An overflow into the treatment system is designed to manage flooding. Floating solid waste will be collected and, depending on their nature, will be sent to either the wastewater treatment station or the trench landfill site (TLFS).

The pump system will be controlled by a float system that will start the pump when the sump water level reaches a given limit. If the water entry exceeds the pump capacity, an alarm will be triggered (red light and audio alarm) and the excess will be evacuated by an overflow into Lake Lagopede.

To account for the possibility of a power outage, a transfer switch will connect the pump system to an emergency generator.

- *WASTEWATER TREATMENT STATION*

The domestic wastewater treatment system will be comprised of three facultative aerated lagoons (Figure 3.10.1). Each lagoon will have a capacity of 1,650 m^3 (26.9 m by 36.9 m surface area with a depth of 3.65 m). A 4 m-wide dike will surround the three lagoons and a geomembrane liner will ensure proper sealing.

The domestic wastewater treatment system will cover a total area of 2 ha, including three aerated lagoons and a prefabricated service building adjacent to the three lagoons. The building will house a system for the aerators, phosphate removal equipment, and a laboratory.

Lagoon aerating will be done using air diffusers installed at the bottom of the lagoons. Only a small fraction of solid will remain suspended while the majority will settle to the bottom of the lagoons forming sludge that will begin the process of anaerobic digestion. For this type of treatment, the applied organic load and the soluble organic matter from the sludge digestion are oxidized in the upper aerobic zones (MDDEP, 2010).

688 00 mE

5 854 000 mN

Émissaire de l'effluent minier traité / Mine wastewater outfall

Bureau administratif / Mine office

Usine de traitement du minerai / Mineral processing building

Usine de traitement de l'eau potable / Potable water treatment plant

Complexe d'habitation / Accommodation complex

Usine de traitements des eaux usées domestiques / Domestic wastewater treatment plant

1 600

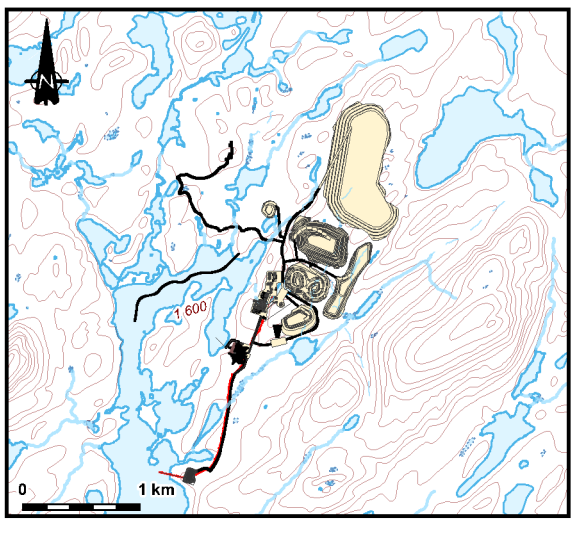
1 650

1 700

0 150 300 m

Échelle / Scale 1 : 7 500

UTM, zone 18 (NAD 83)



Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Réseau de collecte des eaux usées domestiques / Wastewater collection network

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Systèmes de collecte et de traitement des eaux usées domestiques au camp minier / Wastewater collection and treatment system at the mining camp

ROCHE

Carte de base : Canvec, 1: 50 000, 33A16-33A09, RNCan, 2010 et fond hydrographique fourni par Stornoway le 12 novembre 2010.
Fichier : 61470_SystGestionEaux_111219.WOR

Décembre 2011 / December 2011

Carte / Map 3.10.1

The phosphorus inputs will be controlled by a coagulant applied prior to the treated water being discharged into Lake Lagopede. For now, alum (aluminium sulphate) is the coagulant that will be used.

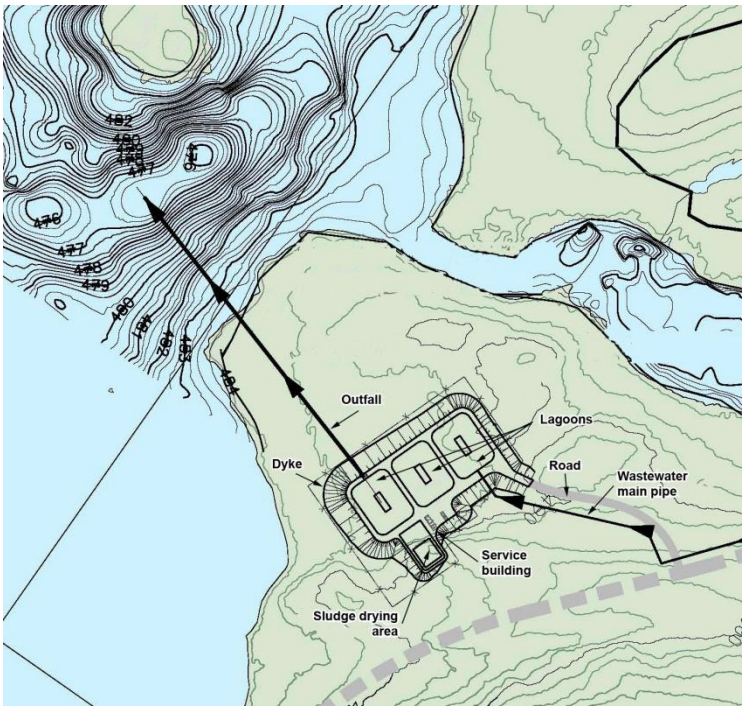


Figure 3.10.1 Location of the Facultative Aerated Lagoons and the Outfall Discharge Point

The design criteria used for the wastewater treatment system are presented in Table 3.10.1. For example, the estimated treatment efficiency using the BOD_5 (Biological Oxygen Demand) indicator will vary between 84 % and 97 % depending on the season and phase of the project (Table 3.10.2).

Table 3.10.1 Wastewater Treatment System Design Criteria

Flows and Loads	Construction Phase	Operation Phase
Average Flow (m^3/d)	165	101
Peak Flow (L/min)	458	281
BOD (kg/d)	25	11.25
DOC (kg/d)	62.5	28.8
TTS (kg/d)	30	13.8
Total phosphorus (kg/d)	1.0	0.5
NH_4-(N) (kg/d)	2.5	1.2

Table 3.10.2 Domestic Wastewater Treatment System Efficiency

Period		BOD_5 Effluent (mg/l)	BOD_5 Effluent (mg/l	Efficiency (%)
Construction	Summer	151.5	4.2	97.2
	Winter	151.5	24.4	83.9
Operation	Summer	114	1.2	98.9
	Winter	114	9.5	91.6

The lagoons will need to be drained for removal and management of the sludge that will accumulate on the bottom. Perforated HDPE pipes will be installed under the geomembrane to maintain a lower level of the water table during the draining of the lagoons. The sludge will be drained via 150 mm diameter PVC pipes installed at the bottom of each lagoon. Pipes used to circulate the wastewater between the lagoons will be equipped with valves to isolate each lagoon during sludge removal.

The frequency of sludge removal will be limited to twice for the first lagoon and once for the two other lagoons over the entire life of the mine. In summary, the wastewater sludge will be dried and taken to the trench landfill site (TLFS) and used to cover the final site or even reused to revegetate if the environmental requirements are met. Wastewater sludge management is detailed in Section 3.11.

- *OUTFALL DISCHARGE POINT*

The outfall discharge point for the treated domestic wastewater will be located in Lake Lagopede, at a distance of approximately 45 m from the shore and at a depth of 6.75 m (Figure 3.10.1). The discharge point was determined in accordance with MDDEP guidelines in the aim to maximize dispersion of the potential contaminants (lake morphology, discharge depth, wind direction, etc.) as well as to minimize the impact on the water quality of Lake Lagopede and on the aquatic life.

The effluent design criterion is 165 m^3/d. The effluent discharge objectives established by the MDDEP for BOD_5, total phosphorous, and total fecal coliforms will be respected.

The domestic treated wastewater effluent characteristics, criteria, and standards are detailed in Section 3.10.5.

3.10.2 Water Management

3.10.2.1 General water management policy

The Renard Project water management policy was developed to prevent and minimize the potential impacts on the quantity and the quality of surface and underground water in the project study area. The management policy includes the management of mine wastewater (water potentially influenced by the construction and mining activities as well as by contact with the mine facilities and infrastructures) and the management of water coming from areas located upstream from the mine site in order to avoid their contamination by the mine activities.

All mine wastewater will be collected by a system of ditches and sumps and directed toward treatment facilities before being released into Lake Lagopede. Water not affected by the mine activities will be channeled by a separate system of ditches and discharged into the environment.

Furthermore, during the operation phase, the recirculation of the processed kimberlite filtration water and the use of a part of the mine water for ore processing will avoid taking additional water from the waterways for the needs of ore process plant.

3.10.2.2 Construction phase

During the construction phase, the main environmental issue related to water management is the source control of erosion and sediment transport towards the lakes and streams located downstream from the work site. This sediment load could be provided by the runoff coming from the site.

- *DIVERSION, DRAINAGE DITCHES, AND SEDIMENTATION PONDS*

To prevent contamination of runoff from upstream areas of the site, a peripheral runoff collection system made of drainage ditches and a sedimentation pond will be built at the beginning of the construction works (Map 3.10.1).

The S18 sedimentation pond located in proximity to the accommodation and services complex (Map 3.10.2) will collect runoff coming from the construction area for removal of particulates before the treated water is sent to Lake Lagopede. This pond will only be used to treat water coming from the accommodation and services complex area.

To control particulates in the water coming from the other construction areas, a second, temporary pond (S22) will be built. An Actiflo-type mobile treatment unit will be installed downstream from the pond in case the permanent mine wastewater treatment plant (P17) is not ready (Map 3.10.2). However, the S22 pond will be dismantled and the mobile treatment unit will be removed from the site once the P17 treatment plant is operational.

The S18 and S22 sedimentation ponds will be designed to contain runoff resulting from rain with a recurrence interval of one in ten years. The pond water quality will be monitored before discharging it into Lake Lagopede.

- *DEWATERING OF F3302 AND F3303 LAKES AND BUILDING A SEDIMENTATION POND IN THE R-65 PIT*

The mining of the R-2/R3 and R-65 pits will require the prerequisite dewatering of the small F3302 and F3303 takes, which have water volumes of 28,360 m^3 and 12,780 m^3 respectively. The water that is removed will be treated as necessary by the mobile treatment unit or even at the P17 permanent treatment plant (if it is ready) and gradually returned after treatment to Lake Lagopede. The water at the bottom of the lakes that could contain higher concentrations of suspended solid will be treated as necessary with EnviroSacs before being released into Lake Lagopede. The sediment at the bottom of

the lake will be excavated at the beginning of the winter to minimize sediment transport toward the water network.

It is important to note that during the construction phase, the activities related to extraction of overburden, waste rock, and ore from the R-65 pit will allow the development of a sedimentation pond inside this same pit. The pond, with a total capacity of 506,000 m^3, will be installed upstream from the permanent mine wastewater treatment plant.

It is possible that a short diversion of a stream will be necessary to facilitate the construction of the pond in the R-65 pit.

- *RUNOFF NOT AFFECTED BY CONSTRUCTION ACTIVITIES*

To avoid affecting the quality of runoff flowing from undisturbed areas located upstream from the mine site, this water will be collected by a drainage ditch system different from the one used for mine wastewater management (Map 3.10.1). The runoff from the surrounding environment will be diverted to the F3295 lake sub-watershed to prevent soil erosion at the discharge point.

- *STREAM DIVERSION*

A stream flowing towards the R-65 pit will be diverted to the F3295 lake watershed located more to the west (Map 3.10.2) with a small dam. This diversion will avoid having to modify the quality of water from upstream areas of the mine site and to reduce the quantity of mine water pumped from the R-65 pit. When mining operations have been terminated, the dam will be dismantled and the water will flow into the lake created in the R-65 pit.

3.10.2.3 Operation phase

The water management measures implemented during the construction phase will be maintained during the operation phase. However, the sources of mine wastewater (known as “contact water”) will be more varied. Mine wastewater includes runoff coming from the mine facilities area, the secondary mine roads, the processed kimberlite confinement area, the waste rock stockpile, the pre-production ore stockpile, and the mine water from the pits and underground workings.

Map 3.10.2 illustrates the main mine wastewater management infrastructures during the operation phase. This includes the following:

- A peripheral drainage ditch system;
- The S18 sedimentation pond (adjacent to the accommodation complex);
- Culverts;
- Sumps at the bottom of the mine shafts, the ramp, and R-2/R-3 pits;
- A pumping station;
- The main collection pond for mine wastewater (sump) located in the R-65 pit;
- The P17 mine water treatment plant located in the area of the R-65 pit.

690 000 m.E

5 856 000 m.N

F3297
F3295
F3298
F3296
Étang
R65
F3303
P17
S22
Étang
Baie
Nord-Est
Halde de stériles/ Waste Rock
Storage Facility
Lac
Lagopède
P6
F3302
Aire d'entreposage du mort-terrain /
Overburden Stockpile
F3301
Pile d'entreposage
temporaire de minerai /
Pre-operation
Ore Stockpile
S18
P18
Baie
Sud
F2607
1 650
1 700
1 600
1 800
1 850
1 780
1 900

0 250 500 m

Échelle/Scale 1 : 10 000

UTM, zone 18 (NAD83)

Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Éléments / Elements

R-x	Identification du gisement / Deposit identification
F3293	Numéro d'identifiant de lac CEHQ / CEHQ lake ID number
	Cours d'eau permanent / Permanent stream
	Cours d'eau intermittent à écoulement de surface et sous-terrain* / Intermittent stream with surface and underground flow
	Fossé de collecte / Collection ditch
PX	Station de pompage / Pumping station
SX	Bassin de traitement / Treatment pond

Source: Water Management Plan,
Golder Associates, October 14, 2011

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Plan général de collecte et de gestion des eaux (Phase de construction) / General stormwater collection and management plan (Construction phase)

ROCHE

Carte de base : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
61470_EAUCONSTRUCTION_111217.WOR

Décembre 2011 / December 2011

Carte / Map 3.10.2

- *MINE WASTEWATER COLLECTION SYSTEM*

A drainage ditch network will be built all around the mine site perimeter to collect all mine wastewater (except water from the accommodation complex). The collected water will be gravity-fed to the pond in the R-65 pit, and, from there, pumped to the P17 mine wastewater treatment plant.

The drainage ditches, the sedimentation ponds, and the culverts that make up the peripheral drainage ditch system will be designed to hold runoff water resulting from rain with a 1 in 100 year recurrence interval, which equates to a flood risk of less than 1 % for a given year.

The pump, ditch, and culvert system within the perimeter of the site will be designed to manage rain with a 1 in 10 year recurrence period. The system of ditches will have a total length of approximately 12.5 km.

Mining infrastructures site

The runoff from the mine facilities will be collected and managed by the peripheral ditch network and directed to the R-65 pit, except the runoff from the accommodation and services complex. This water will rather be sent to the S18 sedimentation pond, built during the construction phase, to remove particulates before releasing the water into Lake Lagopede or pumping it into the R-65 pit. This water will not undergo additionnel treatment because it is not likely to contain contaminants due to the nature of operations in this area.

The runoff from the mine truckshop and light vehicle repair shop area will be collected in an oil-water separator and the oil will be recovered by a vacuum truck to be disposed in an authorized site.

Mine road drainage will occur through a system of ditches and HDPE (high-density polyurethane), 600 mm diameter culverts to facilitate maintenance and progressive freezing in the winter. The sedimentation ponds are also planned to hold water and will allow particle sedimentation of the runoff water before being discharged into the environment. The drainage system will be built to hold rain with a 1 in 10 year recurrence interval.

Processed kimberlite confinement area, waste rock stockpile, pre-production ore stockpile, and overburden stockpile

Runoff from the northern side of the processed kimberlite confinement area and the western side of the waste rock stockpile will be collected by a drainage ditch and directed to the R-65 pit pond (Map 3.10.2).

Runoff water from the southern side of the processed kimberlite confinement area, the eastern side of the waste rock stockpile, the overburden stockpile, and the temporary ore stockpile will be collected by another drainage ditch and directed to the R-65 pit pond (Map 3.10.2). Important excavation work will be needed to build a gravity-fed drainage ditch in the south part. This work could involve excavation of surface soil up to 5 m deep over a distance of 200 m.

It is planned that the R-65 sedimentation pond and the P17 mine wastewater treatment plant be operational at the beginning of year -1 (2014), the mining will begin on the R-2 and R-3 pits. During the transition phase, when mining will have begun and the R-65 sedimentation pond and the treatment plant will be completed, the following measures will be implemented (Golder, 2011e):

- Waste, ore, and overburden management will be done in such a way to minimize and concentrate the total impacted area;
- A minimum amount of cover snow will be left on the periphery of the processed kimberlite area
- Ore, waste rock, and overburden confinement will be done at the beginning of the thaw;
- Temporary ditches will be built around the waste rock, ore, and overburden stockpiles;
- Environmental management best practices will be applied to limit sediment transport;
- Small sedimentation ponds and pumps will be built to direct runoff to the S18 sedimentation pond or to the S22 temporary pond and the temporary mobile mine wastewater treatment unit.

➢ *MINE WATER*

Mine water includes:

- Rainwater directly in the pits (R-2, R-3, and R-65) and runoff draining into the pits;
- Groundwater seeping through the pit walls;
- Groundwater seeping through the walls in the underground workings (R-2, R-3, R-4, shaft and ramp).

Sumps will be installed in the R-65 pit and at the bottom of the R-2 and R-3 underground workings, in the shafts and ramps. These sumps will allow the removal of some particulates before being pumped to the surface.

The mine water from the R-2, R3 and R-65 pits will be directed to the sedimentation pond in the R-65 pit before being sent to the mine wastewater treatment plant.

The mine water from the underground workings (R-2, R3, R-4, shafts and ramp) will be directed to the ore processing plant to be used in the process or even to the R-65 pit sump for subsequent treatment.

3.10.3 Water Balance

The water balance for years 1-2 (2015 and 2016) and 3-6 (2017-2020) of the project are illustrated in Figures 3.10.2 and 3.10.3 respectively. Years 1-2 were selected because the mine wastewater treatment will be at its maximum during this time. Years 3-6 were also selected because the ore processing rate will be at its highest.

690 000 m.E

5 856 000 m.N

F3297
F3298
F3295
F3296
F3301
F2607

Aire de confinement de la kimberlite usinée / Processed Kimberlite Containment Facility

R65
P17
Halde de stériles / Waste Rock Storage Facility
R2
R3
P6
P14
Aire d'entreposage du mort-terrain / Overburden Stockpile
Pile de minerai / Pre-operation Ore Stockpile
S18
P18

Étang
Baie Nord-Est
Lac Lagopède
Baie Sud

1 600
1 650
1 700
1 850
1 900

0 250 500 m

Échelle/Scale 1 : 10 000
UTM, zone 18 (NAD83)
Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Éléments / Elements

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F3293	Numéro d'identifiant de lac CEHQ / CEHQ lake ID number
	Cours d'eau permanent / Permanent stream
	Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
T	Station de traitement des eaux usées minières / Mine wastewater treatment plant
	Fossé de collecte / Collection ditch
	Fossé de dérivation / Derivation ditch
PX	Station de pompage / Pumping station
SX	Bassin de traitement / Treatment pond

Source: Water Management Plan, Golder Associates, October 14 , 2011

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental and social / Environmental and Social Impact Assessment

Plan général de collecte et de gestion des eaux (Phase d'exploitation) / General stormwater collection and management plan (Operation phase)

ROCHE

Carte de base : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier : 61470_EAUOPERATION_111217.WOR
Décembre 2011 / December 2011

Carte / Map 3.10.3

- *YEARS 1-2*

In years 1-2 of the project, direct rain and runoff accumulated in the R-65 pit will be in the order of 474,000 m³. The amount of direct rain and runoff accumulated in the R-2/R-3 pit will be 466,000 m³. The seepage water pumped from the underground workings (R-2, R-3, R-4, shafts and ramp) will reach 355,000 m³ of which 239,000 m^3 will be sent to the ore processing plant and 115,000 m^3 to the R-65 pit.

The direct rain and the runoff from the north side of the processed kimberlite confinement area and the west side of the waste rock stockpile will be in the order of 467,000 m^3. The runoff from the south side of the overburden stockpile, the temporary ore stockpile, and the sedimentation pond will reach 720,000 m^3.

All the water will be directed to the pond built in the R-65 pit. Of this amount, 230,000 m^3 will be routed to the ore processing plant to be used for process. Therefore, the total amount of mine wastewater to be treated will be approximately 2,242,000 m^3.

For ore processing, the annual water requirements are in the order of 373,000 m^3. Of this amount, 239,000 m^3 will come directly from the underground workings or the R-65 pit if settling of suspended solids is required, and 133,000 m^3 will come from the water of the ore itself. Part of the process water will come from the filtered water from the processed kimberlite that was recovered as part of the process. Approximately, 372,000 m^3 of water will be sent to the processed kimberlite confinement area.

- *YEARS 3-6*

In years 3-6 of the project, the amount of direct rain and accumulated runoff in the R-65 pit will be approximately 474,000 m³. The seepage water pumped from the underground workings (R-2, R-3, R-4, shafts and ramp) will reach 401,000 m³. The amount of direct rain and runoff accumulated in the R-2/R-3 pit will be 254,000 m³ and the infiltration water will be negligible. This water will be directed to the underground workings.

The amount water of direct rain and runoff water from the northern side of the processed kimberlite confinement area and the western side of the waste rock stockpile will be in the order of 488,000 m³. The runoff from the southern side of the processed kimberlite confinement area, the eastern side of the waste rock stockpile, the overburden stockpile, the temporary ore stockpile area, and the sedimentation pond will reach 727,000 m³.

All of this water will be directed to the pond in the R-65 pit. The total amount of mine wastewater to be treated will thus be approximately 2,079,000 m³ at this time.

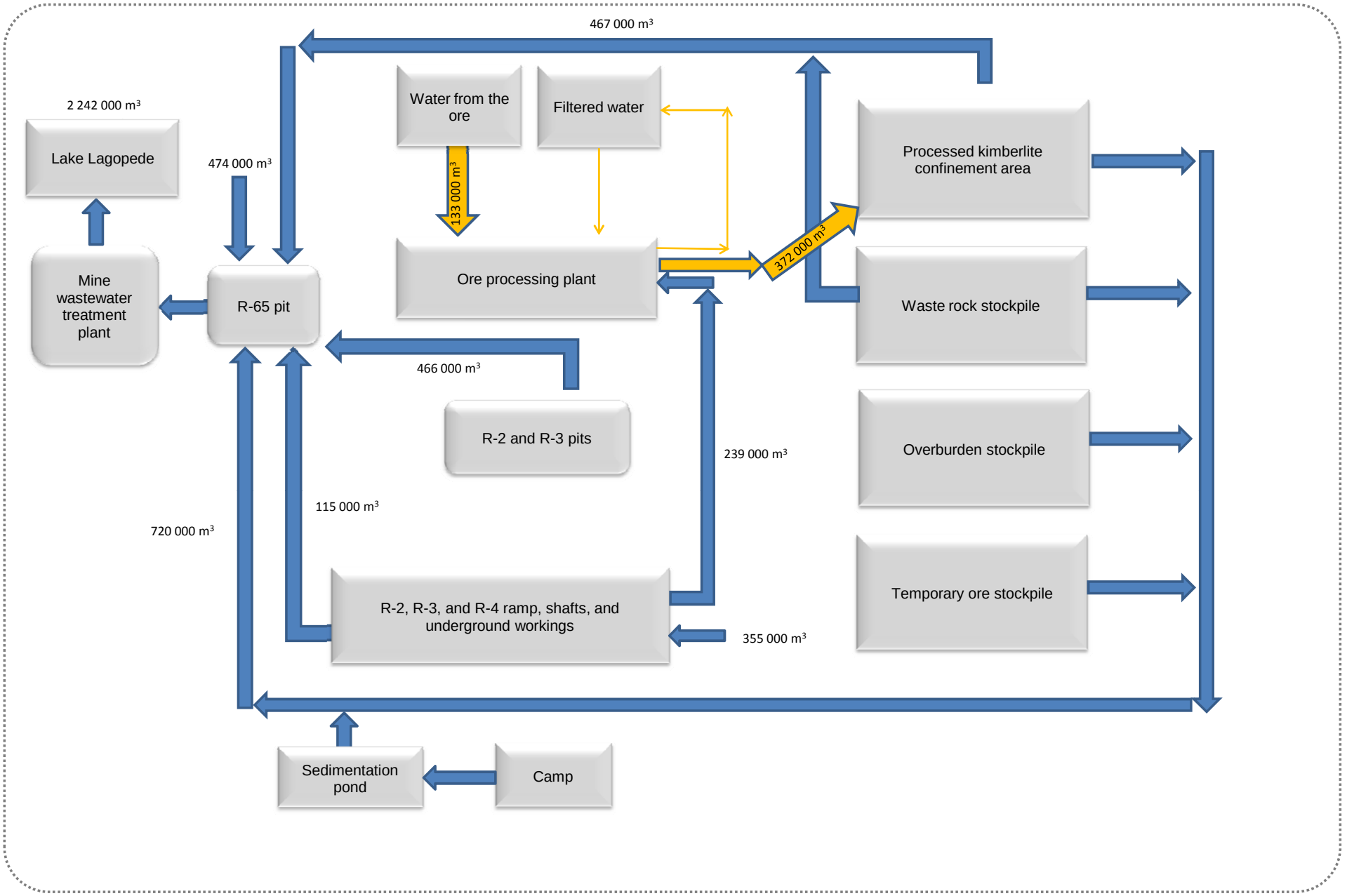


Figure 3.10.2 Annual Water Balance – Years 1-2

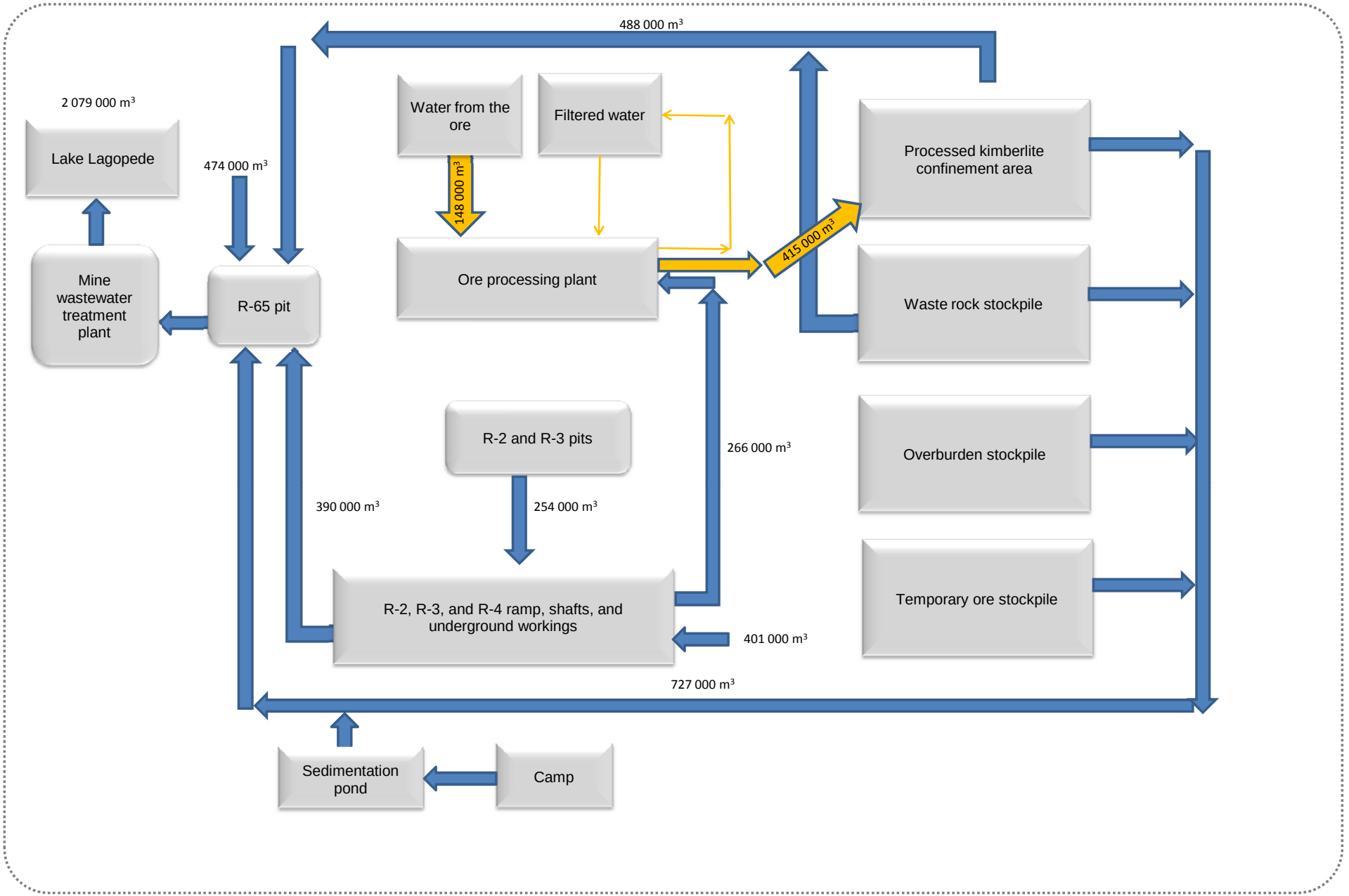


Figure 3.10.3 Annual Water Balance – Years 3-6

The water needs for the processing of the ore will be 414,000 m³. Of this amount, 266,000 m³ will come directly from the underground workings or the R-65 sedimentation pond if settling of suspended solids is required, and 148,000 m³ will come from the water in the ore itself. Part of the processing water will come from the filtered water from the processed kimberlite that was recovered as part of the process.

Approximately 415,000 m³ of water will be sent to the processed kimberlite confinement area.

All of this water will be directed to the pond in the R-65 pit. Of this amount, 225,000 m³ will be directed to the ore processing plant to be used in the process. The total amount of mine wastewater to be treated will thus be approximately 1,570,000 m³ at this time.

The amount of water required for ore processing will be 351,000 m³. In addition to the 225,000 m³ recirculated in the underground workings, 126,000 m³ will come from the water contained in the ore itself. Some of the processing water will come from the filtered water from the processed kimberlite that was recovered as part of the process.

Approximately 350,000 m³ of water will be directed to the processed kimberlite confinement area.

- *SNOW MANAGEMENT*

To ensure the smooth running of the mine operations and the safety of the workers, snow removal will be required in certain areas (roads, ore processing plant). The snow will be stored in one of three sites: northeast of the waste rock stockpile, east of the pre-production ore stockpile, and in the area between the waste rock and overburden stockpiles. To limit a local overload of the drainage network, the snow will be stored, when possible, in the same sub-watershed from which it was removed.

3.10.4 Water Management at the Airstrip

Drainage ditches will be built to evacuate surface water in the area surrounding the airstrip. The ditches will flank the airstrip and the apron (parking area). The ditches were designed based on geographic and climactic studies. In addition, there is a sedimentation pond located at the ditch outlets.

Water supply for the terminal and garage will be drawn from a well, while water bottles will be supplied for drinking water.

3.10.5 Effluent Characteristics

The effluents discharged into Lake Lagopede are the treated domestic wastewater and the treated mine wastewater, including runoff from the mine site having been in contact or not with tailings and mine water.

The domestic waste in the trench landfill site has the potential to generate a leachate characterized by a significant load of organic matter, of nutritive elements, and of certain metals due to rain infiltration and to water from the water table circulating in the residual waste. This organic matter, nutritive, and metal load could, eventually, seep into the surface water. The leachate will be diluted and treated naturally by

the soil filtering process (filtration, retention, absorption), by biodegradation, and by other chemical processes (rain, ionic exchange, absorption) (SNC-Lavalin, 2011) in accordance with the requirements set out by the *Regulation respecting the landfilling and incineration of residual materials* (C.Q.-2.r.6.02.). Therefore, the TLFS will discharge no effluent. A groundwater quality monitoring network will be installed around the site (see Section 11.4.7).

The dispersion plume of the treated domestic and mine effluents was modeled with the help of the CORMIX (version 7.0 VGT) and CE-QUAL-W2 models. The CORMIX (Cornell Mixing Zone Expert System) (V7.0 VGT) digital model was used to calculate the initial dilution in the discharge point area. This model is supported by the US Environmental Protection Agency and is recommended by the MDDEP for this type of project. CE-QUAL-W2 is a 2D hydrodynamic model that is used to simulate water quality and is supported by the US Army Engineers Research and Development Center. Various scenarios were modelled and used to take into account possible water column stratification and various environmental conditions. (Appendix 3.10.1).

The use of these models combined with the field study resulted in the identification of effluent discharge points with depth, current, width, and tributary in flow characteristics that favour treated effluent dispersion and water use protection. The discharge points were selected based on criteria to consider for outfall placement described in the C*alcul et interprétation des objectifs environnementaux de rejets pour les contaminants aquatiques* (MDDEP, 2007) guide. The selected placement for the final effluent discharge point in Lake Lagopede took into consideration several physical criteria (lake morphology, depth, wind direction, etc.), biological criteria (fish habitat, migration routes), and human criteria (fishing sites, water intake, etc.). (See Section 3.2.4.4 for details on domestic and mine effluent discharge point alternative analyses.)

The following section defines the effluent volume, quality, and treatment methods as well as treated effluent plume dispersion as required by the COMEV directive (June, 2010). The domestic and mine plume dispersion modelling report can be found in Appendix 3.10.1.

3.10.5.1 Domestic wastewater

The domestic wastewater will be treated with three facultative aerated lagoons (see Section 3.10.1 for details).

The mine area only contains shallow and with limited discharge. Therefore, in order to maximize dispersion and dilution of the treated effluents, the two discharge points for the domestic and mine wastewater were installed in Lake Lagopede.

The domestic wastewater discharge point is located 45 m from the shore, at a depth of 6.75 m, and 0.2 m from the bottom of the lake (Figure 3.10.4). The discharge point was selected based on MDDEP recommendations and as a function of various technical environmental criteria, physical criteria (lake morphology and bathymetry, depth, lake current velocity and direction, prevailing wind direction, etc.),

biological criteria (fish habitat, migration routes), and human criteria (fishing sites, water intake, etc.). It was notably selected to ensure that the depth and hydrodynamics conditions at the discharge point would favour the dispersion of the treated effluent and protect the use of the water (drinking water intake for the mine facilities, fish habitat, aquatic life).

Volume, average flow rates, and domestic wastewater discharge points during the construction, operation, and closure phases are presented in Table 3.10.2. Considering the operating procedures of the camp, it is estimated that 100 % of the drinking water will be managed by the domestic wastewater treatment plant.

During the construction phase, the volume of water to manage is estimated at 165 m^3/d. During the operation phase, this volume will be lower, about 101 m^3/d, given that there will be fewer workers on-site. During the closure phase, the water volume to manage should be at a minimum due to the low number of workers; this phase should last approximately two years. For system design considerations, a volume of 165 m^3/d of water to be treated was used.

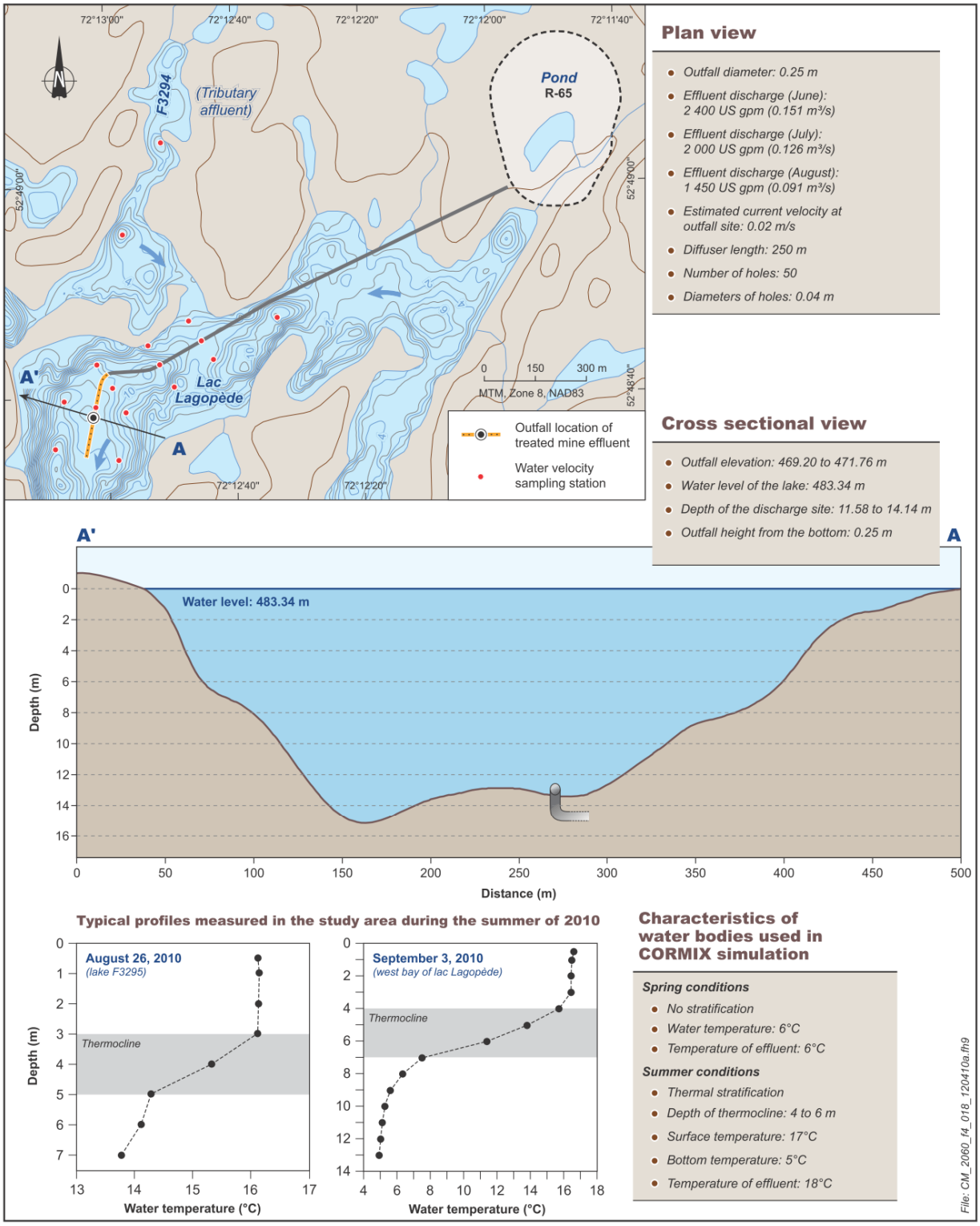


Figure 3.10.4 Location of Domestic Wastewater Effluent Discharge Point and Plume Modelling Parameters

Table 3.10.3 Characterization of Predicted Volume and Flow Rates for Domestic Wastewater Effluent During the Construction and Operation Phases

Parameter	Unit	Construction Phase	Operation Phase
Number of Workers	-	500	230
Average Flow Rate	m^3/d	150	92
Peak Flow Rate	m^3/d	300	184
Maximum Flow Rate	m^3/d	600	368

The environmental design criteria used for the effluent are presented in Table 3.10.4. Respect of the MDDEP effluent discharge objectives established and of the surface water quality criteria for the protection of aquatic life at the edge of the plume mixing zone will limit the impact on the water quality of Lake Lagopede.

The treated mine effluent plume dispersion was modelled using the CORMIX (version 7.0 VGT) and CE-QUAL-W2 models.

During the construction phase, the modelling results indicate that the 1:100 dilution limit will occur at a distance of 52 m from the discharge point based on the estimated average flow rate and 130 m based on the peak flow rate (Figure 3.10.5).

During the operation phase, the modelling results indicate that the 1:100 dilution limit will occur at a distance of 38 m from the discharge point based on the estimated average flow rate and 83 m based on the peak flow rate.

Table 3.10.4 Environmental Design Criteria for Treated Domestic Wastewater and Estimated Effluent Concentrations at the Discharge Point and at the 1:100 Dilution Point Compared to the Recommendations and Water Quality Criteria and Existing Conditions in Lake Lagopede

Parameter	Unit	Environmental design criteria for the treated effluent	Value at discharge point	Estimated value at the 1:100 dilution point (construction: 54 m, operation: 35 m from the discharge point)	*Recommendations and water quality criteria*					Current conditions (water quality) - Lake Lagopede	
					Recommendations and criteria for the protection of aquatic life			Contamination prevention (MDDEP)			
					CCME - Chronic effect	*MDDEP - Chronic effect*	*MDDEP - Acute effect*	With water intake	Without drinking water intake	No. of values	(median - 95th percentile)
BOD_5	mg/l	**25**	Construction: 25 Operation: 9.5	2	-	3 [(g)]	-	-	-	-	(not available)
TSS	mg/l	**30**	Construction: 31 Operation: 11	2	+ 5 to 25 [(a)]	+ 5 to 25 [(c)]	+ 25 [(i)]	-	-	6	<2
Total phosphorus	mg/l	**1**	1	0.010	0.004-0.01 [(b)]	0.02-0.03 [(d)(e)] or >50% [(f)]	-	-	-	6	<0.00-0.007
Fecal coliforms	FCU/ 100ml	**1.000**	1.000	10	-	-	-	1,000 [(j)]	-	18	<1–8

** The distance corresponding to the 1:100 dilution point from the discharge point is 54 m during the construction phase and 35 m during the operation phase.*
- No recommendation or criterion

Source

CCME (Canadian Council of Ministers of the Environment). 2007. "Canadian Water Quality Guidelines for the Protection of Aquatic Life – Summary Table," updated December 2007. In Canadian Water Quality Guidelines. 1999. Winnipeg. The Council.

MDDEP (Ministère du Développement durable, de l'Environnement et des Parcs). 2009. Surface Water Quality Criteria. Environmental monitoring branch. Government of Quebec.

Notes for the Recommendations and Criteria

[a] For clear flow waters, a maximum increase of 25 mg/L from background levels for any short-term exposure e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d). For high flow waters, a maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is >250 mg/L.

[b] The values represent the range of desired concentrations for phosphorus in an oligotrophic environment; exceeding the high limit could signal an eventual environmenta problem. See the CCME the Guidance Framework for Phosphorus factsheet.

[c] During dry periods, the water quality criteria is defined by an average maximum increase of 5 mg/l from the natural concentration. During high water flows (rain, snow) or in turbid waters, the water quality is defined by either a maximum increase at any one time of 25 mg/l of background levels when background levels are between 25 and 250 mg/l or by a 10% increase of background levels when background is >250 mg/l measured at a given time.

[d] This quality criterion applies to waterways flowing towards lakes whose environmental context is not problematic. It aims to avoid changing lake habitats, notably by limiting the growth of algae and aquatic plants.

[e] This quality criterion is designed to limit excessive algae and aquatic plant growth in the streams and rivers. Certain factors influence the potential effect of phosphorus. The main physical factors mentioned include: type of substrate, depth, transparency and temperature of the water, speed of the current, and shade. These characteristics are not considered in the quality criteria. Therefore, the phosphorus quality criteria should be used judiciously according to the relevant medium.

[f] For the oligotrophic lakes whose natural concentration is or was less than 0.01 mg/l, the quality criterion is defined by a maximum increase of 50% from the natural concentration without exceeding 0.01 mg/l.

[g] This value corresponds to the maximum tolerable oxygen deficit for aquatic life at an average summer temperature of 21°C.

[h] All artificial decrease or increase in temperature must not:
- change the water temperature along a a river segment or a portion of a lake resulting in predictable movement or change of present or potential aquatic populations;
- alter certain sensitive, local zones, such as a spawning ground;
- kill living organisms around a discharge point.
In addition, the environment must not undergo sudden changes in temperature caused by, for example, a sudden stop of a thermal discharge in the cold season.

[i] During dry periods, the quality criterion is defined by an average maximum increase of 25 mg/l from the natural concentration.

[j] This quality criterion applies to raw water destined to supply drinking water to areas with complete water treatment: flocculation, filtration, and disinfection.

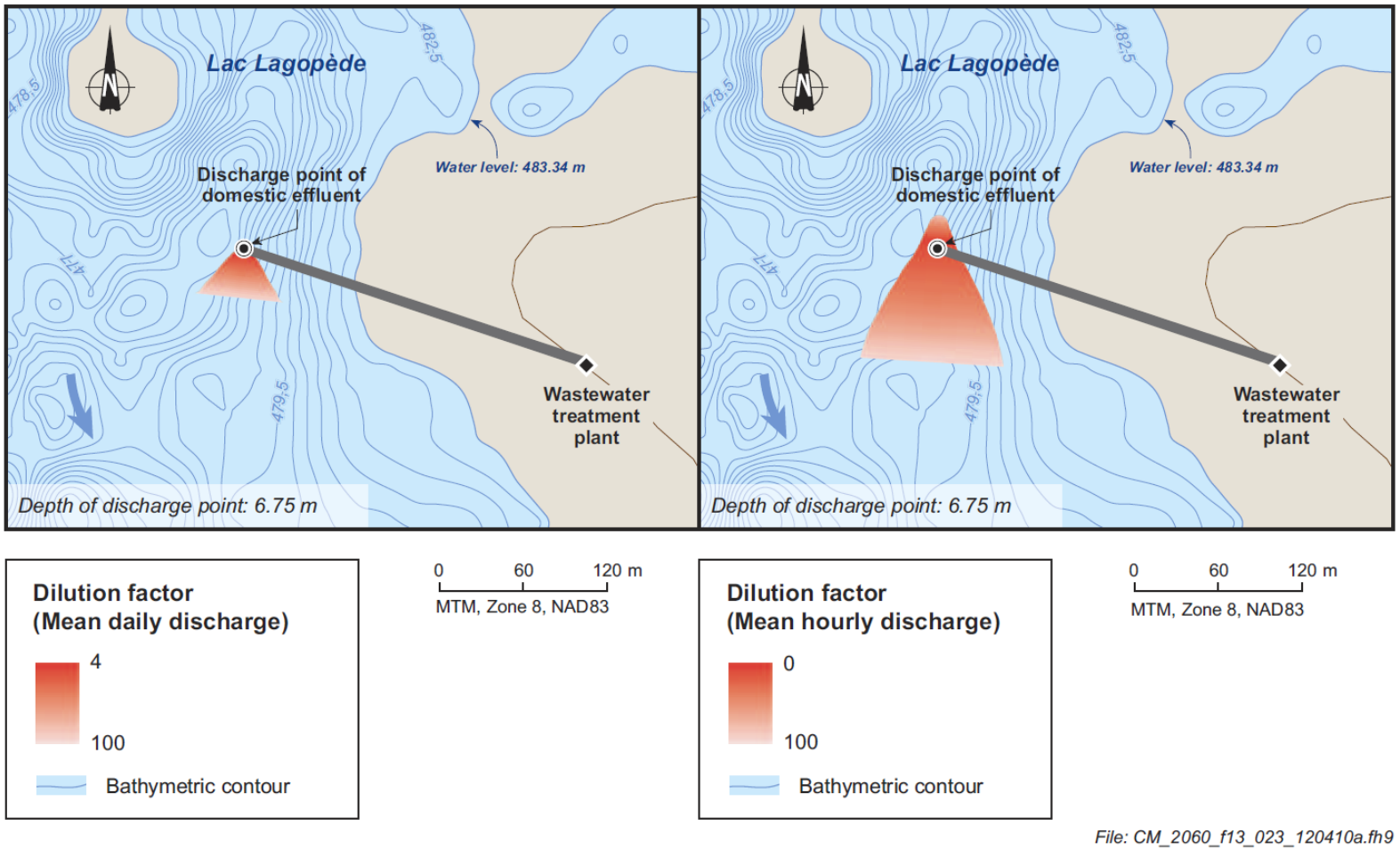


Figure 3.10.5 Extent of the Plume for Domestic Wastewater Effluent During the Construction and Operation Phases for Average and Peak Flow Rates

Changes to the lake water quality and sediment should be limited within the plume mixing zone. At the edges of the plume, BOD_5 values and TSS concentrations, total phosphorus and fecal coliform, will respect the water quality criteria for the protection of aquatic life and will also be in the same order of magnitude as the concentrations measured in the receiving environment between 2009 and 2011. Moroever, any sudden change between the water temperature and the effluent will be avoided in order to respect the MDDEP (2009) criteria for aquatic protection which state that the receiving environment must not undergo sudden changes in temperature due to, for example, a sudden stop of a thermal discharge during the cold season.

The quality of the domestic wastewater effluent will be closely monitored to ensure compliance with established discharge objectives (See section 11.4.4 for details on domestic wastewater effluent monitoring).

3.10.5.2 Mine wastewater

During the operation phase, water in contact with the open pits, the underground mine, the processed kimberlite confinement area, the waste rock and overburden stockpiles will be collected and managed by the network of peripheral ditches and sent to the sedimentation pond located in the R-65 pit. Runoff from the accommodation complex will, instead, be first sent to the S18 sedimentation pond, built during the construction phase, in order to remove suspended solids before being pumped into the peripheral ditch network. Part of the water pumped from the underground mines will be forwarded directly to the ore processing plant. If the water needs to be treated before use, it can be sent to the R-65 sedimentation pond.

Before being released into Lake Lagopede, the waters having been in contact with processed kimberlite will be managed and treated if necessary. The mine effluent treatment will include the addition of anticoagulation agents and polymers, followed by lamellar settling and a filtering in order to ensure the optimal removal of all metals and other ions. The waters not affected by mining activities will be diverted to the west into the sub-watershed of the lake F3395.

Based on the water management plan during the first year of the construction phase (2013), the annual volume to manage is estimated at a maximum of 1.06 Mm^3. These waters will be treated by the ponds built before the use of the mine wastewater treatment plant. During the second year of construction (2014) and the entire operation phase (2015 to 2034), it is estimated that 49.4 Mm^3 of water will be directed to the mine wastewater treatment plant.

However, depending on the ongoing activities and the quantity of runoff to manage, the input rates to be treated may vary considerably between the seasons and to a lesser degree between years. The volume of water to treat will vary in the following manner: 2.20 Mm^3/yr (2014), 2.42 Mm^3/yr (2015-2016), 2.08 Mm^3/yr (2017-2020), and 2.65 Mm^3/yr (2021-2034).

The treatment system was designed to treat up to 13 800 m^3/d taking into account the peak flow rates that could occur during the annual floods. Note that the sedimentation ponds located in the R-65 pit will have a capacity of 506,000 m^3, which will allow control of the input flow to the treatment plant when the snow melts.

The sludge from the mine wastewater treatment plant will generate approximately 330 m^3 of sludge per year. This sludge will be sent to the kimberlite confinement area. It is important to note that the treatment process aims to settle the fine particles and not to form precipitates for the dissolved contaminants. In this context, the sludge will be stable to weathering. In addition, the processed kimberlite is rather basic allowing to buffer the effect of acid rain.

The design criteria for the mine wastewater treatment plant are presented in Table 3.10.5. These criteria were established by calculating a theoretical discharge concentration equal to five times (1:5 dilution) the MDDEP's chronic toxicity criteria[11], except for phosphorus for which the EDO calculation was based on the MDDEP's general approach (2007). The theoretical concentrations were selected as criteria for all the parameters, except for arsenic, iron, and suspended solids because the technological standards from Guideline 019 and from the *Metal Mining Effluent Regulations* (MMER) were inferior to the calculated concentrations with a 1:5 dilution and were, thus, used. Therefore, the design criteria respect all the Guideline 019 and MMER technological standards.

The final effluent criteria will be adjusted as a function of the environmental discharge objectives established by the regional direction of the MDDEP during the authorization process pursuant to Article 32 of the *Environment Quality Act* and according to Guideline 019. When the final effluent will meet the MDDEP guidelines, the treated mine wastewater will be released into Lake Lagopede.

[11] Sylvie Cloutier, MDDEP, personal message, June 8, 2011.

Table 3.10.5 Environmental Quality Objectives for the Theoretical Discharge of Mine Effluent for the Project Compared to the Technological Standards for Treated Mine Wastewater Facilities, Recommendations and Water Quality Criteria and the Current Water Quality of Lake Lagopede and for the Entire Study Area

Parameter	Unit	*Water quality recommendations and criteria Protection of aquatic life - Chronic effect[1]*				Technology standards		Theoretical EDO [3]	Projected quality of mine effluent (Golder, 2011)	Surface water quality (2009-2011)						
										Method detection limit (MDL) for the analysis	Lake Lagopede			Streams and waterways in the study area		
		Federal recommendations (CCME)		*Provincial criteria (MDDEP)*	Date[2]	Directive 019	MMER[3]				No. of values	Median	95th percentile	No. of values	Median	95th percentile
Basic physico-chemical parameters																
Dissolved oxygen	% of saturation	-	-	> 54 to 63[a]	1994	-	-	-	-	*in situ*	3	90.3	94.4	39	87	100.5
	ppm	6.5 to 9.5[a]	1999	> from 5 to 7[b]	1994	-	-	-	-	*in situ*	3	8.2	8.5	39	7.88	9.3
Water temperature	°C	-	-	statement[1]	1992	-	-	-	4.0	*in situ*	24	15.4	23.2	61	15.8	24.8
pH	pH unit	6.5-9	1987	6.5-9[a]	2006	6 - 9.5	6 - 9.5	**>5.9**	6.5	*in situ*	26	6.71	7.59	64	6.12	7.47
Turbidity	UTN	< from 2 to 8[b]	1999	< from 2 to 8[c]	2001	-	-	-	-	*in situ*	25	0.85	1.65	63	0.87	2.02
Conductivity	µS/cm	-	-	-	-	-	-	-	-	*in situ*	13	7.7	9.9	51	10.3	26.2
Suspended matter	mg/l	< from 5 to 25[c]	1999	< from 5 to 25[a]	1999	15	15	**26**	≤15	2	6	<2	<2	44	<2	<2
Total dissolved solids	mg/l	-	-	-	-	-	-	-	-	10.0	6	13	24	44	29	50.9
Redox potential	mV	-	-	-	-	-	-	-	-	-	6	206.7	252.4	44	228.4	292.7
UV absorbance (254 nm)						-	-	-	-	0.005	19	0.17	0.24	19	0.17	0.24
Total organic carbon						-	-	-	-	0.4	20	4.4	6.2	20	4.4	6.2
True colour						-	-	-	-	2.0	19	22	32	19	22	32
Total hardness	mg/l	-	-	-	-	-	-	-	-	1.0	13	<1	2	51	<1	6.8
Ions and major nutrients						-	-	-								
Total Kjeldahl nitrogen	mg/l	-	-	-	-	-	-	-	-	0.15	6	0.40	0.57	44	0.445	0.69
Nitrates and nitrites	mg/l	NO_3: 13, NO_2: 0.197	1987, 2003	NO_3: 2.9[a]; NO_2: 0.02[c]	2003, 2001	-	-	**NO_2: 14.5 NO_3: 0.1**	-	0.02	10	<0.02	0.04	48	<0.02	<0.02
Nitrites	mg/l					-	-	-	-	0.01	7	<0.01	0.02	29	<0.01	<0.01
Ammoniacal nitrogen	mg/l	-	-	1.23[a]	1986	-	-	**6.15**	-	0.02-0.05	26	<0.05	0.10	64	<0.05	0.07
Total phosphorus	mg/l	0.004-0.01[4]	2004	0.02[c], 0.03[a] or >50 %[a]	1998;1994 - 2005	-	-	**0.075**	0.07	0.005	6	<0.005	0.007	44	0.006	0.011
Calcium	mg/l	-	-	statement[a]	1995	-	-	-	10.2	0.1-1	28	<1	<1	66	<1	2
Magnesium	mg/l	-	-	-	-	-	-	-	11.9	0.02-1	28	<1	<1	66	<1	<1
Dissolved sodium (Na)	mg/l					-	-	-		0.2	2	0.45	0.50	2	0.45	0.50
Total sodium (Na)	mg/l	-	-	-	-	-	-	-	10	0.2-0.03	13	0.48	1.64	51	0.52	1.15
Potassium	mg/l	-	-	-	-	-	-	-	9.0	0.1	6	0.2	0.2	44	0.2	0.9
Sulphates	mg/l	-	-	500[a]	2008	-	-	**2500**	1.6	0.1	6	1	1.1	44	0.9	5.3
Fluoride	mg/l	0.12		0.2	1989	-	-	**1**	0.8	0.1	4	<0.1	<0.1	4	<0.1	<0.1
Chlorine demand	mg/l					-	-	-	-	0.1	2	6.2	6.2	2	6.2	6.2
Sulfide	mg/l					-	-	-	-	0.02	7	<0.02	0.03	7	<0.02	0.03
Total cyanide	mg/l					-	-	-	-	0.01	4	<0.01	<0.01	4	<0.01	<0.01
Chloride	mg/l	-	-	230[f]	2006	-	-	**1150**	-	0.05	13	0.26	0.31	51	0.23	0.48
Metals and metalloids						-	-	-								
Dissolved aluminium (Al)	mg/l					-	-	-	-	0.03	2	0.11	0.11	2	0.11	0.11
Total aluminium (Al)	mg/l	0.005 to 0.1[a]	1987	0.087[a]	2006	-	-	**0.115**	0.10	0.01-0.03	10	0.08	0.13	48	0.12	0.46
Dissolved antimony (Sb)	mg/l					-	-	-	-	0.006	2	<0.006	<0.006	2	<0.006	<0.006
Total antimony (Sb)	mg/l	-	-	0.24	2008	-	-	**1.20**	≤0.004	0.006-0.03	10	<0.03	<0.03	48	<0.03	<0.03
Dissolved silver (Ag)	mg/l					-	-	-	-	0.0003	2	<0.0003	<0.0003	2	<0.0003	<0.0003
Total silver (Ag)	mg/l					-	-	-	-	0.0003-0.002	4	<0.002	<0.002	4	<0.002	<0.002
Dissolved arsenic (As)	mg/l					-	-	-	-	0.002	2	<0.002	<0.002	2	<0.002	<0.002
Total arsenic (As)	mg/l	0.005	1997	0.15	2006	0.2	0.5	**0.2**	≤0.001	0.001-0.002	10	<0.002	<0.002	48	<0.002	<0.002
Dissolved barium (Ba)	mg/l					-	-	-	-	0.03	2	<0.03	<0.03	2	<0.03	<0.03
Total barium (Ba)	mg/l	-		0.038[d]		-	-	**0.19**	0.086	0.03	4	<0.03	<0.03	4	<0.03	<0.03
Dissolved boron (B)	mg/l					-	-	-	-	0.05	2	<0.05	<0.05	2	<0.05	<0.05
Total boron (B)	mg/l	1.5		5		-	-	**25**	0.008	0.05	4	<0.05	<0.05	4	<0.05	<0.05
Dissolved cadmium (Cd)	mg/l					-	-	-	-	0.001	2	<0.001	<0.001	2	<0.001	<0.001
Total cadmium (Cd)	mg/l	0.000005[f]	1996	0.000049[ee]	2006	-	-	**0.0002**	≤0.0001	0.0005-0.001	10	<0.001	<0.001	48	<0.001	<0.001
Dissolved chrome (Cr)	mg/l					-	-	-	-	0.03	2	<0.03	<0.03	2	<0.03	<0.03
Total chrome (Cr)	mg/l	-	-	-	-	-	-	-	-	0.001-0.03	10	<0.03	<0.03	48	<0.03	<0.03
Chrome III	mg/l	0.089	1997	0.013[ch]	1998	-	-	**0.065**	≤0.001	-	-	-	-	-	-	-
Dissolved cobalt (Co)	mg/l					-	-	-	-	0.03	2	<0.03	<0.03	2	<0.03	<0.03
Total cobalt (Co)	mg/l	-	-	0.1	2008	-	-	**0.5**	≤0.001	0.001-0.03	10	<0.03	<0.03	48	<0.03	<0.03
Dissolved copper (Cu)	mg/l					-	-	-	-	0.003	2	0.009	0.012	2	0.009	0.012
Total copper (Cu)	mg/l	0.02[a]	1987	0.0013[cc]	1998	0.3	0.3	**0.007**	≤0.001	0.001-0.003	10	<0.003	0.007	48	<0.003	0.004
Tin	mg/l	-		-		-	-	-	≤0.0005	-	-	-	-	-	-	-
Dissolved iron (Fe)	mg/l					-	-	-		0.1	7	<0.1	<0.1	7	<0.1	<0.1
Total iron (Fe)	mg/l	0.3	1987	1.3[gg]	2000	3.0	-	**3.0**	0.05	0.02-0.1	13	<0.1	0.1	51	0.2	0.5
Lithium	mg/l	-		0.44		-	-	**2.2**	0.00022	-	-	-	-	-	-	-
Dissolved manganese (Mn)	mg/l					-	-	-	-	0.003	7	<0.003	0.005	7	<0.003	0.005
Total manganese (Mn)	mg/l	-	-	0.28[ee]	2008	-	-	**1.30**	0.007	0.001-0.003	13	0.004	0.005	51	<0.003	0.006
Mercury	mg/l	0.000026[h]	2003	0.00091[ff]	1998	-	-	**0.0046**	-	0.0001	10	<0.0001	<0.0001	48	<0.0001	<0.0001
Dissolved molybdenum (Mo)	mg/l					-	-	-	-	0.03	2	<0.03	<0.03	2	<0.03	<0.03
Total molybdenum (Mo)	mg/l	0.073	1999	3.2	2008	-	-	**16**	0.006	0.001-0.2	10	<0.2	<0.2	48	<0.2	<0.2
Dissolved nickel (Ni)	mg/l					-	-	-	-	0.01	2	<0.01	<0.01	2	<0.01	<0.01
Total nickel (Ni)	mg/l	0.025[f]	1987	0.0074[gg]	1998	0.5	0.5	**0.037**	0.003	0.001-0.01	10	<0.01	<0.01	48	<0.01	<0.01
Dissolved lead (Pb)	mg/l					-	-	-	-	0.001	2	<0.001	<0.001	2	<0.001	<0.001
Total lead (Pb)	mg/l	0.001[f]	1987	0.00017[hh]	1998	0.2	0.2	**0.0009**	0.001	0.001	10	<0.001	<0.001	48	<0.001	<0.001
Dissolved selenium (Se)	mg/l					-	-	-	-	0.001	2	<0.001	<0.001	2	<0.001	<0.001
Total selenium (Se)	mg/l	0.001	1987	0.005	2008	-	-	**0.025**	0.00048	0.001	10	<0.001	<0.001	48	<0.001	<0.001
Strontium	mg/l	-		21		-	-	**105**	0.0248	-	-	-	-	-	-	-
Titanium	mg/l	-		-		-	-	-	0.002	-	-	-	-	-	-	-
Uranium	mg/l	0.015		0.014		-	-	**0.07**	≤0.00009	0.02	4	<0.02	<0.02	4	<0.02	<0.02
Vanadium	mg/l	-		0.012		-	-	**0.06**	0.0011	-	-	-	-	-	-	-
Dissolved zinc (Zn)	mg/l					-	-	-	-	0.005	2	0.012	0.015	2	0.012	0.015
Total zinc (Zn)	mg/l	0.03	1987	0.017[f]	1998	0.5	0.5	**0.085**	≤0.001	0.002-0.005	10	<0.005	0.010	48	<0.005	<0.005
Other parameters						-	-	-								
Phenols	mg/l	0.004		0.45		-	-	**2.25**	≤0.004	-	-	-	-	-	-	-
Silicone	mg/l	-		-		-	-	-	9.1	-	-	-	-	-	-	-
						-	-	-								
Fecal coliforms	CFU/100 ml									1	18	<1	7.9	18	<1	7.9
Atypical bacteria	CFU/100 ml									1-10	18	85	730.5	18	85	730.5
Total coliforms	CFU/100 ml									1	16	49	465	16	49	465
Total count (HPCB)	CFU/ml									1	2	57.5	58	2	57.5	58
Escherichia coli***	CFU/100ml									1	2	<1	<1	2	<1	<1
						-	-	-								
Monochlorocetic Acid	ug/L									5	8	<5	<5	8	<5	<5
Monobromoacetic Acid	ug/L									5	7	<5	<5	7	<5	<5
Dichloroacetic acid	ug/L									5	7	<5	<5	7	<5	<5
Trichloroacetic acid	ug/L									5	7	<5	<5	7	<5	<5
Bromochloroacetic acid	ug/L									5	7	<5	<5	7	<5	<5
Dibromoacetic acid	ug/L									5	7	<5	<5	7	<5	<5
Total haloctic acids	ug/L									5	7	<5	<5	7	<5	<5
Chloroform	ug/L									1	7	<1	<1	7	<1	<1
Bromodichloromethane	ug/L									1	7	<1	<1	7	<1	<1
Dibromochloromethane	ug/L									1	7	<1	<1	7	<1	<1
Bromoform	ug/L									1	7	<1	<1	7	<1	<1
Total trihalomethanes	ug/L									1	7	<1	<1	7	<1	<1
						-	-	-								
Benzene	ug/L									0.2	2	<0.2	<0.2	2	<0.2	<0.2
Toluene	ug/L									0.1	2	<0.1	<0.1	2	<0.1	<0.1
Ethylbenzene	ug/L									0.1	2	<0.1	<0.1	2	<0.1	<0.1
Total xylenes	ug/L									0.4	2	<0.4	<0.4	2	<0.4	<0.4
Petroleum hydrocarbons (C_{10}-C_{50})	mg/l	-	-	0.1[i]	1996	2	-	**0.5**	-	100	8	<100	<100	45	<100	<100
Acenaphthene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Anthracene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Benzo(a)anthracene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Benzo(b+j+k)fluoranthene	ug/L									0.06	2	<0.06	<0.06	2	<0.06	<0.06
Benzo(a)pyrene	ug/L									0.008	2	<0.008	<0.008	2	<0.008	<0.008
Chrysene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Dibenz(a,h)anthracene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Fluoranthene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Fluorene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Indeno(1,2,3-cd)pyrene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Naphtalene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Phenanthrene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Pyrene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
Benzo(a)pyrene	ug/L									0.003	2	<0.003	<0.003	2	<0.03	<0.03
Acenaphtylene	ug/L									0.03	2	<0.03	<0.03	2	<0.03	<0.03
7,12-Dimethylbenzanthracene	ug/L									0.1	2	<0.1	<0.1	2	<0.1	<0.1
3-Methylcholanthrene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Benzo(ghi)perylene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Dibenzo(a,j)pyrene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Dibenzo(a,h)pyrene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Dibenzo(a,l)pyrene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Benzo(c)phenanthrene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
2-Methylnaphtalene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Benzo(e)pyrene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
1-Methylnaphtalene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
1,3-Dimethylnaphtalene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
2,3,5-Trimethylnaphtalene	ug/L									0.1	2	<0.1	<0.1	2	<0.01	<0.01
Ethylene glycol	mg/L									5	2	<5	<5	2	<5	<5
Tetraethylene glycol	mg/L									5	2	<5	<5	2	<5	<5
Triethylene glycol	mg/L									5	2	<5	<5	2	<5	<5
Propylene glycol	mg/L									10	2	<10	<10	2	<10	<10
Diethylene glycol	mg/L									5	2	<5	<5	2	<5	<5

[1] The table notes are available in Appendix 3.10.2. A hardness of 10 mg/l of $CaCO^3$ was used to calculate the criteria that vary relative to the hardness of the water.

[2] The most recent reference document date cited for the criteria or a given recommendation.

[3] The theoretical environmental discharge objectives (EDO) correspond to the lowest value between the technological standard (Directive O19 and MMER) and five times the MDDEP's aquatic life protection criterion (chronic effet), except for phosphorus where the EDO calculation was done following MDDEP's method (2007).

[4] Metal mine effluent regulation

- : no value.

Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. "Canadian Water Quality Guidelines for the Protection of Aquatic Life – Summary Table," updated December 2007. In Canadian Water Quality Guidelines. 1999. Winnipeg. The Council.

MDDEP (Ministère du Développement durable, de l'Environnement et des Parcs). 2009. Surface Water Quality Criteria. Environmental monitoring branch. Government of Quebec.

MDDEP (Ministère du Développement durable, de l'Environnement et des Parcs). 2007. Calculation and interpretation of environmental discharge objectives for contaminants in an aquatic environment. 2nd editon.

Golder, 2011. Water Treatment Evaluation. 18 October 2011. 10-1427-0020/5012 no. 061 Rev.0

The modelling of discharge into lakes poses several constraints and can be more complex than for a river. The morphology of Lake Lagopede implies a confined area with low current velocity, which ensures that the characteristics of the outfall (location and position of the outfall, pipe diameter, presence of a diffuser, etc.) are parameters that have an important influence on the initial dilution of the effluent in the receiving environment.

The treated mine effluent will enter the lake at approximately 250 m from the shore at a depth of about 11 m to 13 m (Figure 3.10.6). The treated mine effluent discharge point is equipped with a 250 m long diffuser and was positioned in Lake Lagopede in such a way as to favour rapid dispersion and dilution of the effluent.

The parameter most susceptible to influence the mine effluent dispersion is the current velocity in the lake at the discharge point (Appendix 3.10.1). The inflow of the main tributary (F3294) of Lake Lagopede, the mouth of which is located upstream of the discharge point, contributes to the dispersion and dilution of the plume. The thermocline effect on the effluent dispersion was also taken into account in order to determine the discharge depth. The technical characteristics of the outfall also influence the effluent's initial dilution considering the morphology of the lake (confined area with slow currents) (Appendix 3.10.1). All of these characteristics were considered in the effluent dispersion analysis.

The results of the treated mine effluent plume modelling (Appendix 3.10.1) indicate that in severe low water level conditions, the initial concentration of the treated mine effluent will reach a 1:10 dilution at a distance of 750 m from the discharge point (Figure 3.10.7) and from 300 m during fall turnover (see Section 3.10.5.2 and Figure 3.10.8). The particular bathymetry of the lake divides the lake into 2 distinct basins: the north basin that receives the mine effluent and the south basin that is in the downstream portion of the lake (Figure 3.10.7). The line separating the north basin from the south basin does so in such a manner that the south basin is mildly affected by the treated mine outflow. In the north basin, at the edge of the plume, the concentrations of various contaminants will be within the range of concentration measured in the environment during the environment baseline study (Roche, 2011), with the exception of the total phosphorus whose concentration at the edge of the plume could be slightly higher (0.01 mg P/l) than in the lake (95° percentile = 0.007 mg P/l). The mine and domestic effluent plumes will not overlap (Environnement Illimité, 2011).

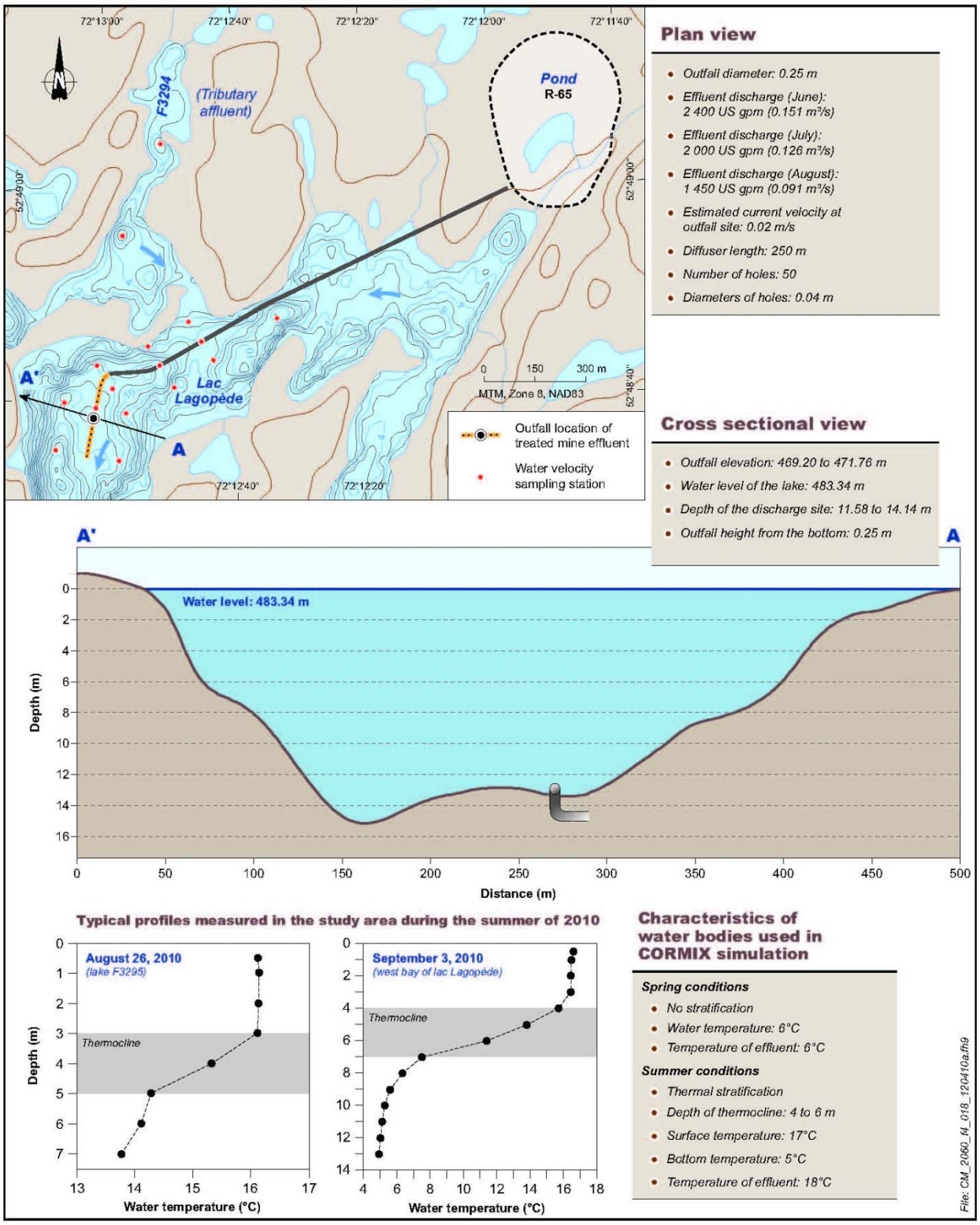


Figure 3.10.6 Location of Mine Effluent Final Discharge Point

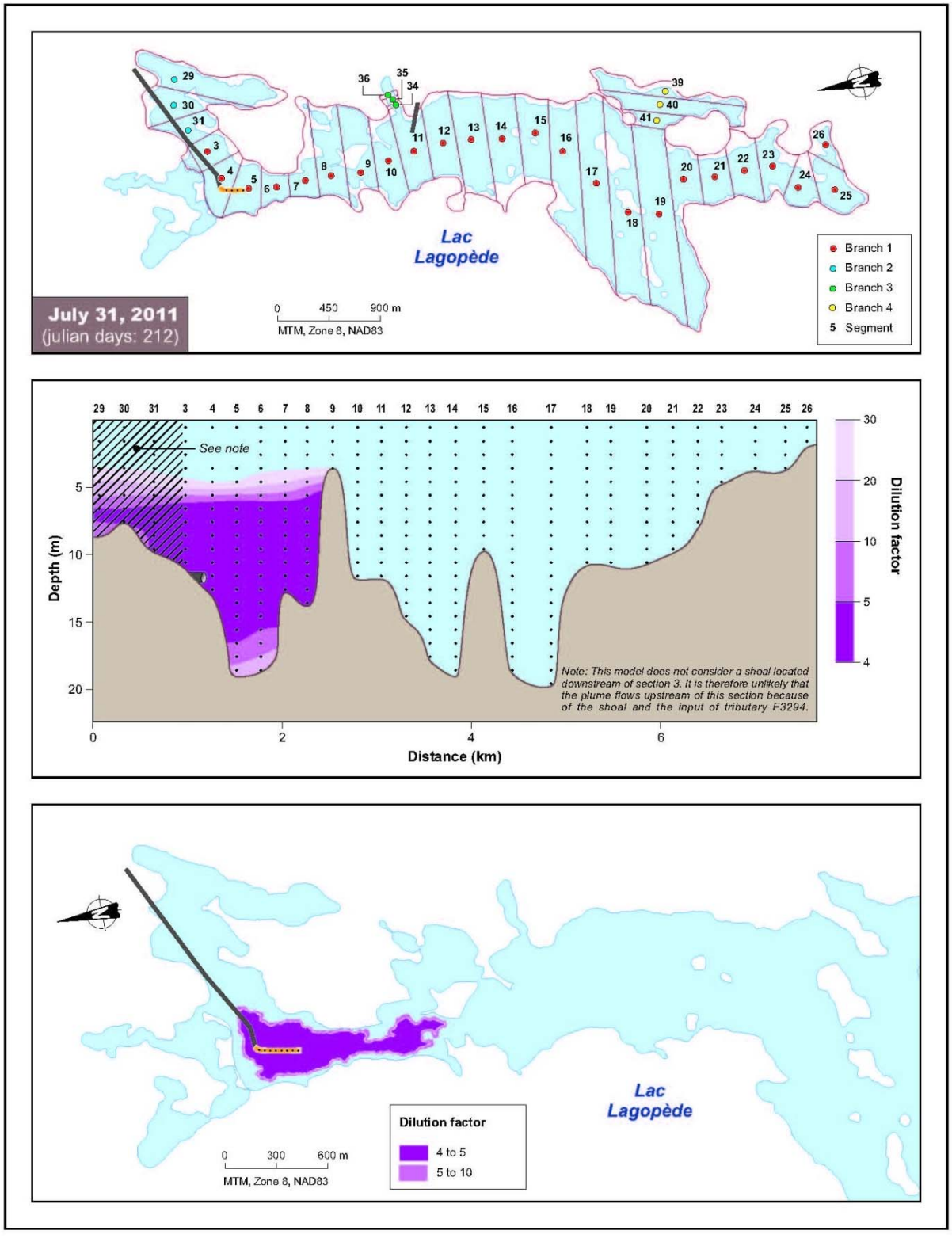


Figure 3.10.7 Extent of Mine Effluent Plume During Low Water Period, Modelled Using CE-QUAL-W2

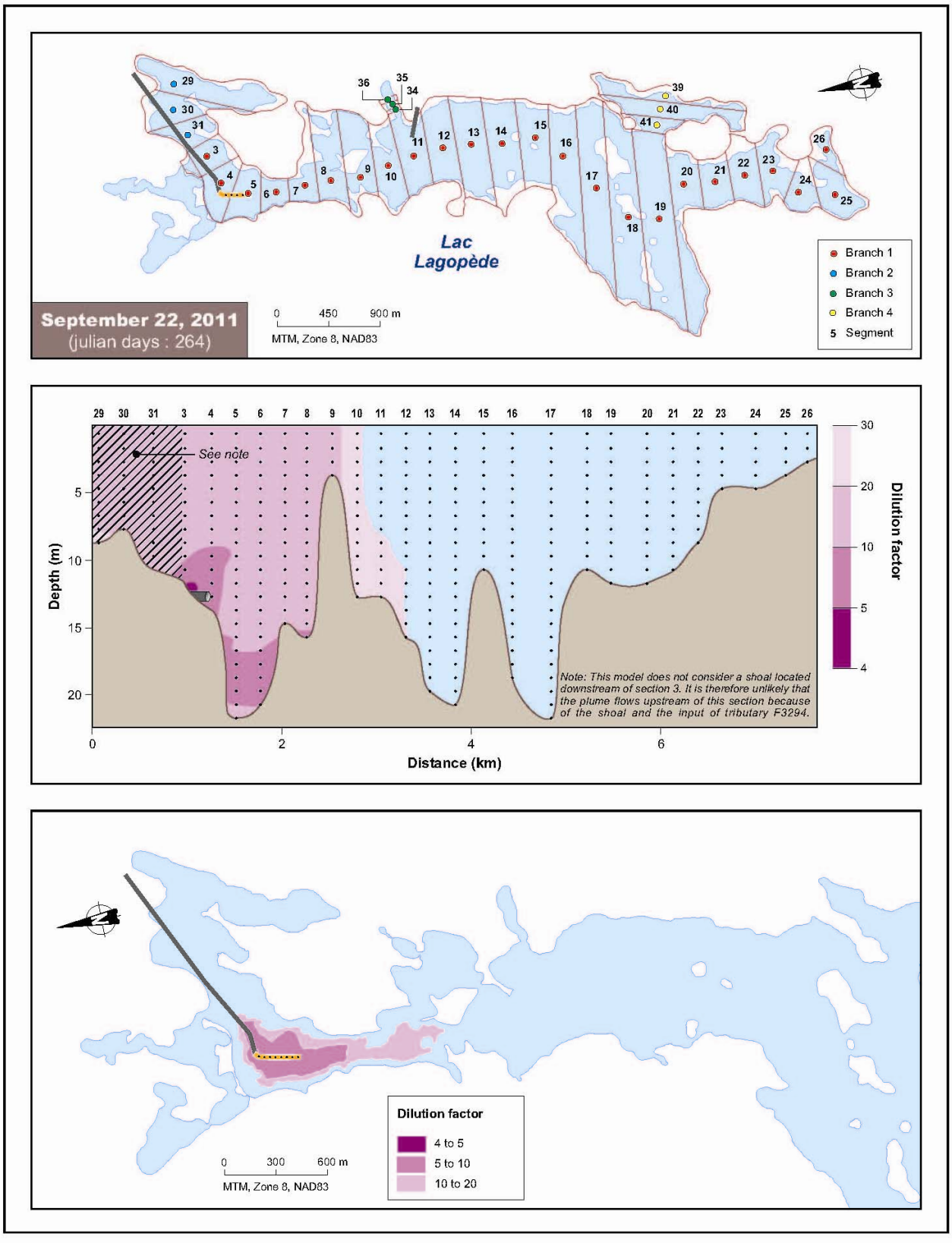


Figure 3.10.8 Extent of Mine Effluent Plume During Fall Turnover, Modeled Using CE-QUAL-W2

Phosphorus inputs from the mine effluent could result in the north basin of Lake Lagopede to a temporary (around the month of August) and local increase in the total phosphorus concentration corresponding to those of an oligo-mesotrophic lake (typically between 0.007 mg/l and 0.013 mg/l of total phosphorus; MDDEP, 2007). Depending on the proportion of total phosphorus that will be bio-available in the form of orthophosphates, these inputs could possibly contribute to a localized and temporary productivity increase in this area of Lake Lagopede and in its halieutic potential. Considering the hydraulic residence time of water in Lake Lagopede, which is about fifty days, and the decrease in temperature usually occurring in September, this effect will be of short term and possibly limited to the month of August.

A treated mine effluent monitoring program will be implemented to ensure compliance with discharge objectives established by the MDDEP. The quality of the water, sediment, and aquatic organisms (benthos and fish) in proximity levels with the discharge point will also be monitored in order to detect any negative effect from the discharge and to implement in place corrective measures if necessary. The details of the mine effluent monitoring program and the water sediment quality monitoring and the aquatic organisms monitoring are presented in Section 11.4.

The water management facilities, the pits, sedimentation ponds, and water treatment plant will remain operational until the closure activities are completed and monitoring indicates that the contact water on the mine site complies with environmental discharge objectives (Guideline 019, MDDEP 2005) and do not require treatment (Golder, 2011e). Therefore, the drainage pattern of the streams and lakes located on the periphery of the mine site can be re-established, where possible, to conditions similar to those observed prior to the beginning of the project. For example, the R-2/R-3 and R-65 pits will stop being dewatered and, with time, will become lakes; once the R-2R-3 pits are filled with water, a hydraulic connection will be built with the surrounding environment.

3.11 Solid Waste Management and Storage

As mentioned in Section 3.2.7, the Renard Project's on-site operations will generate a non-negligible quantity of solid waste that must be recycled, disposed of, or repurposed. Measures must also be taken to minimize the amount of waste generated and maximize reuse of all products. More than 500 tons of solid waste material will be generated annually; it is estimated that this waste will take up a total volume of 920 m^3 annually. This section defines the area where the solid waste will be generated, its characteristics as well as the equipment that will be used to manage it.

The main waste management principle used by the Renard Project is sorting at the source. Based on the type of solid waste generated at any given location, equipment will be available to sort the waste at the source as a function of the various approved methods. The solid waste management plan will favour a continuous improvement approach that will encourage all of the employees to propose and implement innovative solutions to improve solid waste sorting and collection.

The underlying philosophy will be to use the 3R-RD approach as much as possible. This entails, as a first step, to reduce the quantity of waste material at the source, then to favour reuse, followed by maximizing recycling and repurposing of waste material. All material that cannot be repurposed will be disposed of in a responsible manner.

3.11.1 Solid Waste Production Areas and Characteristics

- *ACCOMODATION AND SERVICES COMPLEX*

The waste generated in the accomodation and services complex includes the following categories:

- Recyclable material (plastic, metal, paper, cardboard, tetrapak);
- Glass (all colours);
- Ultimate waste (plastic wrap, Styrofoam, multilayer, others);
- Ultimate waste with high organic content (meal leftovers, toilet paper, soiled paper products).

The project's procurement policy specifies that the purchase of over-packaged food will be limited in order to reduce the amount of waste at the source. The use of reusable dishes and utensils will also reduce the production of waste.

In addition, the waste management will be facilitated by a sorting system at the source that includes, separate bins for recyclable waste, glass, and ultimate waste in each area and specifically in eating areas and sanitary facilities. Waste with high organic content could also be separated and eventually undergo specific processing. Garbage cans should be emptied separately and on a daily basis (especially food waste) to avoid odours and to prevent attracting wildlife to the camp.

Outside of the buildings, larger garbage cans will be available for waste and will be emptied once or twice a week. Recyclable waste will be taken to the compactor located at the transfer site, the glass to a designated container, and the ultimate waste to the trench landfill site (TLFS).

Ultimate waste with high organic content will be collected each day to avoid attracting wildlife. At first, it will be taken to TLFS with the other ultimate waste. However, should this cause recurrent problems with the surrounding wildlife or to reduce the environmental impact of the project, the possibility to take this waste to another landfill site equipped with a leachate treatment system and a tighter control on methane emissions and odours could be evaluated.

Also of note, the used cooking oil that will be generated in the cafeteria will be disposed of with the other used oil generated on site.

➢ *STORE AND PROCUREMENT*

Three types of waste are most susceptible to accumulate in the store and at the project procurement centers:

- Paper and cardboard;
- Styrofoam and plastic wrap;
- Wood pallets, plastic containers, and other refundable packaging.

Where possible, clauses that reduce packaging to a strict minimum and that privilege the use of refundable packaging will be included in the tendering and procurement. This packaging could simply be stored in the reception areas and returned to the sender at the next delivery. This method would considerably reduce packaging issues related to procurement.

Concerning the remaining waste (paper, cardboard, Styrofoam, and plastic wrap), two separate recycling bins could be placed in all areas where merchandise is received. The first would be used for ultimate waste (Styrofoam and plastic wrap) and the second for recyclable waste (paper and cardboard). Both recycling bins would be collected each day; the former would be taken to the TLFS and the latter to the compactor.

➢ *OFFICES*

The mine will have an administrative centre with offices for managers and professionals, meeting rooms, and computer services. These different functions will generate various types of waste, among which includes the following:

- Paper and cardboard;
- Confidential documents;
- Used office material;
- Printer cartridges;
- Used computer equipment.

Each of these waste products will have their own waste management procedure.

For the paper and cardboard, recycling bins will be installed in each office and at strategic points in the administrative building (meeting rooms, etc.). The contents of the bins will be collected weekly and put into a larger bin and the contents of which will be sent to the compactor.

For confidential documents, a recycling bin will be equipped with a shredder. This bin will be identified as such, and an employee will supervise it. The shredded paper will be managed in the same way as the rest of the paper; that is, it will be collected weekly and taken to the compactor at the Ecocentre.

The used office material will be disposed of in the same manner as the ultimate waste. A garbage bin will be placed in a visible strategic location and will be emptied once a week or as needed. This waste will be taken to the TLFS to be buried. Larger material (desks, chairs, etc.) will be disposed of at the Ecocentre in a container or sent to the TLFS if it is not repurposeable.

Ink cartridges from the printers will be put in a specific bin that will be sent to a recycler. An agreement will be signed with a supplier stating that the used ink cartridges be recovered when new ones are supplied.

The used computer equipment will be stored at the Ecocentre in a big container. The container will be sent to an authorized recycling facility for this type of waste so that it can be managed in a responsible manner.

- *WORKSITES (ABOVE GROUND AND UNDERGROUND)*

The waste that is most likely to accumulate in the work areas, be it above ground or underground, includes the following:

- Various used packaging (plastic, metal, glass, cardboard, etc.);
- Used tires;
- Used equipment parts;
- Used hardware parts:
- Other domestic waste.

Where possible, use of refillable containers and the purchase of large-format products will reduce the quantity of generated waste. The use of high-performance and durable parts will also reduce equipment and parts replacement when available and feasible. In addition, the reuse of the various containers on-site (pails, barrels, etc.) is favoured.

Used tires will be stored near the Ecocentre or in designated containers. These containers will be periodically sent to a supplier (3 to 4 times a year) to be disposed of in a legal manner. When the tires are purchased, a deposit will be paid to the supplier to handle tire recovery.

Used equipment and hardware parts will be stored on-site when required by repair work. Once the repair work is done or the part is replaced, the used parts will be taken to the Ecocentre where they will be put in a designated container. The temporary storage sites for this material will be deployed at certain points throughout the site, particularly underground so that a reasonable quantity is accumulated before moving them. These sites will contain enough containers based on the generated waste in the area.

For the rest of the waste that must be treated, designated bins can be placed in the areas where the waste will be produced. The first bin will be for ultimate waste (Styrofoam, plastic wrap, and dirty packaging) and the second for recyclable items (plastic, metal, cardboard, etc.). The two bins will be collected each day (or based on need); the first will be taken to the TLFS and the second to the compactor. A third alternative could be implemented for areas where large quantities of glass are generated since this material must be disposed of separately. It is important to note that the waste storage sites will be implemented outside of buildings and at certain strategic areas underground in order to accumulate the waste and only transfer them when needed.

➢ *CONSTRUCTION, RENOVATION, AND DEMOLITION DEBRIS*

Debris generated during site construction, renovation, and closure will be managed separately because this type of waste is generally larger and takes up more space. It mainly consists of scrap pieces and surplus material from construction and renovation work. For the closure phase, it includes all of the infrastructure material.

The debris includes the following categories:

- Ferrous metals (steel, iron, etc.);
- Non-ferrous metals (aluminum, etc.);
- Non-contaminated wood (beams, boards, etc.);
- Inert materials (stone, brick, asphalt, cement, etc.);
- Other yards debris (domestic waste).

To reduce the quantity of waste produced at the source, several strategies will be implemented. The first consists of using modular, pre-fabricated buildings that will be assembled on-site. During closure, parts of the buildings could be disassembled, transported, and reused elsewhere for other uses.

The leftover material will be sent to the Ecocentre where it will be stored and then taken to a proper recycling facility.

During construction, renovation, and closure work, four separate bins will be placed near the construction area to sort the material at the source. The first three bins will be for Ecocentre waste and the fourth for ultimate waste that will be taken to the TLFS.

Furthermore, specific clauses for this waste will be included in the tenders to ensure the suppliers working on-site conform to the policy.

➢ *WASTEWATER TREATMENT PLANT SLUDGE*

During mining, the domestic wastewater treatment system will generate very low sludge dryness content (2 to 4%). This sludge will be treated by aerated lagoons and then sent to drying beds for a minimum period of 4 years. The time in the drying bed combined with the exposure to the freeze-thaw cycles will dehydrate the sludge to a dryness point between 15% and 20%. Following this operation, the sludge will be taken to the TLFS or, if the quality permits, it will be used for site revegetation.

➢ *SLUDGE FROM TEMPORARY SANITARY FACILITIES*

At the beginning of the construction, before the domestic wastewater treatment system is operational, temporary sanitary units will be used. These units consist of traditional dry toilets and chemical toilets and will generate sludge that will be treated with a temporary bio-disc or bio-pond treatment system that will be installed on-site. A mobile unit equipped with sludge suction and adjustable load capacity will recover the sludge from the sanitary units and transfer it to a temporary treatment system. The waste

generated by the treatment equipment (concentrated sludge) will be accumulated in sealed containers and disposed in an appropriate place.

- *BIOMEDICAL WASTE*

Biomedical waste will be generated at the on-site infirmary. Bandages, needles, syringes, and other used medical equipment will be stored in a secured bin, clearly identified, and located in a refrigerator at 4° Celsius. An agreement will be made with the hospital at Chibougamau for compliant disposal of this waste. The waste could be transported to Chibougamau each week for processing (if necessary).

- *WASTE SNOW*

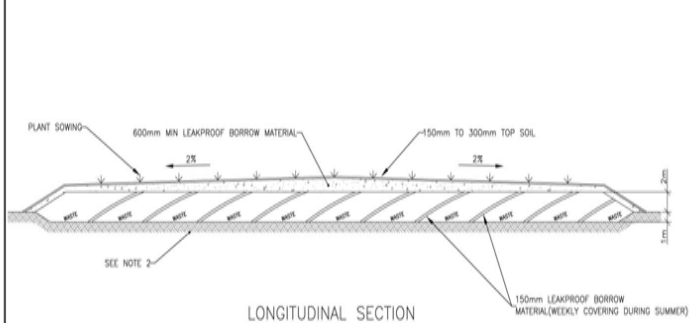
The snow on the mine site roads will be removed to permit the safe movement of vehicles and equipment. The snow will be ploughed by motorized equipment (truck, bulldozer, loader, etc.) equipped with a snow plough, a snow blade, or other equipment appropriate for moving snow. All the snow will be moved to a designated snow dump area within the perimeter of the project site; therefore, all the runoff from the melting snow will be collected and treated.

3.11.2 Summary Description of the Equipment Needed for Solid Waste Management and Treatment

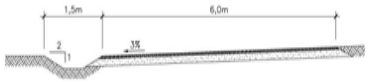
3.11.2.1 Trench landfill site (TLFS)

As previously mentioned, a landfill site will be built for disposal of ultimate waste on the Renard Project site itself. The TLFS will comply with design criteria in Section 3 of the *Regulation respecting the landfilling and incineration of residual materials* (RLIRM, LRQ c. Q-2, r. 19).

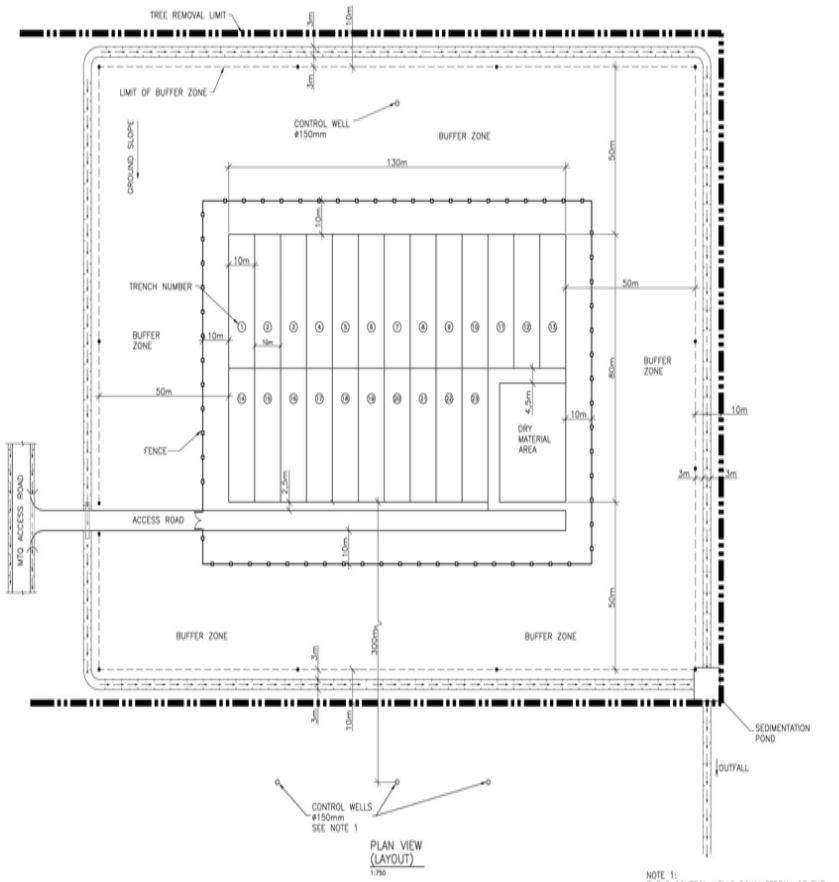
Section 3.2.7 of this document presents the main characteristics of the landfill trenches site planned for the project. To this can be added 23 trenches and a pit that will be the width of two trenches and will be used to bury large, dry material. The site is also equipped with two piezometers already installed that will monitor underground water, pursuant to Articles 65 and 66 of the RLIRM, during the entire time the TLFS is in operation. A third observation well will also be drilled to comply with the existing installation and regulations. A proposed site plan is illustrated in Figure 3.11.1.



LONGITUDINAL SECTION OF TYPICAL TRENCH
1:250



TYPICAL ACCESS ROAD SECTION
1:50



PLAN VIEW
(LAYOUT)
1:750

NOTE 1:
THE 3 CONTROL WELLS DOWN STREAM OF THE TRENCH LANDFILL (LEET) WATERTABLE WILL BE INSTALLED AT 300m FROM THE LIMIT OF THE LEET.

NOTE 2:
THE BOTTOM OF THE TRENCH MUST BE LIMITED TO 1m ABOVE THE ROCK OR THE HIGHEST NATURAL WATERTABLE LEVEL, WHICHEVER COMES FIRST.

Figure 3.11.1 Trench Landfill Site (TLFS)

3.11.2.2 Ecocentre

An Ecocentre will be built to accommodate construction (Figure 3.11.2), renovation, and demolition waste as well as to store larger waste and waste with a high repurposing potential. It will consist of containers with retractable lids to prevent snow from filling the containers and wildlife from entering. The containers should be positioned against a small rise to allow loaders, workers, and trucks to dump their loads inside. The content of each container will be identified to favour sorting at the source. Eight containers are planned that would contain the following waste:

- Ferrous metal;
- Non-ferrous metal;
- Wood;
- Used tires;
- Used aerosols;
- Cement and other aggregates;
- Plastics;
- Glass.

This layout will allow “Roll off” type container trucks to load the containers. When a container is full (or when a delivery truck going south is empty), it will be transported to the nearest recycling facility or to the one that offers the best price for the contents. In the case where there is no demand for the recovered waste, it will be stored and then disposed of.

It is important to note that the company will never store more than 2,000 tires on the project site to avoid being subject to the regulation on used tire storage.



Photo 3.11.1 Ecocentre Example

3.11.2.3 Compactors

To reduce the amount of recyclable waste that will be stored on-site, compactors will be installed at several strategic locations. This will allow more recyclable waste to be accumulated in the containers and to optimize transportation costs.

It is planned to install one compactor at the warehouse for paper and cardboard collection. Given that the majority of this waste will be collected here, it is logical that the equipment also be installed here, allowing paper and cardboard collection to be centralized for the whole site.

The possibility to install one or two compactors in the kitchen is also being studied. This will allow for the collection of metals (cans) and non-metals (aluminum cans). These compactors could be of smaller size and be used as a transfer point between the kitchen and the Ecocentre.

3.11.2.4 Transportation equipment

The purchase of a small dump truck with a loader will be necessary to facilitate the transport of waste between the buildings and sites. This vehicle will be able to load 320 litre, wheeled garbage cans and unload easily into the various equipment.

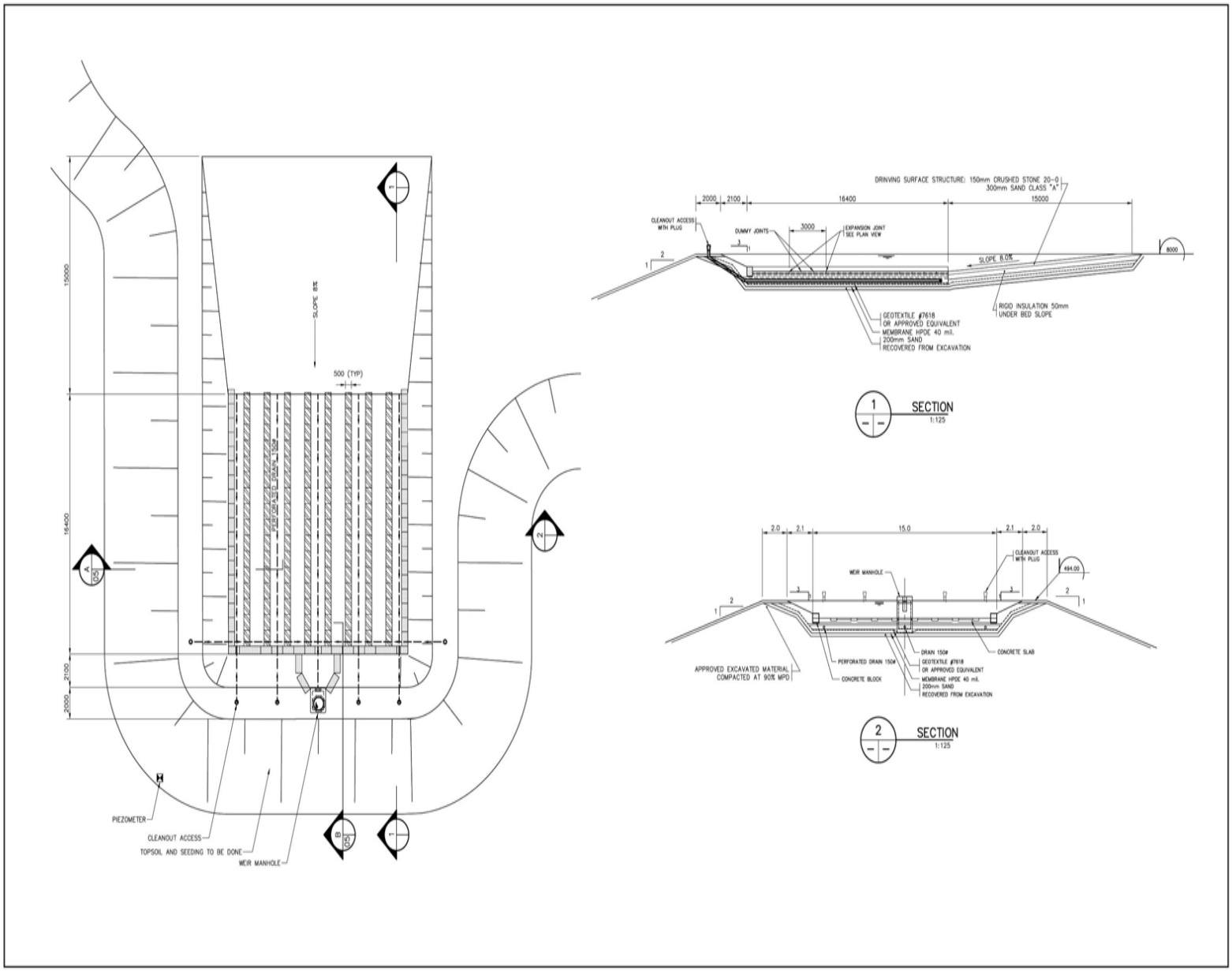


Figure 3.11.2 Sludge Drying Bed

3.11.2.5 Drying bed

As discussed in the previous section, the wastewater treatment will require a drying bed that will increase the dryness of the sludge from the aeration lagoons. A drying bed consists of a sealed pond with a drain and a layer of aggregates at the bottom. The aggregates vary in size from coarse gravel to sand (Figure 3.11.3). The structure allows the retention of the solids present in the sludge with the sand while allowing the water to seep into the drain.

After 4 years and as many freeze-thaw cycles, the high organic sludge can be recovered and used, if its quality permits, for the site rehabilitation or disposed of in the TLFS.

3.12 Hazardous and Combustible Material Storage

3.12.1 Hazardous Material

Hazardous materials that will be on-site fall into the following three categories:

- Hazardous material representing all new material purchased for operations;
- Fuel; and
- Hazardous waste material at the end of its lifecycle and therefore must be disposed of.

Table 3.12.1 presents all the hazardous material that will be on-site.

3.12.1.1 Source

➢ *EXTRACTION PROCESSES*

The hazardous materials that will be used in the extraction process are mentioned in section 3.6.4, table 3.6.1 of the ESIA. These products are used to clean the diamonds and have corrosion potential (NaOH and HCl) or are used in the process to generate an intermediate liquid phase (FeSi). It is planned to use 3 t of NaOH, 1,830 litres of HCl, and 432,000 kg of FeSi annually.

The storage and use of these materials will be on-site and will comply with Articles 33 to 80 in the *Hazardous Materials Regulations*.

➢ *WATER TREATMENT PROCESSES*

The products used to treat the drinking water are commonly used in domestic wastewater treatment plants: alum and sodium hypochlorite. The former is used at the flocculation step for water dephosphatation; the latter is used to disinfect the water to make it drinkable.

It is planned to use, annually, 100 litres of sodium hypochlorite, 214 litres of liquid alum, and 1.36 t of solid alum during the operation phase while 44.7 litres of liquid alum and 2.82 t of solid alum will be used during the construction phase.

A polymer and a coagulant ($Fe_2(SO_3)_4$) will also be used in the water treatment process to neutralize contaminants that may exist in the mine effluent. It is planned to use 119,920 kg of coagulant ($Fe_2(SO_3)_4$) and 8,570 kg/yr of a polymer.

- *MATERIAL ASSOCIATED WITH DAILY OPERATIONS*

Various cooling liquid, oil, and grease will be necessary for the daily mine operations and vehicle maintenance. The use of a refrigerant, such as halocarbons, will also be necessary at certain facilities on the site.

These materials are not necessarily considered hazardous materials, but are related to hazardous materials according to the *Hazardous Materials Regulations* (Article 4) or the *Halocarbon Regulation* (Article 4).

It is estimated that the facilities will use, annually, 319,000 litres of various oil and grease, 8,035 litres of coolant, and an undetermined number of litres of refrigerant.

- *AIRSTRIP, TERMINAL, AND GARAGE*

Other than the use of aviation fuel, the operation of the airstrip will also require propylene glycol for de-icing the planes in the winter. This material will not be controlled according to SIMDUT criteria; however, the use of this product will be controlled in a similar way as the hazardous material. It is anticipated that 250 gallons/yr of this product will be used.

- *EXPLOSIVES*

Explosives will be used to mine the ore. They will be controlled by the *Explosives Act* (R.S.Q., Chapter E-22) and the regulation on the application of the *Explosives Act* (R.S.Q., c. E-22, a. 22).

It is estimated that approximately 1,200,000 kg of liquid and solid phase explosives and detonators will be used annually.

Table 3.12.1 List of Hazardous Material Used During the Operation Phase

Chemical Product	Location of Use/Use	Annual Consumption (kg), (L)	Storage site
Explosives			
Emulsion explosives		1,080,000 kg/yr	Emulsion storage site to the north of the actual camp
Packaged explosives		120,000 kg/yr	Explosives storage site to the north of the actual camp
Various Chemical Products			
$Fe_2(SO_3)_4$ - Ferric sulphate (concentration: 30-60% ferric sulphate and 0.1 to 1% sulphuric acid)	Water treatment plant - used as a coagulant	119,920 kg/yr	Mine wastewater treatment plant site
Polymer	Water treatment plant - used as a flocculent	8,570 kg/yr	Mine wastewater treatment plant site
Ferro silicon (FeSi) Ferrosilicon composed of Iron (70-80%) and Silica (10-20%)	Ore processing plant	432,000 kg/yr	Stored inside the ore processing plant (Concentrator - DMS) in a dry area
Flocculent (Floerger AN 923 VHM) - Ionic polymer soluble in water	Ore processing plant	7590 kg/yr	Stored inside the ore processing plant (Concentrator - DMS) in a dry area
Caustic soda (NaOH)	Ore processing plant	3 t/yr	Cleaning room for diamonds from the concentrator - DMS
Hydrochloric acid (HCl)	Ore processing plant (recovery plant) for cleaning diamonds	1,830 litres	Stored in the cleaning room for diamonds from the concentrator - DMS
Grease (Engen collector DB; will also be used to adjust the texture of the grease: Microwax 2528 + Tekniwax petrolatum)	Ore processing plant - Grease table	3,460 L/yr	Concentrator - DMS - recovery area
Chlorine - Sodium hypochlorite 12% NaOCl (Bleach)	Drinking water treatment system	100 L/yr	
Alum (construction phase)	Domestic wastewater treatment plant - phosphate removal from the treatment ponds	44.7 L/yr Liquid alum and 2.82T/yr Dry alum	Domestic wastewater treatment plant
Alum (operation phase)		214 L/yr Liquid alum and 1.36 T/yr Dry alum	
Polypropylene glycol or propylene glycol	Airstrip - de-icing of planes	250 gallons/yr	Airport
Various industrial oil	Vehicles, motorized equipment, industrial equipment	319 300 litres/yr	Hazardous material storage, garage, plant
Hydrocarbons (other than grease for the grease table)			
Jet fuel (kerosene)	Airstrip	100,000 L/yr	Airport
Gasoline	Garage/for the generator at the emulsion site	100,000 L/yr	Garage - Gasoline tank 25 m from the garage.
	Fuel station		Plant site (mill)
Diesel	Fuel station	2,181,640 L/month	
	Airstrip		Airport
Oil	Machinery (surface, underground mine, ore processing plant, etc.)	18,256 L/month	Hazardous material storage site and in compliant areas of use
Propane	Plant site (mill) - Underground mine heating	193,056 L/10 days for 5 months	Propane tank storage area
	Kitchen, laundry room	19,801 L/10 days	
Other Hazardous Material			
Halocarbons	Refrigerators, air conditioners	Undetermined	In the equipment (office, cafeteria, underground)
Nuclear sources	Plant, detection and automation equipment	Undetermined	Ore processing plant
Used batteries	Various uses	0.25 m^3/an	Residual hazardous materials storage area
Light bulbs and neon containing mercury	Lighting throughout the site	30/month	Residual hazardous materials storage area
Used oil	From oil changes in all motorized and hydraulic equipment	319,300 litres/yr	Used oil tank near the garage
Various new and used gas containers	Used throughout the site (paint, WD-40, Mercaptan, etc.)	50/month	Outdoor hazardous material storage area and container at the Ecocentre

N/A: Not Available

3.12.1.2 Equipment Needed for Hazardous Material Management

➢ *HAZARDOUS MATERIAL RECEPTION AREA AND STORAGE*

A special depot designed specifically to store and manage hazardous material will be built on-site. This depot will meet the stated criteria in the *Hazardous Materials Regulations* (Articles 33 to 92).

Indeed, it will have the following characteristics:

- Water resistant to rain and snow and resistant to freezing and heat;
- Building with 4 walls, a sealed roof and floor resistant to the stored material and sitting on a foundation that will hold 25% of the total capacity of the containers within its walls or 125% of the biggest container;
- The interior will be designed to avoid any chemical reactions between materials likely to interact.

➢ *OTHER STORAGE AREAS*

Some material will be stored in others areas more appropriate to their use, particularly to minimize material moving around and favour a certain proximity. The following is a list of these storage areas:

- Outside shelter for pressurized propane bottles;
- Airport storage area (for the propylene glycol and other material likely to be used in the underground mine;
- Underground storage area (for oil and grease and other material used in the underground mine).

All these areas will follow the guidelines set out in the *Hazardous Materials Regulations* (Articles 33 to 92).

➢ *HAZARDOUS MATERIALS REGISTER*

A central register will be created to register all hazardous material entering the project site and all movement of material inside the site in order to tightly monitor these materials. This register will be controlled by the person responsible for the on-site environment.

3.12.2 Fuels

3.12.2.1 Construction phase

The construction works will require the use of the following fuels:

- Gas for vehicles that will initially be stored in a 50,000 litre, double-lined reservoir until the permanent reservoir is ready;
- Diesel for the power generating sets will be stored in a reservoir;
- Propane supply for the kitchens.

3.12.2.2 Operation phase

A fuel station will be built to receive and store the following hydrocarbons:

- Arctic-type fuel for light vehicles, trucks and mobile equipment, water heaters, and the power generating sets;
- Regular, unleaded gas for light vehicles;
- Propane reservoirs near their area of use.

The fuel station will be mostly automated and equipped with a communication and alarm system. Radio frequency identification cards (RFID) will be used to ensure monitoring of vehicle fuel consumption. Since it is assumed that the access road could be closed for a maximum of 10 days during the winter, the fuel station will have a 10-day capacity to ensure the mine can operate over this period.

For the diesel, a single distillate will be used as the main source of fuel for all uses (vehicle, power generating sets, heating). The system includes a loading station for 50,000 L cistern trucks to fill the reservoirs totalling 8,100,000 L. The site will have a confinement ditch around the reservoirs in the case of an accidental leak. An oil-water separator will be installed at the bottom of the confinement platform to control the presence of hydrocarbons in the water.

Two diesel distribution containers will be connected to the diesel reservoirs to fuel the mine site via an underground system designed for this purpose. Each container will also distribute diesel to the daily use reservoirs:

- A double-lined reservoir with a 5,000 L capacity for the services building;
- A double-lined reservoir with a 5,000 L capacity for the boiler;
- Thirteen daily use reservoirs for the generator set;
- A double-lined reservoir with a 100,000 L capacity with an integrated refueling system near the maintenance workshop to fuel the mine vehicle fleet like the Caterpillar 775, the light vehicles, and the ancillary equipment;
- A double-lined reservoir with a 12,500 L capacity with an integrated refueling system will be installed at the airstrip and will be fed directly by the cistern trucks;
- A double-lined reservoir with a 50,000 L capacity with an integrated refueling system will be installed on-site to fuel the small vehicles.

In total, 26,179,680 litres of diesel are planned to be used per year.

There will be three main areas of propane use: the underground mine (heating and ventilation systems), the cafeteria and the laundry room. There are three, 113,560-litre reservoirs for the underground mine and two, 18,925-litre reservoirs for the cafeteria and the laundry room. The propane capacity of these reservoirs is enough to operate for 10 days. In total, 3,618,576 litres of propane is estimated to be used annually.

In addition to the fuel stored at the fuel station, an aviation fuel station (jet-fuel) will be built at the airstrip. It will include a double-lined reservoir with a capacity of 25,000 L with an integrated refueling system. It is estimated that 100,000 litres of jet-fuel will be used annually.

3.12.3 Residual Hazardous Materials

3.12.3.1 Types and source

➢ *OIL AND GREASE WASTE*

The use and maintenance of the heavy machinery, and the vehicle fleet, and the operation of the mechanical processes necessary for the extraction and processing of the diamonds, requires the use of an important quantity of oils, lubricants, and solvents. Once used, this material becomes residual hazardous material and must be managed accordingly. All the material contaminated by this material is also considered as residual hazardous material and must be treated accordingly. The residual hazardous material in this category includes the following:

- Contaminated rags and absorbent material;
- Used oil and lubricants;
- Used solvents;
- Oil filters.

A sound management of equipment including preventative maintenance and a program that encourages employees to detect and report leaks and operational problems will be put into place to reduce the amount of this material generated.

A clear and efficient management plan will be implemented.

For the rags and absorbent material, bins dedicated to hazardous material and clearly identified as such (e.g.: red bins) will be placed in all areas likely to be frequented by workers who could generate this type of material. In addition, spillage clean-up kits (e.g.: barrels of absorbent, shovels, brooms, etc.) will be placed in all areas where oil, lubricant, or solvent spillage is a possibility.

For the used oil and lubricants, a mobile disposal unit with a pump and sealed reservoir will be used to collect these products from the various equipment to be maintained. A large, secure reservoir equipped with a pump will be used on-site to store used oil before it is recovered by a supplier specialized in the management of used oil. In the region, the supplier is Les Serres de Guyenne located in Amos.

➢ *OTHER RESIDUAL HAZARDOUS MATERIAL*

A variety of other residual hazardous material will also be generated on-site. Employees will be trained on how to manage these materials so that the processes will be understood and applied in order to minimize the risks and ensure respect of the existing laws and regulations. Other residual hazardous material includes the following:

- Light bulbs containing mercury (fluorescents, high pressure bulbs, compact fluorescents);
- CFCs and other halogens;
- Various aerosol spray cans;
- Explosives and explosive packaging;
- Nuclear sources (densimeter, debit meter in the piping);

- Oily water;
- Other (small and large batteries).

As a first step, a responsible procurement policy will be put into place to minimize the use of these materials. For the remaining material, the following procedures are to be followed:

- Light bulbs containing mercury will be handled with care to avoid breakage which would release the mercury. When replaced, the old bulbs will be put in the packaging of the new bulb and taken to the hazardous material depot or will be disposed of in a specialized, dedicated garbage container. In this container, the bulb will be broken, the gas will be drawn into an air filtration system, and the pieces of glass and metal will be stored. The contents of the full container will be recovered by a company specialized in this type of material.
- Equipment containing CFCs must be recorded in the register for equipment containing refrigerants (refrigerators, freezers, air conditioners, etc.). It is mandatory that the maintenance, cleaning, or replacement of these appliances be done by an authorized company. All maintenance work done on these appliances will be recorded in the register.
- Pressurized gas tanks containing hazardous material (or not) must be punctured and emptied before being recycled. To this end, garbage containers with special piercing and recovery mechanisms will be placed strategically throughout the site. The contents of these containers will be recovered by companies specialized in managing this type of material.
- Unexploded explosives and the explosive's packaging will be burned each day at a controlled burn site. This site will be cleaned before each burning. The ashes are classified as residual, non-hazardous material and will be treated accordingly.
- Sources of nuclear radiations will be stored in a secure location and disposed of by a specialized company on the matter. In addition, all devices containing radioactive material will be recorded in a register where the location of the device will be noted as well as the material it contains. The personnel who will handle these devices will have the required qualifications as well as a permit from the Canadian Nuclear Safety Commission.
- Oily water will be taken to an oil separator that will extract the oil from the water and store it with the other used oils. The remaining water will be sent to the mine wastewater treatment plant.
- The other solid waste will include batteries and used batteries used in the various devices on-site. A large, sealed, plastic container located at a strategic place (the building where devices that use batteries are stored) will be used to collect the batteries. The full container will be recovered by a company specialized in treating this type of material. Battery depots should also be deployed at various locations likely to generate this type of waste (accommodation complex, cafeteria). An awareness program will be implemented for employees so that they have to dispose of this material in the proper collection bins.

3.12.3.2 Summary Description of the Solid Waste Management Equipment

➢ *RESIDUAL HAZARDOUS MATERIAL STORAGE*

All hazardous material generated on-site will be stored in a centralized location that will comply with the design criteria in the hazardous materials regulation. This area will be adjacent to the hazardous materials depot described in Section 3.12.1.2 of this document and will have the same design criteria which are:

- Water resistant to rain and snow and resistant to freezing and heat;
- Building with 4 walls, a sealed roof and floor resistant to the stored material and sitting on a foundation that will hold 25 % of the total capacity of the containers within its walls or 125% of the biggest container;
- The interior will be designed to avoid chemical reactions between materials likely to interact.

All the hazardous materials recovered on-site will be stored in this area, and for each material, there will be a specific container identified accordingly: totetanks (sealed, mobile reservoirs) for non-oily liquids, 360-litre bins for solids, and larger bins for more abundant material. A special bin equipped with a carbon filter will be located in this area to puncture and store pressurized tanks as well as fluorescent tubes and all other used lighting systems containing mercury.

Each garbage container will be equipped with a system to note the beginning of storage which will not exceed one year as specified in Article 70.8 of the *Environment Quality Act*. In addition, a residual hazardous materials register will allow tight monitoring of the quantity generated and the disposal management of these quantities.

- *BURN CONTROL AREA*

A burn control area will only be used to burn residual explosives and their packaging. The burning of the latter must be done without delay in a confined area delineated by 3 walls opened at the top to let the exhaust gas escape. A used, blue container with one side open and a chimney hole is sufficient.

The destruction of explosives must be done in front of a witness who is of legal age and signed into a register. The following information must be noted in the register: place, date, and hour of the destruction; the quantity and description of the explosives; and the name, address, and date of birth of the witness.

3.13 Power Generating Sets

The power supply alternative currently selected for the project is a diesel power generator set (gen-set). However, the option to connect to the Hydro Quebec network is being studied and could be considered if the price of fuel increases significantly or other partners share the construction costs.

The power generating sets will be located near the mining area, close to the primary crusher (Map 3.13.1). It will include a total of 12 generators of 1,800 kW each in order to meet the needs of the mine which are 13,560 kW at peak periods (SNC-Lavalin, 2011F). The operation of the gen-set will be managed from an electrical room and a control room that will be adjacent to the power generating sets.

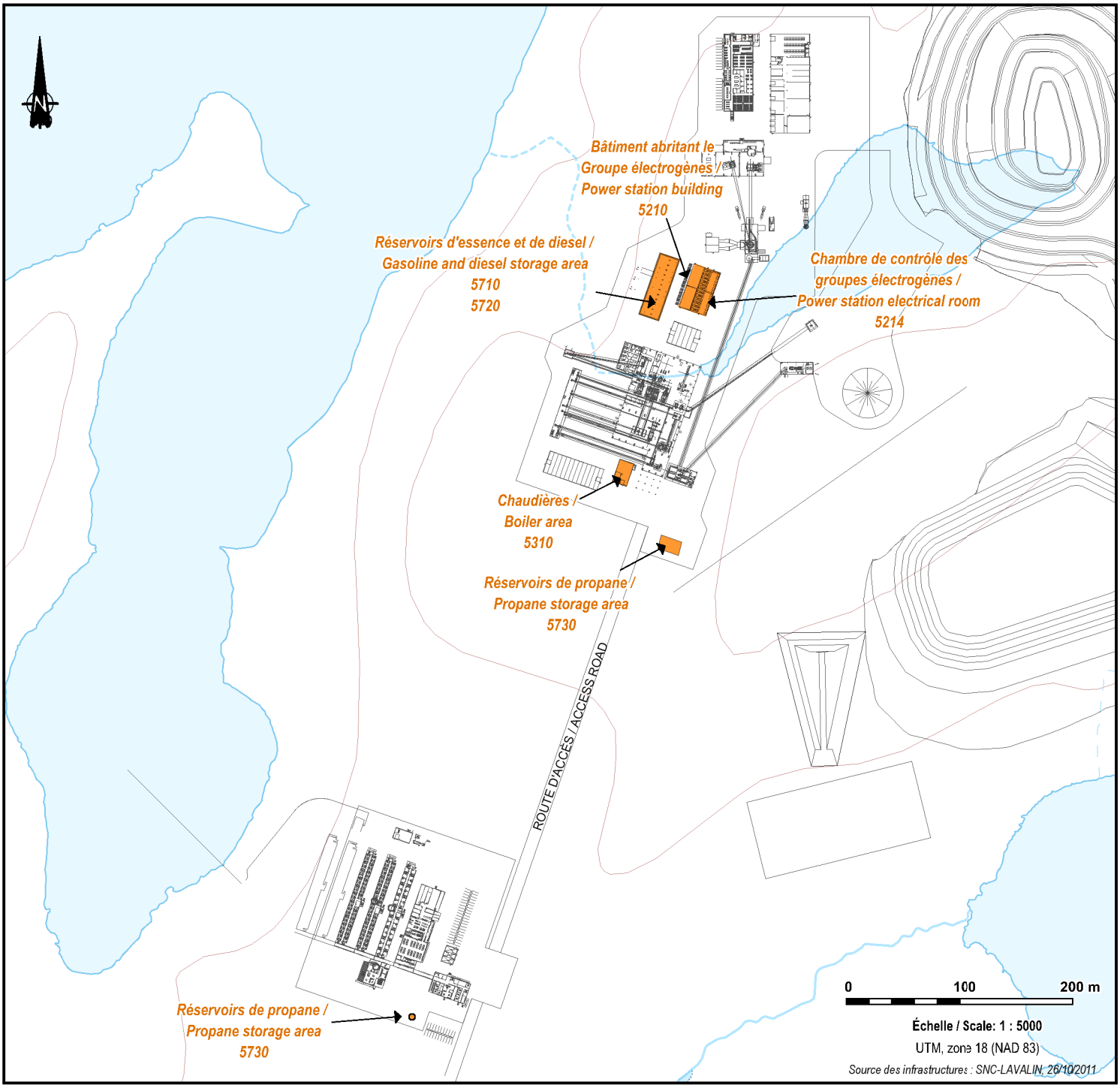
An air-water recovery system will capture heat from the equipment and exhaust gas, which will be transferred to a glycol boiler that will redistribute the heat to the ore processing plant and the service buildings. This system will save energy and reduce greenhouse gases. Additional diesel-powered, glycol boilers will be installed between the mine offices and the ore processing plant, and will act as a supplementary heating system for these facilities (Map 3.13.1).

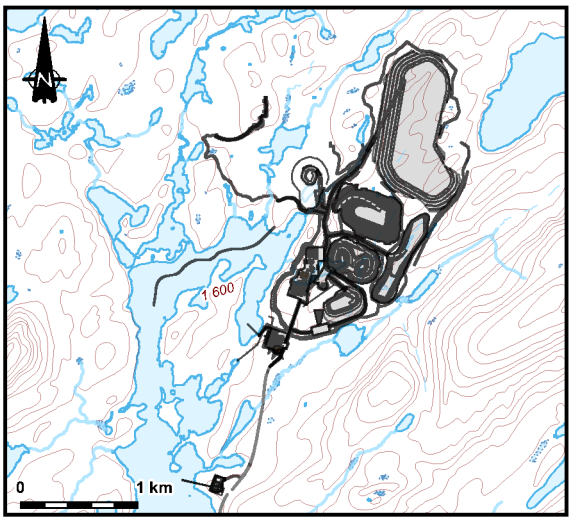
The power will be fed to various site facilities based on the voltage requirements. Underground substations will be installed to step-down the voltage as a function of the size of the motors (Stantec, 2010). The power distribution will be supplied by the following:

- A substation (4160 V) and a switchgear for primary distribution of power around the site, including the accommodation complex;
- A secondary distribution system (4160 V) including power lines on poles or placed directly on the ground when necessary (e.g.: in the pit areas).

The power produced by the gen-set will be distributed to the open pits, the underground mine, the crushing plant, the ore processing plant, the offices, the warehouses, the garages, the accommodation and services complex, and the various isolated pumping systems.

The fuel station will be able to receive and store, among others, Arctic-type diesel for the gen-set (see Section 3.12.1). For the diesel, a single distillate will be used as the main source of fuel for all uses (vehicle, power generating sets, heating). The system includes a loading station for 50,000 L cistern trucks to fill the reservoirs totalling 8,100,000 L. The site will have a confinement ditch around the reservoirs in the case of an accidental leak. An oil-water separator will be installed at the bottom of the confinement platform to control the presence of hydrocarbons in the water.





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Groupes électrogènes, réservoirs de carburant et chaudières / Power station building, fuel reservoir and boiler area

ROCHE

Carte de base : Canvec, 1: 50 000, 33A16-33A09, RNCan, 2010 et fond hydrographique fourni par Stornoway le 12 novembre 2010.
Fichier : 61470_EIES_ComplexeElectro_111219.WOR

Décembre 2011 / December 2011

Carte / Map 3.13.1

Two diesel distribution containers will be connected to the diesel reservoirs to supply the mine site via a dedicated underground network. Each container will also distribute diesel to various daily-use reservoirs including the thirteen for the power station (see Section 3.12.1).

3.14 Airstrip and Ancillary Facilities Operation

The airstrip will be located 8 km by air (11 km by road) south of the Renard mine site, along the Route 167 extension alignment (Map 3.14.1). Stornoway will be the sole owner and operator of the airstrip.

The airstrip will be used only to transport people. The equipment and material will be transported to the site via MTQ roads. There will be three to five flights per week, depending on the type of plane used.

The site will have one airstrip, 1,494 m long and 30 m wide. DASH-8 300 Series (50-passenger capacity) will be used as a reference plane for the design of the runway. The surface of the runway will be gravel. A turn-around area of 45 m x 45 m will be built at both ends of the runway to facilitate operations of a C-130 type plane. A taxiway of 150 m long and 18 m wide will link the apron and the runway.

The dimensions of the apron (100 m x 70 m) are designed to accommodate two planes at the same time. The surface of the apron will be gravel. The runway and the apron will be connected by a graveled taxiway of 150 m long and 18 m wide.

A fuel station as well as a de-icing system will be adjacent to the apron. A 2,300 L tank of propylene glycol, for de-icing planes, will be stored in a heated shelter. The fuel station will contain two, above ground, double-lined tanks, one with a capacity of 25,000 L (jet-fuel) and one with a capacity of 12,500 L (diesel).

The terminal will be a modular, pre-fabricated building containing an office for the radio operator and the runway director, a first-aid section, and a septic system. A water well will be drilled to supply the terminal and the garage with water while bottled water will be available as drinking water. The baggage check will be done at the accommodation and services complex, and a waiting room has not been planned at the airstrip.

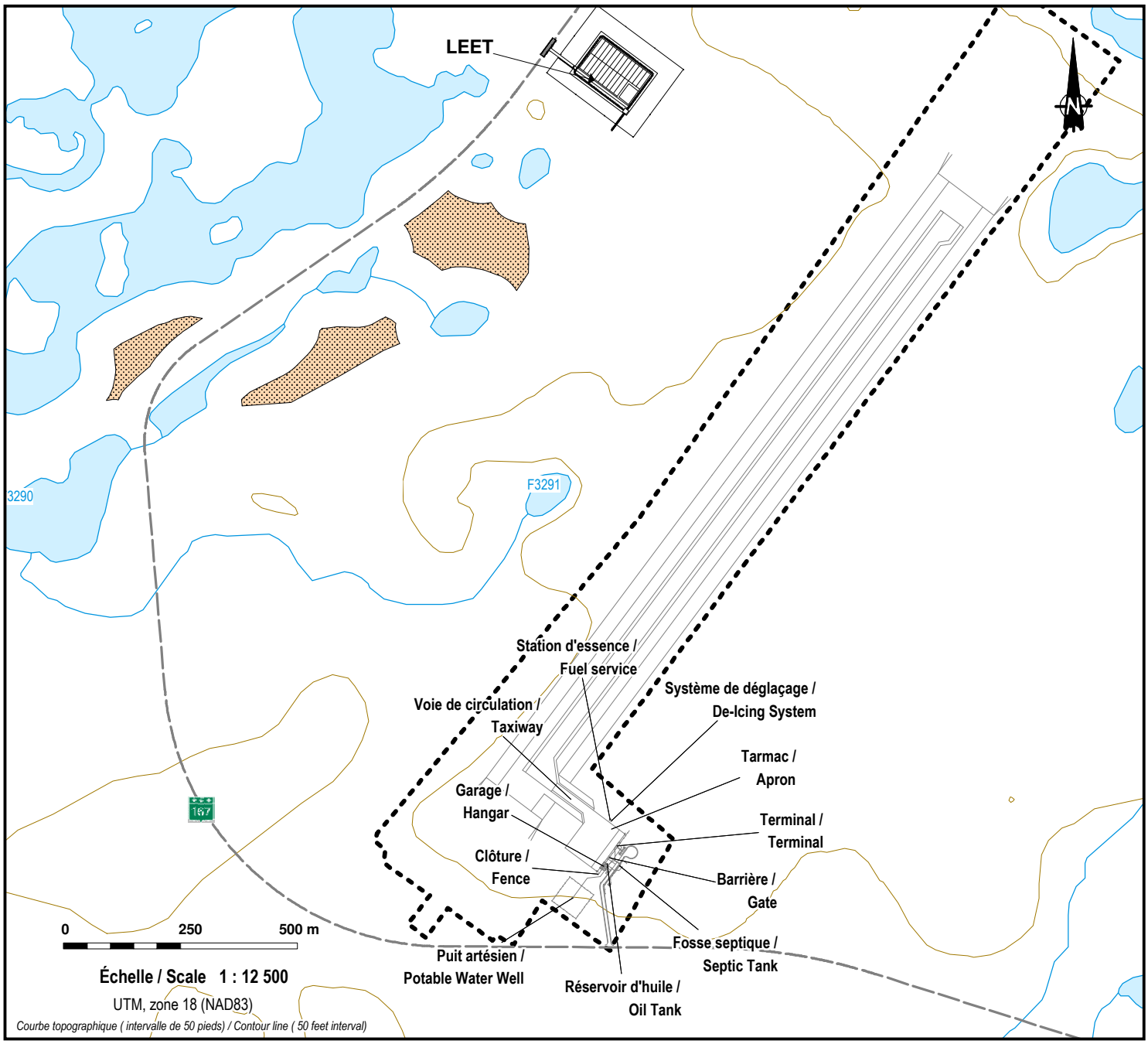
A 167 m^2 garage will be used to store vehicles used to maintain the runway in the summer and for snow removal equipment in the winter. The garage will be made of metal and erected on a cement platform to avoid soil contamination. Equipment maintenance will be done at the repair garage and truck maintenance will be done at the mine site. A contamination recovery kit will be available at the airstrip to contain all accidental spillage of petroleum products.

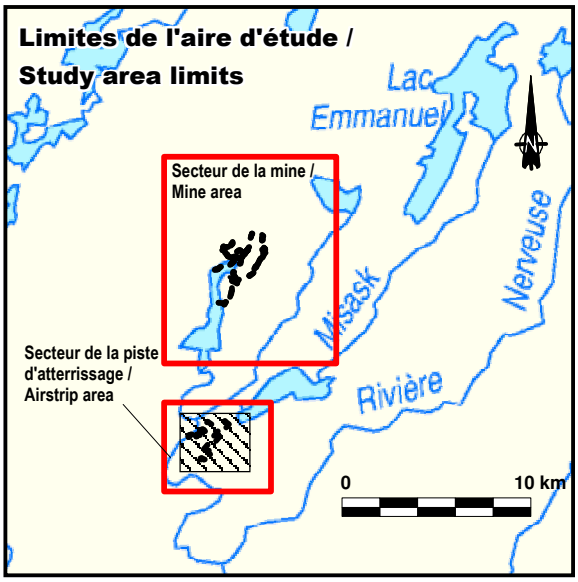
The power for the terminal and garage will be supplied by two power generating sets with a capacity of 72kW/90kVA (347/600V, 3 phases, 60Hz). The power generating sets will be placed in a prefabricated shelter near the garage and will contain a cooling and ventilation system and all the required

accessories. An oil heater and a separate 900 L tank will be installed to heat the terminal when it is not being used and the power generating sets are not working.

A 1.8 m fence will be built around the terminal. A gate between the terminal and the garage will control access to the apron. A peripheral fence to keep animals off the runway was determined to be unnecessary. In the winter, such a fence would not be efficient because of the large accumulation of snow. Before each landing and takeoff, a visual inspection of the surroundings will be done to ensure the absence of animals.

The runway, apron, and taxiway will be equipped with a lighting system. In addition, instruction and exit signs will be posted along the runway and apron.





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Bancs d'emprunt potentiels / Potential borrow pits

Emprise du projet / Project footprint (26/10/2011)

Piste d'atterrissage et installations connexes / Airstrip and ancillary facilities

ROCHE

Carte de base / Base Map : BNDT50, 33A16
Fichier / File : 61470_aeroport_111215.WOR

Décembre 2011 / December 2011

Carte / Map 3.14.1

3.15 Accommodation and Services Complex

It is estimated that the construction of the mine will require the hiring of over 500 specialized workerswhile in the operation phase, a total of 450 workers will be employed (based on a mine life of approximately 20 years).

To facilitate its dismantling and future reuse, the accommodation complex will be modular (Photo 3.15.1) and located slightly away from the buildings dedicated to the operation of the mine (Map 3.15.1).





Photo 3.15.1 Type of Building Used for the Accommodation Complex

The building includes a reception (three units), a laundry room (three units), a kitchen and dining room (13 units), a leisure area (three units), 17 dormitories (including two dormitories for executives (66 rooms) and 15 regular dormitories (345 rooms)), and eights units for hallways connecting the security buildings. The buildings associated with accommodation complex include a heating system, ventilation system, a propane storage area, and an electrical room. A garage adjacent to the accommodation complex is also planned for emergency vehicles (ambulance and fire truck) (SNC-Lavalin, 2010).

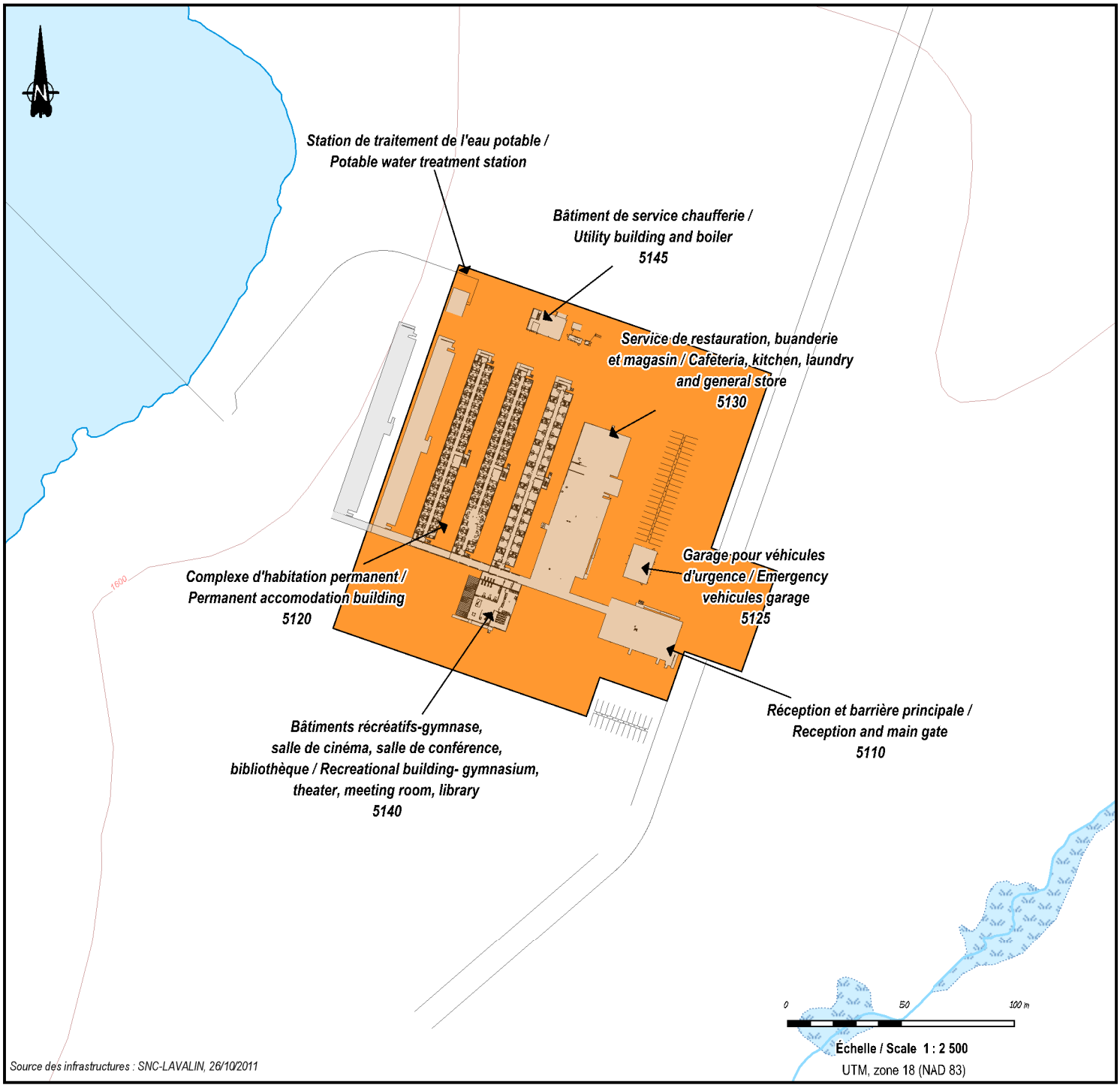
A recreational building, located near the accommodation complex, will include a movie room, a conference room, a library, and a room for electrical, mechanical, and maintenance services. An additional building dedicated to the services necessary for the accommodation complex will also include a residential area and will house an emergency generator and other services necessary to the proper functioning of the accommodation complex.

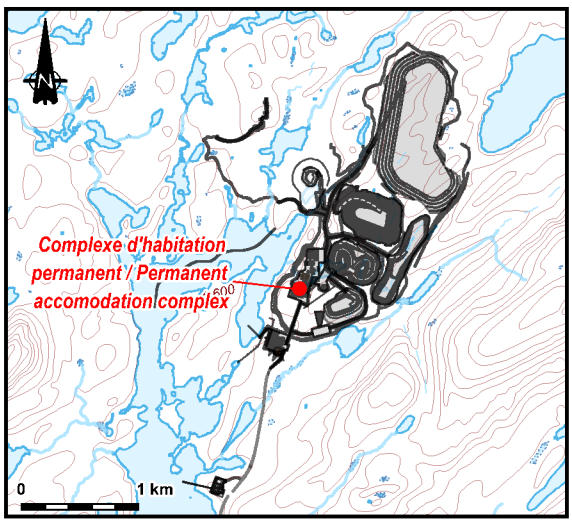
A building located near the plant will house a workshop for minor equipment repairs, a warehouse, and light vehicle garage and ancillary services (e.g.: equipment for oil changes and for vehicle maintenance). An oil-water separator will be installed at these facilities. The separated oil will be collected, stored in special containers, and transported outside the site to authorized recycling or disposal sites in accordance with applicable regulations (Stantec, 2010; Scott Wilson, 2010). A MegaDome®-type cold storage room will also be located in the facilities area of the plant.

The mine office (Map 3.15.1) will include 22 private offices and 40 semi-private, two meeting rooms, an eating area, a photocopy room, an office supplies room, a computer room, a reception area, a secure area, and a first aid room (SNC-Lavalin, 2010). Adjacent to the mine office, a building is planned for showers, and separate lockers and toilets in the men's and women's sections.

A security system will be installed and will include a closed-circuit television (CCTV) system, an alarm system, and various access control systems as well as a monitoring station that will be part of the mine Security Centre, located near the ore processing plant. Site access will also be controlled by an exterior CCTV system connected to the different video surveillance offices that will monitor, among other things, truck traffic between the mine, the accommodation complex, and the airstrip. Access to the site will also be controlled by gates located at strategic points (Map 3.15.1). All of these facilities will be fenced. The main access to the mine will be controlled by a gate at the accommodation complex that will be installed when the Route 167 extension is complete. In addition, the security system will include magnetic card readers, access doors with magnetic locks and an emergency mechanism, and motion detectors.

The ore processing control system will be independent from the main security system and will include a CCTV system with cameras in the ore processing plant and the underground mine. A control station will be located in the plant's main control room and a baggage scanner is also planned for checking the bags of the personnel when leaving the plant.





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Complexe d'habitation et de services / Accommodation complex and ancillary services

ROCHE

Carte de base : Canvec, 1: 50 000, 33A16-33A09, RNCan, 2010
et fond hydrographique fourni par Stornoway le 12 novembre 2010.
Fichier : 61470_EIES_ComplexeElectro_111219.WOR

Décembre 2011 / December 2011

Carte / Map 3.15.1

3.16 Manpower and Procurement

3.16.1 Manpower

The Renard Project will be developed in a region where mining and forestry industries have been established for a long time. Although mine exploration was reported in northern Quebec as early as 1903, northwestern Quebec effectively opened to mining operations between 1920 and 1930. Hydroelectric development in the region increased in the seventies in the James Bay region. The first forestry operations in the mid-north of Quebec go back to settlement of the James Bay region (1930-1940) with the construction of the first forestry roads. One of the results of these activities is the development of a qualified and experienced regional workforce.

However, in recent years, the economic activity in the Nord-du-Québec region has considerably diminished. Several mines in the area have stopped producing, the forest industry has been hit hard by a serious reduction in demand, and large hydro-electric project development has slowed. The economic slowdown has lowered the demand for workers in the region, which has caused these workers to seek employment outside of the region or even update their skills and move to other industries or to jobs within Cree and non-Cree public institutions.

Today, the situation has completely changed. The Quebec mine industry is booming: according to the 2010-2020 report from the *Comité sectoriel de main-d'œuvre de l'Industrie des mines* (CSMO Mines), the number of mines in production is expected to increase by 31% between now and 2015, and this percentage could reach 41% between now and 2020 (with respect to the 2010 numbers). The important growth of the mining industry combined with an aging workforce closing in on retirement hints at a labor shortage. Several mining companies in the Nord-du-Quebec will be faced with this phenomenon. According to CSMO Mines, on the 2020 horizon, 12,800 jobs will need to be filled in the Abitibi-Temiscamingue and the Cote-Nord regions, but mainly in the Nord-du-Quebec region.

Mining projects at the advanced exploration phase that are located in the Renard Project's area of influence are likely to create pressure on the regional workforce (see Section 10.4 for a detailed description of these projects):

- The Eleonore Project (Opinaca Mines, Goldcorp) with more than one billion dollars invested and the creation of more than 600 jobs;
- The Blackrock Project (BlackRock Metals, Inc.) could employ 250 people;
- The McLeod Lake Project (Xstrata Zinc) should generate 250 jobs and $160 M in investment;
- The Eastmain Mine and Ruby Hill Project (Eastmain Resources, Inc.) (undefined number of jobs);
- The Matoush Project (Stateco Resources) anticipates approximately 300 jobs will be created;
- The Lavoie Project (Abitex Resources, Inc.) (undefined number of jobs);
- The Gonzague-Langlois Project (Breakwater Resources, Inc.) anticipates approximately 300 jobs will be created;

- The Whabouchi Project anticipates approximately 150 jobs to be created in addition to studying the opportunity to establish a lithium processing plant in Chibougamau which would generate 70 local jobs.

The workforce required for the Renard Diamond Project is indicated in Table 3.16.1. The types of construction jobs concern major work such as infrastructure construction (road, camp, warehouses, garages and service buildings), the kimberlite processing plant construction as well as the mine site development (open pits, extraction shafts, hoist, ramp, etc.). On average, 343 people will be hired during the construction phase. During the operation phase, an average workforce of 450 people will be maintained over the anticipated twenty years of operation. The required workforce will come from various fields: mine development and mine engineering, geomatics, geology, metallurgy, mechanic and electro-mechanics, extraction, drilling, blasting, environment, heavy equipment operation, administration, human resources, etc. During the closure phase, approximately 50 jobs will be required mainly for the dismantling of the facilities and the revegetation.

The Renard Project is located on the territory governed by the James Bay and Northern Quebec Agreement (JBNQA). The JBNQA signed by the government of Quebec and the First Nations, including the Cree, the Inuit, and the Naskapi encompasses economic development and property issues in northern Quebec, and establishes an environmental and social protection regime for First Nations who are signatories to the treaty. The main Cree community impacted by the Renard Project is the Cree Nation of Mistissini, which has a population of approximately 3,300 people.

Given the anticipated shortage of qualified workers in the northern regions of Quebec, it is probable that Stornoway must broaden its recruitment pool in order to meet its staffing requirements even though the company is committed to promote and favour local employment. However, local candidates will be hired as much as possible. Stornoway will recruit from a pool of candidates such as recently graduated students, experienced workers, First Nations candidates, immigrants, and inexperienced workers for whom on the job training programs will be developed and made available. The company will also encourage and facilitate the registration of potential candidates in appropriate training programs offered by well-known training institutions. In addition, Stornoway will actively participate in job fairs and other regional and national employment events.

Table 3.16.1 Manpower Requirements for the Renard Project

Phase	Average Number of Jobs	Main Job Types
Construction Phase (2013 to 2016)	343	Related to the following fields: civil engineering; cement; steel; architecture; mechanics; piping; electricity; instrumentation; mine development; shaft, hoist, and ramp construction; and management and supervision.
Operation Phase (2014 to 2033)	450	Miners, heavy equipment and truck operators, mechanics and electro-mechanics, engineers, nurses, administrative and human resource personnel, etc.
Closure Phase (last two years following the end of operations)	50	Workers to dismantle the facilities and planters.

Source: Stornoway, 2011

3.16.2 Procurement

Procurement for the Renard Project includes the purchase of goods and services for mine construction, operation, and closure. A responsible procurement policy will be adopted by Stornoway to maximize the implementation of 4R-D (Reduce, reuse, recycle, renew and dispose) principles (see Section 3.2.7).

3.16.2.1 Material and Equipment

The material and equipment purchased at the beginning of the project will serve, first, to build the mine site, and second, for its operation. Once the mine site is permanently accessible via Route 167, one of the priorities will be to build a warehouse (temporary or permanent). Usually, the space required for this type of storage area is at least 2,100 m^2. All the equipment and merchandise that can be stored outside will be in a designated area of approximately 10,000 m^2.

The merchandise will mainly be delivered by truck to the mine site. The main route will go through Montreal since the Port of Montreal will receive most of the cargo sent by ship and because the main consolidation warehouse is in the Montreal region. As such, the merchandise originating from overseas, eastern Canada or United States will be transported to the camp by truck via the following route: Highway 40, Route 155, Route 169 and Route 167 (permanent access to the mine site is planned for August 2013). Montreal is located 1,125 km from the Renard mine site. The merchandise from northeastern Ontario and western Quebec (e.g.: Rouyn Noranda, Val d'Or) will be transported via Val d'Or and Routes 117, 113, and 167 for a total distance of 827 km to the Renard mine site. Finally, if the merchandise arrives at the Port of Saguenay by ship, Highways 170 and 169 from La Baie will be used, totalling 768 km. This transport route will also be used for cargo coming from Quebec and eastern Quebec (Baie-Comeau, Sept-Îles).

There will possibly be two consolidation warehouses and/or sorting yards located in Montreal and Chibougamau. The warehouse in the region of Montreal is preferred since a large amount of the cargo

will go through Montreal (via the port or from elsewhere in America). Truck delivery from the region of Montreal to the Renard mine site should take between 15 and 18 hours. The Chibougamau site will mainly be used once the access through Route 167 will be opened and the end of the restriction period for road freezing at the end of May 2014. In fact, between the months of March and May 2014, trucking restrictions impose load weight reductions of 20 to 25%. All deliveries during this period must be planned to avoid transporting overweight merchandise. Since the Chibougamau site is designed for inside and outside storage, it will be used for a number of important deliveries which will potentially be transported in convoy; this will also reduce the travel time to the mine site by about 8 hours each way compared to traveling directly from Montreal.

As soon as Route 167 to the mine site will be accessible, a regular flow of deliveries will begin. More precisely, it is expected that 364 trucks deliveries will be required over the three-year construction period. The cost of transport is $2M including maritime transportation, where applicable[12]. A few regional and provincial companies have been identified as potential sub-contractors for the transport of material and equipment. Ideally, the same company will manage storage as well.

The approximate total tonnage of freight to be shipped for the Renard Project is estimated at 6,385 metric tons (mt) or 18,175 cubic metres (m^3). Of the forty or so batches of material and equipment purchased for the construction and operation of the Renard mine, three come from Abitibi-Temiscamingue and nine come from elsewhere in Quebec, mainly from the Montreal region. The batches include the following equipment:

- Underground pumps for the dewatering, rockbreakers, and the aeration pumps (Abitibi-Temiscamingue);
- Wastewater treatment units, drinking water treatment plant, conveyors and stackers (including underground conveyor), compressors, general and airstrip maintenance equipment, electrical transformers and a pre-fabricated electrical room (elsewhere in Quebec).

The rest of the material and equipment will come from elsewhere in Canada (Ontario, Manitoba, Alberta), the United States, Mexico or overseas (South Africa, Switzerland, Germany).

3.16.2.2 Mobile Equipment

The mobile equipment will be sent to the mine site at the beginning of the construction phase. In total, 125 trucks and mobile equipment of all kinds will be purchased or rented. This includes, but is not limited to, mining trucks, track dozers, pick-up trucks, light tower mobile trucks, articulated trucks, production scoops, a school bus, an ambulance, etc. This equipment will be used for the open pit and underground mining, surface services, and activities related to security and the warehouses.

[12] Does not include the cost of purchasing equipment. This cost is included in the total cost of investment.

3.16.2.3 Cement, Reinforcing Steel, and Built-in Parts

The cement, reinforcing steel, and built-in parts will be delivered to the mine site at the beginning of the construction phase. Approximately 344 deliveries by truck for this material are estimated over the three years of construction.

3.16.2.4 Prefabricated Facilities

The prefabricated facilities will be purchased at the beginning of the construction period. This includes, for example, a camp for the mine personnel, a reception complex, garages (for emergency vehicles and vehicle maintenance), a recreational centre (cafeteria, gym, movie room, common room, library), service buildings, vehicle maintenance garage, office building, power generating sets, water treatment plant, etc. Approximately 330 deliveries by truck for this material are estimated over the three years of construction.

3.16.2.5 Other Deliveries

Other deliveries of various supplies (e.g.: alum for the wastewater treatment plant) as well as containers for construction supplies, material, and equipment are planned to be sent to the mine site for the construction phase. In total, 354 and 100 truck deliveries respectively will be needed for this material during the construction phase.

3.16.2.6 Recurrent Procurement for Operations

The goods delivered on a recurrent basis to the mine site mainly consist of inflammable liquids (diesel, gas, jet fuel), inflammable gas (propane), corrosive material (hydrochloric acid), chemical products (ferrosilicium, grease), explosives, oil, and food.

Food (520 trucks over three years) as well as diesel, gasoline, and oil (1,560 trucks over three years) will be delivered at the beginning of the construction phase.

On a recurring basis, nearly 1,000 deliveries by truck are planned to the mine site each year for the twenty years the mine will be in operation; this represents an average of 19 trucks per week.

3.17 Construction Plan

The facilities construction plan is based on a strategy that favours optimal use and/or reuse of the facilities for the operation phase while minimizing the risks for the workers and the environment. The schedule for the planned construction activities is presented in Table 3.17.1.

3.17.1 Preliminary Construction Phase

The preliminary construction phase is designed to lay the groundwork for a smooth transfer to the main construction phase. The preliminary construction phase will include building a series of basic infrastructures such as access roads, drinking water supply, power supply, and accommodation and services complex.

Table 3.17.1 List of Hazardous Material Used During the Operation Phase

	2013				2014				2015				2016			
	Q2	Q3	Q4		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Preliminary Phase																
Temporary access road																
Dewatering of F3302 and F3303 lakes																
Initial site clearing																
Permanent access road																
Temporary camp																
Temporary road network and water management system																
First crushing plant in the airstrip area																
Airstrip																
2. Main Phase																
Infrastructures																
Site clearing																
R-65 pit overburden, waste rock, and ore excavation																
R-2 and R-3 pit overburden, waste rock, and ore excavation																
Aggregate production																
Permanent camp																
Road network and water management system																
Accommodation complex																
Service buildings and water treatment stations																
Water treatment discharge setup																
Power plant installation																
Power plant ramp up																
Ore processing plant																
Site clearing																
Foundations																
Structure, architecture, and ancillary installations																
Mechanical equipment																
Piping, electricity, and instrumentation																
System testing																
Ramp up to 60% of nominal operating capacity																
Commercial production (60% of nominal operating capacity for 30 days)																
Shafts and Hoist																
Site clearing																
Surface facilities and setup																
Shaft sinking																
Hoist equipping																
Shaft development (electricity, mechanics)																
Underground Mine and Ramp																
Site clearing																
Portal ramp																
Ramp and underground workings																
Ventilation shafts																
Underground equipment (crushers, ventilators)																
Surface equipment (ventilators, boiler)																
Underground production start up																
Additional Civil Work																
Road and water collection systems																
Landscaping																

3.17.1.1 Preliminary Work

Two small lakes (F3202 and F3303) located at the future R-3 and R-65 pit sites will need to be drained to be able to mine the open pits. These two small lakes, F3302 and F3303, contain 28,360 m^3 and 12,780 m^3 of water, respectively. The water pumped from these two lakes will be treated by mobile water treatment units, and their quality will be controlled before gradually being released after treatment into Lake Lagopede.

The water at the bottom of the lakes is likely to contain important concentrations of suspended solids and will be treated as necessary by an "EnviroSac"-type facility before being discharged in to Lake Lagopede. The sludge at the bottom of the lakes will be excavated during the 2012-2013 winter to minimize sediment transport toward the waterways. The project schedule indicates that construction will begin in May 2013.

The work will include the following:

- Excavation of the first series of drainage ditches in the spring of 2013 (see Section 3.10.2.2 for a description of the water collection and management system);
- Installation of the first crushing and screening plant near the airstrip to allow the airstrip to be built and the production of granular material. This material will be hauled to the main mine site when Route 167 will be ready;
- Most of the deforestation and clearing work will be done outside of the peak nesting period of the forest birds, which extends from May 1 to August 15 in the area, as recommended by the Canadian Wildlife Service (CWS). This precautionary measure will reduce nest destruction;
- Deforestation work will be strictly limited to the identified areas, such as the construction zones. Buffer zones around lakes and other environmental risk areas will be protected from any human alteration, thereby protecting vegetation and favouring a faster and more efficient site rehabilitation during the entire life of the mine and its closure;
- Precautions will be taken to avoid solid waste disposal sites from contacting surface and underground waters;
- Management of unconsolidated deposits and organic soil will be done so that the organic soils are available for rehabilitation work when the time comes.

3.17.1.2 Access Roads

The MTQ's Route 167 extension project will give permanent access to the site in August 2013. As of May 2013, the road under construction will allow restricted access to the airstrip area.

Transportation will be done by truck convoy from Chibougamau. All-terrain vehicles, heavy equipment, and combustibles will be transported to the mine site. However, semi-trailer trucks will not have access beyond the airstrip until the access road to the mine site is completed in August 2013.

3.17.1.3 Lodging

During the preliminary construction phase, the existing exploration camp (Camp Lagopede) will be used to build a temporary camp.

3.17.1.4 Drinking Water Supply

A temporary water intake will be installed in Lake Lagopede, and a portable, temporary water treatment plant (by filtration, ozonation, and ultraviolet radiation) will be used. The drinking water quality will be monitored.

3.17.1.5 Wastewater Management

At the beginning of construction, before the domestic wastewater treatment plant is built, temporary sanitary facilities, like dry or chemical toilets, will be used. The domestic wastewater that is generated (e.g.: toilets, showers) will be sent to temporary BioDisc or bio-pit type treatment facilities for as long as the permanent domestic wastewater treatment plant is not operational. Effluent quality will be monitored to ensure the discharge meets the applicable discharge quality criteria.

3.17.1.6 Solid Waste Management

Storage sites for the industrial solid waste material from construction will be established, and this material will be disposed of in compliance with the regulations.

3.17.1.7 Hazardous Material Management

Hazardous material will be stored in compliance with the existing standards. Gas will be initially stored in a 50,000 L, double-lined reservoir until the permanent reservoir is ready. A diesel reservoir will also be installed to supply the power generating sets in the power station. The hazardous material will be stored and then transported to off-site treatment and landfill sites.

3.17.1.8 Power Supply

A diesel generator and a temporary supply network will be built until the permanent facilities are completed.

3.17.1.9 Workforce and Procurement

The workforce will mainly be transported to the mine site via airplane and will obviously be less than during the main construction phase but more than during the operation phase. Construction material and heavy equipment will be transported to the site via Route 167.

During all construction work, particular care will be taken to comply with health and safety standards, and basic medical support will be available on-site at all times.

3.17.1.10 Telecommunications

Telecommunications (fibre-optic network, telephone, Internet, fax, UHF radio) will be set up at the beginning of the preliminary construction phase. This implies a site specific clearing along the network and soil removal to bury optical fiber cables on-site.

3.17.2 Main Construction Phase

The main construction phase will begin as soon as the Route 167 extension and the on-site secondary roads to the main facilities are completed. The work will consist mostly of various building and industrial infrastructures and facilities, the accommodation and services complex, and the ancillary service facilities.

3.17.2.1 Construction Work

During the main construction phase, the construction work will be focused in the mine site entry area (Map 3.17.1 in Vol. 3, Compendium of maps). This includes the following:

- An accommodation and services area;
- A contractors offices area;
- Two laydown areas for construction equipment and material.

Material storage area will also be built near the shaft and underground access ramp area. The former will be transformed into covered storage area, workshops, and garages; the latter will be used as a storage area for the underground mine.

The overburden excavation work will begin in the R-65 deposit area once the personnel and equipment are in place. The R-65 deposit will be used, among other things, as a quarry to supply aggregates and backfill. A cement factory will be built. A sedimentation pond will also be built to collect runoff water from the piles of aggregates.

3.17.2.2 Access Roads

The on-site road network will be built.

3.17.2.3 Lodging

A semi-temporary camp will be set up as soon as the semi-trailer trucks will have access to the site, in August 2013. Part of the modular dormitories will be used as permanent dormitories in the operation phase. Trailers will be used as offices for the various contractors and logistics staff.

3.17.2.4 Drinking Water Supply

The workers will have access to drinking water at strategically located distribution points throughout the site. The drinking water will come from Lake Lagopede and will be treated and monitored to ensure it is apt for human consumption.

3.17.2.5 Wastewater Management

The dewatering rate of the R-65 pit will depend on the hydrogeological conditions and the size of the pit. Test results show that the excavated material will not be acid generating and is not likely to leach contaminants in concentrations that could represent a risk for the aquatic life. However, the mine water could contain suspended solids and residual nitrogen from the blasting (nitrates and ammonia nitrogen).

The water management plan (see Section 3.10.2.2) includes multiple measures to control sediment transport. Ammonia nitrogen levels will be controlled by a sound explosive management program. The domestic wastewater (locker room and showers, cafeteria) will have its own collection network and will be separate from the industrial wastewater. The domestic wastewater will be treated at the treatment plant that will be built south of the mine site and will comply with the environmental discharge criteria in the *Regulation respecting waste water disposal systems*.

3.17.2.6 Solid Waste Management

Residual organic material could be used for compost. Concerning other solid waste such as used tires, steel scrap, solid recyclable waste, it will be taken to MDDEP authorized sites.

3.17.2.7 Hazardous Material Management

A safe, temporary depot will be built for the explosives and for chemical products needed for construction work.

3.17.2.8 Power Supply

Diesel power generating sets will be used as the power supply until permanent facilities are built.

3.17.2.9 Workforce

During the main construction phase, the workforce will be larger than during the operation phase. Therefore, between the construction and operation phases, there is an opportunity to reduce the size and breadth of the construction facilities as well as the human pressure on the environment by the reduction of the domestic treated wastewater discharge and the revegetation of the temporary bulk material storage areas.

688 000 mE

690 000 mE

5 856 000 mN

5 856 000 mN

Aire d'entreposage du puit / Shaft laydown area

Aire de bureau / Field offices

Aire d'entreposage en surface / Laydown area

Aire d'entreposage en surface / Laydown area

Aire d'entreposage de la rampe / Ramp laydown area

Complexe d'habitation temporaire / Dormitory area

0 250 500 m

Échelle / Scale : 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude / Study area limits

Secteur de la mine / Mine area

Secteur de la piste d'atterrissage / Airstrip area

Lac Emmanuel

Rivière Nerveuse

0 10 km

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Plan d'aménagement des aires d'entreposage en phase de construction / General laydowns site layout during the construction phase

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010

Fichier / File : 61470_EIES_Construction_111222.WOR

Décembre 2011 / December 2011

Carte / Map 3.17.1

3.18 Progressive Rehabilitation and Closure Plan

The government of Quebec is responsible for all mining activity taking place on its territory. This activity is subject to the *Mining Act* (R.S.Q., c. M-13.1) that defines, notably, the legal right to the mineral substances (claim, mining exploration permits, mine lease, mine concession, etc.) and the rights and obligations of the mining right title holder awarded by the State.

From an environmental perspective, it is important to mention that Section III of Chapter IV of the *Mining Act* specifies that that the mining right title holder is under the obligation to carry out rehabilitation and restoration work on the lands where exploration and/or mining activities have occurred. This work must be completed in conformance with the rehabilitation plan previously approved by the Minister of Natural Resources and Wildlife (MRNF). The following section presents the rehabilitation plan for the Renard Project (also called the progressive rehabilitation and closure plan) that is presented in its entirety in Appendix 3.18.1 of the ESIA.

The rehabilitation plan revolves around the following principles:

- No building will remain on-site and all buildings will be sold with the equipment they contain, in totality or in part. All mobile equipment and vehicles will be removed from the site and sold or recycled;
- The secondary roads will be scarified and revegetated;
- The flat surfaces of the processed kimberlite confinement area and the overburden stockpile will be replanted;
- The waste rock stockpile and the pre-production ore stockpile area will be replanted;
- The domestic wastewater treatment plant and the mine wastewater treatment plant will be dismantled;
- The R-2/R-3 and R-65 pits will stop being dewatered and will become “lakes.” Where possible, surface drainage will be re-established to conditions similar to those observed before the project began;
- A safety berm will be placed around the pits and a cement slab will be installed on the access to the mine shaft, the access ramp, and the ventilation and backfill raises;
- The airstrip will be offered to local authorities since it constitutes a regional development infrastructure that could be used by all. If, for whatever reason, the local authorities do not want to keep the airstrip, it will be scarified and revegetated. The airstrip’s ancillary buildings will be dismantled;
- A post-closure monitoring period.

3.18.1 On-site Security

A safety berm will be placed around the pits. A cement slab will be installed on the access to the mine shaft, the access ramp, and the ventilation and backfill raises. Waste rock will be put at the ramp’s entrance.

3.18.2 Revegetation Principles

As soon as production activities are terminated, revegetation will begin on a major part (75%) of the impacted surfaces in order to gradually re-establish a forest cover, with the exception of the processed

kimberlite confinement area and the overburden stockpile slopes as well as the flooded pit that will not be revegetated, which represents a total area of 76.8 ha (25% of the impacted area). However, it is important to note that the flat surfaces of the processed kimberlite confinement area and the overburden stockpile will be revegetated. In addition, on a longer term, the plant species having colonized the flat surfaces could naturally propagate and cover the unplanted slopes so that a plant cover would be present over 90% of the site once it has closed. The pit that will be flooded when the mine closes represents the only long-term vegetation loss; the area covered by this pit represents 7% of the impacted area.

Revegetation will occur in two steps. First, hydro-seeding will be undertaken. The selected species will be adapted to the northern climate and will not be invasive. A mixture such as the “Nordic Mountain Mix” will be used. This mixture only includes grass seeds. Secondly, black spruce seedlings will be planted at a density of 2,000 seedlings per hectare.

3.18.3 Dismantled Material Management Principles

A program to manage the dismantled material will be developed. All the material that can be reused or repurposed (e.g.: steel beams) will be sent south to be recycled by firms specialized in recycling this material.

3.18.4 Buildings and Surface Infrastructures

No building will remain on-site and all buildings will be sold with the equipment they contain, in totality or in part. During the demolition work, a recycling program will be integrated into the work and the waste will be buried at the trench landfill site. The secondary roads will be scarified and replanted. The main access road belonging to MTQ will be kept as a regional sustainable development infrastructure to maintain access to the area.

3.18.5 Overburden Stockpile

Part of the organic matter will be used for revegetating the mine site. The overburden stockpile will be constructed in four steps of 5 m. The slopes will be covered with waste rock for stability. The flat surfaces will be revegetated. The flat surfaces represent 40.5 % of the total overburden area and essentially consist of the final plateau. Figure 3.18.1 illustrates the appearance of the overburden stockpile at the end of operations.



Figure 3.18.1 View Toward the North of the Mine Site After Rehabilitation Work

3.18.6 Waste Rock Stockpile

All the waste rock will be returned to the pits or will be used to fill the underground mine or for construction use. The waste rock stockpile area will be covered with a 0.5 m layer of overburden and a 0.3 to 0.5 m layer of topsoil and then revegetated (Figure 3.18.1).

3.18.7 Temporary Ore Stockpile Area

The temporary ore stockpile site will be covered with a 0.5 m layer of overburden and a 0.3 to 0.5 m layer of topsoil and then revegetated (Figure 3.18.1).

3.18.8 Processed Kimberlite Confinement Area

The processed kimberlite confinement area will be partially revegetated. Only the flat surfaces will be revegetated (32.7% of the confinement area): the 5 m wide berms on eight levels and the final plateau. The rehabilitation of the berms will be done progressively during the operation phase. The flat surfaces will be covered with a 0.5 m layer of overburden and a 0.3 to 0.5 m layer of organic matter and then revegetated. The slopes will be covered with waste rock for stability.

Figure 3.18.1 presents a visual simulation of the processed kimberlite confinement area at the end of operations.

3.18.9 Mine Wastewater Treatment Plant

During the rehabilitation phase, the mine wastewater treatment plant will continue to operate as long as the water quality requires treatment. It will be dismantled when the water quality is deemed satisfactory.

In fact, since the water pumped from the mine containing the greatest amount of suspended matter will no longer be pumped from the pond in the R-65 pit, the water quality should be excellent once the rehabilitation work is completed. The various piles of material will have, in fact, reached stability since the particles most susceptible to erosion will have already been displaced.

3.18.10 Other Water Management Infrastructures

Where possible, the surface drainage network will be re-established to conditions similar to those observed before the project began.

At first, the drainage ditches will be routed toward the pits to promote their accelerated filling (Map 3.10.1). Some of the ditches will be routed toward pit openings that connect with the underground workings (ramps, shafts and ventilation raises).

Pumping of pits R-2/R-3 and R-65 will cease, and the pits will become “lakes” with morphometric characteristics suitable for growth of salmonids. A surface hydrological link will be made between the R-65 “lake” and Lake Lagopede, which will allow an accelerated filling of the pit. The flow in the channel will be controlled so that pit R-65 will be completely filled at the same time as pits R-2/R-3. Once

completed, the level of water in pit R-65 will be the same as the level of water in Lake Lagopede. Moreover, the stream that will be diverted during mining operations to limit the water flowing into pit R-65 will be redirected to that pit (that will become a lake once the filling of R-65 is complete) to ensure free movement of fish.

When pits R-2 and R-3 are filled, a stream will be developed between the newly established lake and the natural waterways that flow into Lake Lagopede. Once filled, the water levels in pits R-2/R-3 will be 24 m higher than Lake Lagopede.

The pits should be completely filled by 2040, some six years after the end of mining operations.

The sedimentation pond in the accommodation complex sector (S18) will no longer be used once the revegetation of this sector is complete. The embankments will be pushed to the interior and the pond itself will be revegetated.

3.18.11 Wastewater Treatment Facilities

The domestic wastewater treatment facility will be dismantled and the three aeration lagoons will be emptied of their solids. These basins will be shaped to form wetlands or filled with overburden for revegetation. The buried outflow will be left in place.

3.18.12 Equipment and Heavy Machinery

All mobile equipment and vehicles will be taken off-site and sold or recycled.

690 000 m.E

5 856 000 m.N

Aire de confinement de la kimberlite usinée / Processed Kimberlite Containment Facility

Aire d'entreposage du mort-terrain / Overburden Stockpile

F3297
F3298
F3295
F3296
F3301
F2607
S18

Étang
Baie Nord-Est
Lac Lagopède
Baie Sud

1 700
1 650
1 600
1 800
1 850
1 900
1 950

0 250 500 m

Échelle/Scale 1 : 10 000
UTM, zone 18 (NAD83)
Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Éléments / Elements

- Station de traitement des eaux usées minières / Mine water treatment plant
- Lien hydraulique / Hydraulic link
- Fossé de collecte post-fermeture / Post closure collection ditch
- Réaménagement du réseau hydrographique / Restoration of the hydrographic network to its original path
- Fossé de collecte / Collection ditch
- Fossé de dérivation / Derivation ditch
- SX Bassin de sédimentation / Sedimentation pond

- R-x Identification du gisement / Deposit identification
- F3293 Numéro d'identifiant de lac CEHQ / CEHQ lake ID number
- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Source: Water Management Plan, Golder Associates, October 14 , 2011

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Plan de collecte et de gestion des eaux (Phase fermeture) / General stormwater collection and mangement plan (Closure phase)

ROCHE

Carte de base : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier : 61470_EAUAPRES_111217.WOR
Décembre 2011 / December 2011

Carte / Map 3.18.1

3.18.13 Petroleum Products, Chemical Products, Solid Waste, Hazardous Waste, Contaminated Soil and Material

All the residual hazardous waste will be managed in compliance with current regulations and will be taken off-site for final treatment and disposal at authorised sites.

Also, in compliance with Article 31.51 of the *Environment Quality Act*, six months following the closure of the mine site, a characterization study will be carried out in the industrial areas susceptible to have been contaminated by the mining activities, excluding the accumulation areas.

If the characterization study reveals the presence of contaminants with a concentration greater than the limits established in Appendix II of the *Land Protection and Rehabilitation Regulation* or greater than the conditions established in the last paragraph of Article 1 of the said regulation, a rehabilitation plan will be submitted to MDDEP for approval.

3.18.14 Airstrip

The airstrip will be offered to local authorities because it constitutes a regional sustainable development infrastructure for the community. If, for any reason, the local authorities do not want to take charge of the airstrip, it will be scarified and revegetated.

3.18.15 Explosives Storage Area

The explosives storage area will be dismantled. The area of the depot will be covered with a 0.3 to 0.5 m layer of organic matter and revegetated.

3.18.16 Borrow Pits

The borrow pits will be covered with topsoil and revegetated.

3.18.17 Trench Landfill Site

The trench landfill site (TLFS) will be used for solid, residual, non-recyclable material. The TLFS will be completely covered at the end of the rehabilitation period and revegetated.

3.19 Project Implementation Schedule, Personnel Requirements, and Estimated Costs

3.19.1 Implementation Schedule

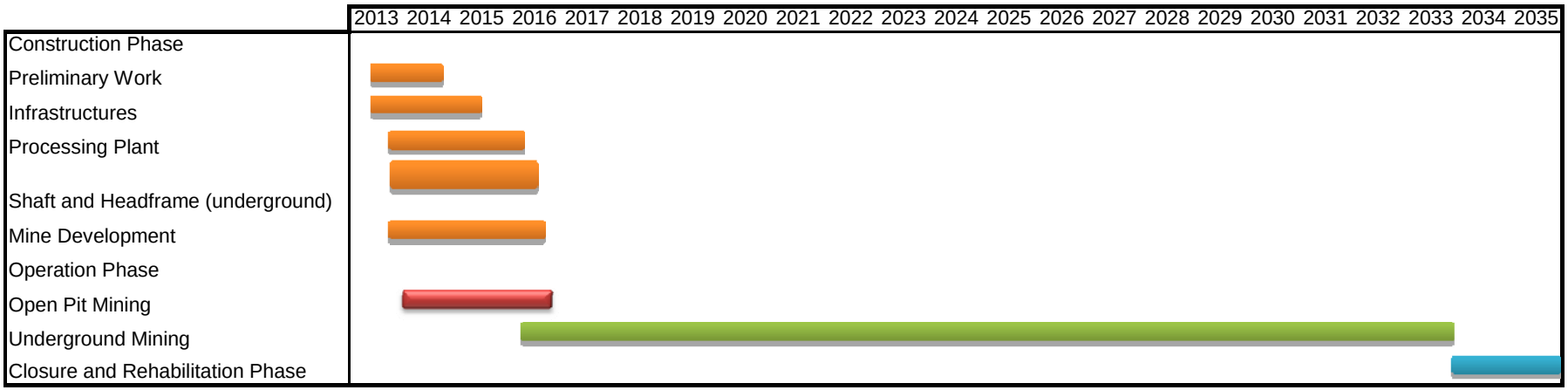
The construction phase of the Renard Project is scheduled to begin in May 2013 with the preliminary work: site preparation and development, roads, temporary camp, water management, water treatment system, etc. The first road access to the Renard Project site will be established between now and July 2013, based on the construction schedule of the Route 167 extension project. The Ministère du Transports du Québec (MTQ) is responsible for building the entire road. The site construction work will

begin with construction of the infrastructures (permanent camp, services building, power generating sets airstrip, etc.), the kimberlite processing plant (structure, mechanics, electricity, instrumentation, etc.), the shafts and headframe, as well as the mine site development (pit preparation, ramps, underground construction). The construction phase will continue to 2016.

The airstrip could be ready for limited use in August 2013. It should be fully operational by December 2013.

Mining operations will take place over a period of about twenty years. The open pit mining activities will begin in 2014 and be completed in September 2016. Meanwhile, the kimberlite processing plant will begin production at the end of September 2015. Underground mining activities will begin in 2016 and continue to around 2033.

The site rehabilitation work (dismantling of infrastructures and reforestation) will begin in 2033 and will last approximately two years until 2035 (Figure 3.19.1).



Source: BFS, Chapter 25 and Yves Thomassin for closure

Figure 3.19.1 Renard Project Implementation Schedule

3.19.2 Personnel Requirements

3.19.2.1 Construction Phase

The first major hiring period will be at the end of 2013, once the project site becomes accessible by the Route 167 north extension. The work will begin with infrastructure construction (e.g.: camp), airstrip construction, and site preparation and development. A second hiring phase will occur in the middle of 2014 during the intensive work to set up the kimberlite processing plant. The work will comply with the Quebec Construction Decree except for the shaft and access ramp work which will be done by a sub-contractor.

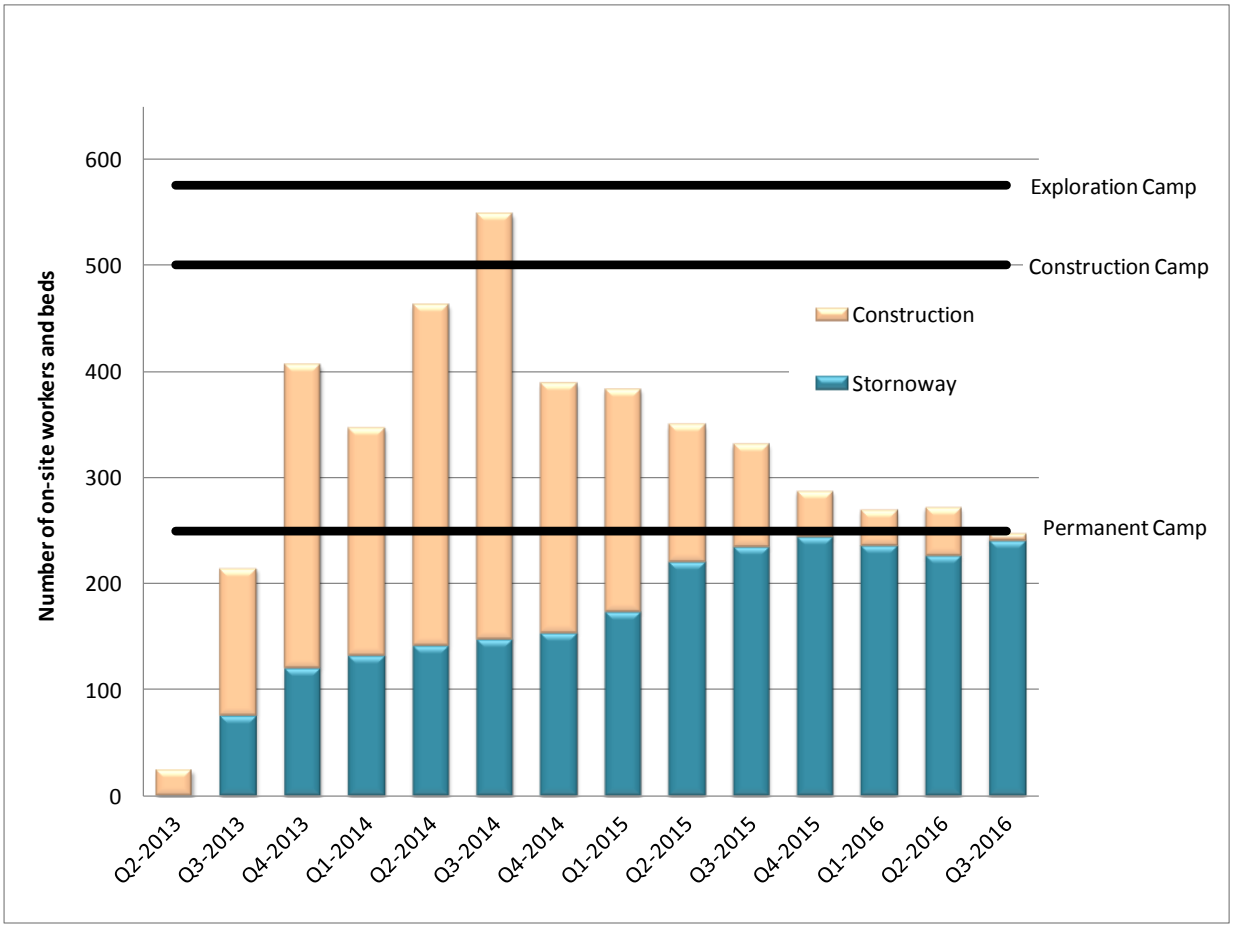
At the peak of the construction work, during the third quarter of 2014, close to 550 people will be working on-site, including nearly 350 construction related jobs, around 50 for the shaft and headframe construction jobs (specialized sub-contractor work), and some 150 for the mine development jobs. Therefore, the camp will have a capacity of 575 (Figure 3.19.2).

For the entire construction phase, the average number of employees will reach 343.

The types of construction jobs required are related to engineering (civil, structure), architecture, electrical and mechanical work, plant construction (e.g.: instrumentation), mine development, as well as personnel and work supervision and management.

- *WORK SCHEDULE*

Depending on the type of work, the typical work week during the construction phase will vary between 70 and 84 hours (10 to 12 hours per day, seven days a week), with rotations of 2 to 4 weeks on followed by 1 to 2 weeks off.



Source: Stornoway, December 2011

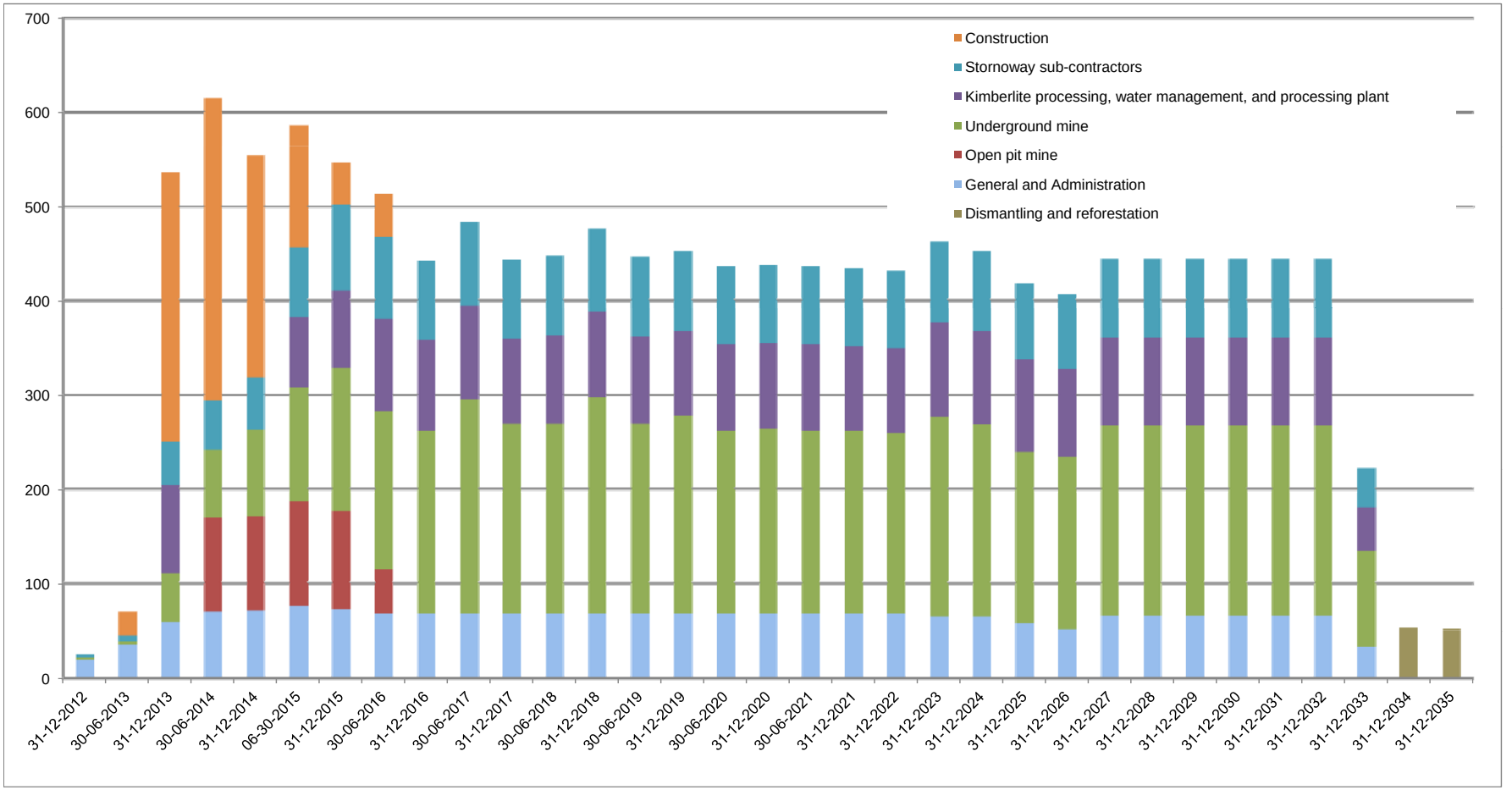
Figure 3.19.2 On-site Manpower and Cumulative Capacity of the Camps

3.19.2.2 Operation Phase

Over the roughly twenty years of the operation phase (2014-2033), the average number of employees will reach 450, of which 85 will be employed by the sub-contractors. During the entire operation phase, the underground mine workers will be highest in number (Figure 3.19.3). Stornoway anticipates operating with approximately 230 employees on the site based on two, rotating shifts.

The types of jobs required for the operation phase relate to the following activities: ore processing plant (e.g.: process engineer), technical services (e.g.: geologist), mining activities (e.g.: machine operator), diamond recovery facilities (e.g.: diamond sorter), maintenance (e.g.: electrician), security (e.g.: security agent), environment (e.g.: environmental technician), human resources (e.g.: trainer), procurement (e.g.: warehouse clerk), and camp logistics (e.g.: housekeeping).

Several of the management and administration jobs will be located off-site, at Longueuil, Toronto, Vancouver, or Chibougamau (e.g.: Vice President, Business Development).



Source: Stornoway, 2011, Process by : Roche Ltd, Consulting Group

Figure 3.19.3 Evolution of Personnel Requirements

- *WORK SCHEDULE*

To allow employees a longer rest period, to compensate for working remotely, and to favour a sound balance between work and quality of life, Stornoway will implement a work schedule based on two (2) weeks on-site followed by two (2) weeks off-site. The work week will be 84 hours (twelve (12) hours a day, seven (7) days a week).

- *EMPLOYEE TRANSPORTATION*

The workers will be flown from the Chibougamau airport, which will be the main transit hub, to the mine site. Another plane will be based in Montreal that will act as a secondary travel zone. If necessary, alternative stopovers will be established based on the geographic distribution of the employees.

3.19.2.3 Closure Phase

For the closure phase that should begin in 2033, jobs will be significantly reduced. Approximately fifty workers will be required for the dismantling of the site plus a few tree planters for the reforestation.

3.19.3 Investment and Operation Cost Estimation

The investment and operation costs presented in the impact assessment are based on financial data provided by Stornoway. They do not include Stornoway's contribution of $44 M (under certain conditions) for the construction of the Route 167 north extension.

3.19.3.1 Construction Phase

The construction costs amount to $802 M as detailed in Table 3.19.1. The main cost items are as follows:

- The mine site development (equipment, infrastructures, ramps, storage, open pit mining, etc.) (29%);
- The ore processing plant construction (21%);
- The construction of the various buildings (camps, garages, warehouses, reception, etc.), the power station (if the site is not supplied by power lines), and the airstrip and ancillary services (water, heat, etc.) (13%);
- The indirect costs account for one-third of the expenses. These costs include but are not limited to: engineering, procurement, and construction management (EPCM), temporary facilities operation and maintenance costs, general and administrative costs for the construction phase, camp related costs, transport and customs fees, and contingencies (34%).

The manpower costs are incorporated into each of the cost centres. The cost of the workforce is based on a 70-hour work week. In total, 2.9 M work hours are estimated for all on-site employees.

Table 3.19.1 Initial Cost Evaluation

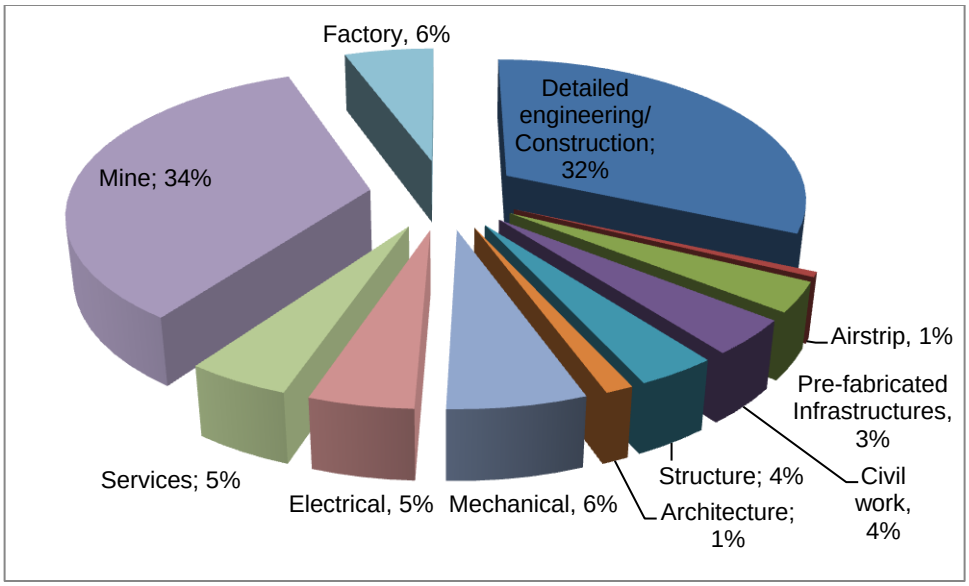
Cost centre item	Amount ($)	%
Direct costs	***$530,597,391***	
Site preparation	$22,938,518	3%
Mining infrastructures*	$236,193,724	29%
Mine area surface facilities	$674,045	0.1%
Ore processing plant	$168,423,172	21%
Utilities and infrastructures	$102,367,932	13%
Indirect costs	***$271,189,490***	
Owner's costs	$86,153,168	11%
Spares, fills, tools	$10,170,767	1%
Engineering, procurement, and construction management services (EPCM)	$45,000,000	6%
Standard field costs	$13,101,363	2%
Field costs – Various provisioning	$6,887,000	1%
Lodging and transport during construction	$24,976,257	3%
Vendor reps construction and P.O.V. + assistance by sub-contractors during P.O.V.	$2,473,746	0%
Freight, duties fees	$8,108,937	1%
Contingencies	$74,318,252	9%
Total investment before production	**$801,786,881**	100%

**The costs related to mine infrastructures include open pit mining since this and the construction phase will be done simultaneously.*

Note: The investment costs are estimated with an accuracy between -13 % and +17 %. The high-voltage power line is not included in these costs.

Source: Stornoway, 2011

The cost breakdown is represented in a pie chart in Figure 3.19.4. Work related to mining development, engineering, and construction accounts for two-thirds of the expenses. The final one-third of the construction costs is almost divided evenly among the other areas.



Source: Stornoway, 2011.

Figure 3.19.4 Initial Investment by Area

3.19.3.2 Operation Phase

The annual average operational costs for mining are estimated at $125.1 M (2016 to 2033) (Table 3.19.2). The underground mine activities represent 44% of the operating costs. A little more than a quarter of the expenses are attributed to operating the kimberlite processing plant. This plant is designed to process 7,000 t of kimberlite per day. The general and administrative costs account for a quarter of the annual operating expenses.

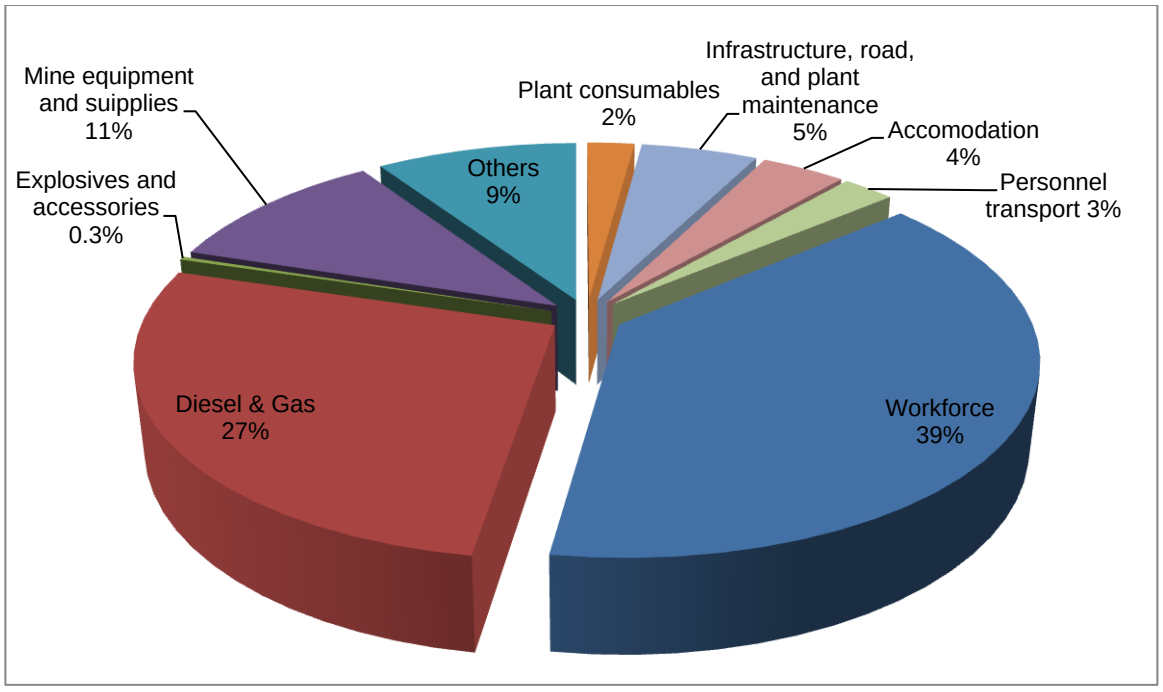
Table 3.19.2 Annual Average Operating Cost Evaluation

Activities	Amount ($CAN)	%
Open pit mine*	$5,628,000	4
Underground mine	$54,441,000	44
Processing	$33,263,000	27
General and administrative costs	$31,775,000	25
Total operational cost	$125,107,000	100 %

**A major part of the open pit mining costs of Renard 2 and 3 will occur before January 1, 2016 and are included in the investment cost estimates.*

Source: Stornoway, 2011.

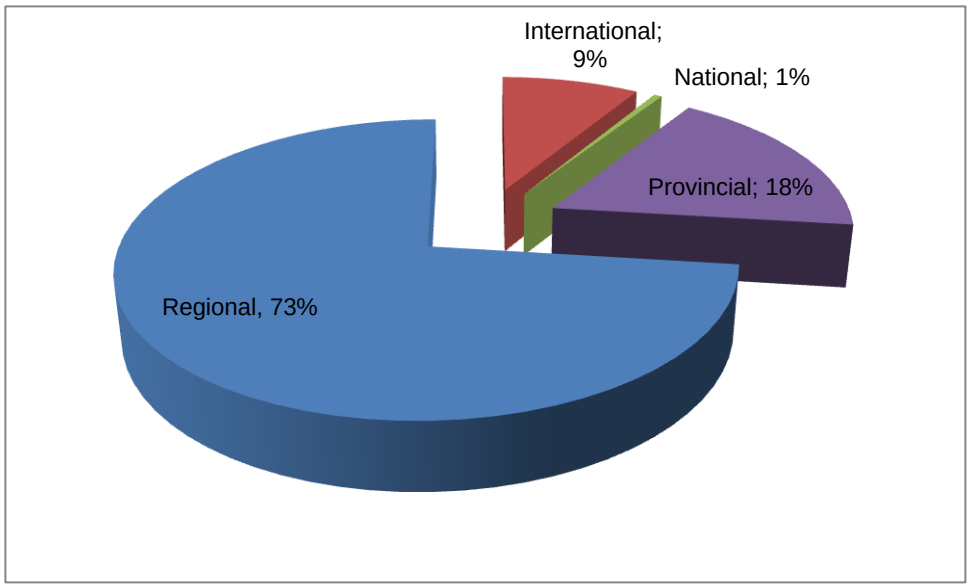
A major part of the operating costs are attributed to the cost of the workforce (39% or $48.2 M) and the purchase of diesel and gas (27% or $34 M). The other expenses (mine equipment and supplies; infrastructure, road, and plant maintenance; transportation of personnel; etc.) account for a little more than one-third of the remaining operational costs (34% or $42.8 M) (Figure 3.19.5).



Source: Stornoway, 2011.

Figure 3.19.5 Annual Average Operating Cost Breakdown

An initial evaluation of the operating cost breakdown by Stornoway indicates that the majority of the amount will be spent in the province, around 91% or $113.67 M annually of which 73% will be spent in the region (Figure 3.19.6).



Source: Stornoway, 2011.

Figure 3.19.6 Annual Average Operating Cost Breakdown

3.19.3.3 Closure and Rehabilitation Phase

The budget for the mine closure and rehabilitation is estimated at $9.8 M (see Section 3.18 – Progressive Rehabilitation and Closure Plan for a detailed description of the costs) (Table 3.19.3).

Under the *Mining Act*, Stornoway must provide a financial guarantee to ensure the rehabilitation of the mine site. This amount totals $2.5 M and represents 70% of the rehabilitation costs of the accumulation areas.

Table 3.19.3 Total Mine Site Rehabilitation Costs

Item	**Amount ($CAN)**
Accumulation area restoration	$3,235,880
Replanting other than the accumulation areas	$1,674,900
Other rehabilitation activities	$4,873,344
Total	**$9,784,124**
Financial guarantee	***$2,635,780***

Chapter4

Communication and Public Consultation

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4 Communication and Public Consultation

4.1 Objectives and Methodological Approach

For the Renard Diamond Project to gain public acceptance, Stornoway Diamonds (Canada) Inc. implemented a proactive communication and consultation process with project stakeholders.

The process started as soon as the land was first explored in the early years of the new millennium. It became more intensive during the bulk sampling program in 2006-2007 and when the feasibility study and the environmental and social impact assessment for the project were started in 2010. At this point, an in-house public relations resource was appointed to coordinate and manage communications and consultations. Relying on its extensive knowledge of mining development issues in the James Bay territory and on Cree territory, the public relations professional advised Stornoway in the development of a communication plan and the selection of the most appropriate consultation and information mechanisms.

The main purpose of the selected communication and consultation process was to establish an environment of trust between the Renard Project proponent and the Cree and Jamesian communities and administrative bodies concerned. To do so, Stornoway used a number of communication methods to inform the public adequately about progress in the project and to obtain their views and concerns, particularly from the Cree community of Mistissini.

4.2 Communication and Consultation during the Environmental Assessment

In June 2000, the partners involved in the project informed the authorities in the Cree community of Mistissini about their intentions, since the Renard Project was to be located within traditional Mistissini territory. These exchanges quickly led to the first official meeting with Mistissini representatives in early 2002.

Over the years, different communication and consultation initiatives were implemented. The most important ones are as follows:

- Meetings with the Mistissini Band Council and the elected officials of Chibougamau and Chapais;
- Working groups;
- Regular feedback and discussion meetings with the tallymen and their families;
- Open house events;
- On-site tours;
- Participation in local public events;
- The opening of a Stornoway office in Mistissini;
- Negotiation of agreements with the Crees;
- Pre-consultation meetings.

4.2.1 Meetings with the Mistissini Band Council and Regional Elected Officials

The first official meeting with the Mistissini Band Council and the Swallow family took place January 28, 2002, a little more than a month after the diamond potential of the kimberlites discovered on the Renard property in September 2001 (December 14, 2001, press release) was confirmed. In addition to Chief Longchap and several of his counsellors, members of the Swallow family and a representative of the Cree Trappers' Association (CTA) attended the meeting.

Stornoway later committed to providing the Band Council with annual updates of the work carried out and the work yet to be done. More meetings followed every year, allowing the elected officials of Mistissini to follow progress in the Renard Project. Press releases on the Renard Project were emailed to the Chief of Mistissini and mailed to the tallymen.

Over the years, meetings with the mayor of Chibougamau and, more recently, with the mayor of Chapais and representatives of the *Conférence régionale des élus de la Baie-James* (CRÉBJ) were called more frequently. During those meetings, updated information on the progress of the Renard Project was provided to local and regional elected officials. In addition, the meetings allowed stakeholders to work together on common issues, such as the extension of Route 167, and helped elected officials to gain a better understanding of the scope of potential spinoffs from the Renard Project for the region and the niche markets to develop.

4.2.2 Working Groups

In 2007, the Renard-Mistissini Working Group was created to keep the members of the Swallow family and Mistissini Cree better informed about potential jobs at the Renard Project. Representatives of the Cree Human Resources Development (CHRD) service joined this working group to coordinate Cree training programs. The working group officially met two to four times a year. It was disbanded in the summer of 2010 following the signature of a Pre-development Agreement (PDA) and the creation of a monitoring committee.

4.2.3 Agreement Negotiations with the Crees

In early 2007, Stornoway and the Cree community of Mistissini entered into preliminary discussions regarding a memorandum of understanding to serve as guidance for relations between the Renard Project representatives and the community of Mistissini. In 2009, Stornoway Diamonds (Canada) Inc., the Cree Nation of Mistissini and the Grand Council of the Crees (Eeyou Istchee) began negotiations that led to a Pre-development Agreement (PDA) in July 2010. Negotiations for the PDA were held in a spirit of cooperation and nine meetings were required between October 2009 and July 2010 that resulted in a final document being signed July 16, 2010. The agreement provided for business and job opportunities for the Crees during the pre-development phase, the evaluation of business and job capacities during the operation phase, the development of a common communication strategy, and

Cree cooperation in the ESIA and any other relevant study. Following the PDA, the stakeholders entered into discussions on the development of an Impact and Benefit Agreement (IBA) in the fall of 2010.

4.2.4 Environment Exchange Group

In October 2010, an environment exchange group was created to contribute to developing the project and preparing the ESIA (Photo 4.2.1). A first committee meeting was held in Mistissini on February 16, 2011. The group brought together a number of Cree participants from Mistissini (including family members of the M11 trapline users, elected members of the Mistissini Band Council, management members of the Cree Nation of Mistissini (the general director, environmental protection managers, an economic development manager), local representatives of several organizations like the Cree Mineral Exploration Board (CMEB), the Cree Human Resources Development (CHRD) service, the Elders Council of Mistissini, the Cree Trappers' Association (CTA) and the Cree Board of Health and Social Services of James Bay (CBHSSJB), representatives of the Cree administration, and Stornoway representatives and its environmental consultant. Environment Exchange Group meetings (Photo 4.2.1) took place on a regular basis throughout the environmental and social impact assessment (Table 4.2.1).



Photo 4.2.1 Third Sitting of the Environmental Exchange Group, Mistissini, April 6, 2011

Table 4.2.1 Calendar of Environmental Exchange Group Meetings

No.	Date	Topics Discussed	Nbr. of Participants
1	February 16, 2011	• Background and technical review of the Renard Project • Environmental baseline study –preliminary results of the surveys (2010) and scheduled activities (2011) • Environmental and social impact assessment	17
2	March 16, 2011	• Environmental baseline study – Human aspects • Mining method • Processed kimberlite – Selection of a confinement site and disposal strategy	26
3	April 6, 2011	• Layout of the mining facilities • Philosophy underpinning the mining activities • Solid waste management	19
4	June 9, 2011	• Impact assessment method • Water management (including surface water and groundwater) • Diamond extraction	17
5	August 18, 2011	• Impact assessment and mitigation measures • Geochemical characterization and testing	17
6	October 13, 2011	• Water management and mitigation measures • Gradual restoration of the mine site • Environmental management plan • Power supply – line at 161 KV	19

4.2.5 Open House Events

Two open house events were organized in the region. The first event took place in Mistissini in February 2006 and the second event, in March 2010 in Chibougamau and Mistissini successively. The events allowed Stornoway to reach out to the communities and answer their questions, and to take stock of public concerns and expectations regarding the Renard Project.



Photo 4.2.2 Open House Event of the Renard Project in Chibougamau in March 2010



Photo 4.2.3 Open House Event of the Renard Project in Mistissini in March 2010

4.2.6 Stornoway Office in Mistissini

The opening of a corporate office in Mistissini in January 2011 allowed Stornoway to secure a presence within the community. The office serves as a liaison and forum for sharing information with the Crees about a range of social, environmental and economic issues and about training, job and business opportunities related to the Renard Project.

In addition, general information on diamond exploration and mining will be available at the office. Ms. Hélène Robitaille, Director, Community Relations – Training and Development, is the Stornoway representative available at the office a few days a week.



Photo 4.2.4 M11 Tallymen Taking Part in the Inauguration of the Stornoway Development Office in Mistissini in January 2011

4.2.7 On-site Tours

From 2004 on, the exploration work became more intense and several on-site tours were organized to explain and describe the nature of ongoing activities to the Crees and their representatives. Overall, there were eight official tours between 2004 and 2010. The M11 tallymen were part of practically every tour. The Chief of the Mistissini community took part in two of the tours; in September 2004 and October 2006. The tours allowed the Crees to gain a clearer picture of the operations and a better understanding of the many steps involved in the development of the Renard Project.



Photo 4.2.5 Tour of the Renard Project in September 2004 with Chief John Longchap, M11 Tallymen and Members of the Cree Community of Mistissini

4.2.8 Road Committee

To ensure partnerships with local and regional stakeholders, Stornoway representatives joined several regional co-development initiatives. For instance, the mayor of Chibougamau and the Chief of Mistissini jointly created the Otish Mountains Road Committee in 2006. In cooperation with other mining companies and several regional and provincial socio-economic stakeholders, Stornoway joined the Committee to increase government authorities' awareness of the importance of the infrastructure of this multi-service road in regional development. In addition, the road committee convened two to three times a year to establish information and communication sharing activities on the progress of the Renard Project, which is perceived as the driver of this regional file.

4.2.9 Stornoway's Involvement in Local Public Events

In recent years, Stornoway was involved in several public events allowing the company to inform local communities about the progress in the Renard Project and potential spinoffs for the region. As such, several presentations of the Renard Project were given during conferences held by the local CIM (Canadian Institute of Mining, Metallurgy and Petroleum) division, *Développement Chibougamau* and

the local chamber of commerce. Stornoway also took an active part in the '*Symposium Mines Baie-James*' held in Chibougamau and Mistissini in the spring of 2011.

4.2.10 Pre-consultation Meetings

Pre-consultation meetings with regional socio-economic stakeholders were held October 12, 13 and 14, 2010, in Chibougamau and Mistissini. The meetings served to establish contact with the communities and collect additional information. Representatives of several organizations were invited to meet Renard Project managers and the project's environmental consultant to share their knowledge of the area, along with their objectives, expertise, as well as local and regional development orientations (Photo 4.2.2).



Photo 4.2.6 Stornoway Representatives Examining Documents Collected during Pre-consultation (Source: Karine Desbiens, La Sentinelle, October 21, 2010)

The pre-consultation meetings first provided an opportunity to give an overall presentation of the Renard Project, describe the environmental assessment process followed by the project proponent, and highlight the objectives of Stornoway's consultation process. Secondly, attendees were invited to voice their expectations and concerns to identify sources of information available from their own or other organizations. This approach greatly contributed to the Environmental Baseline Study (EBS) and the Environmental and Social Impact Assessment (ESIA).

The organizations met included:

- *Commission régionale sur les ressources naturelles et le territoire de la Baie-James* (CRRNTBJ);
- *Centre régional de santé et de services sociaux de la Baie-James* (CRSSSBJ);
- *Emploi Québec* (EQ);
- *Centre local d'emploi* (CLE);
- *Conseil régional des partenaires du marché du travail* (CRPMT);
- *ComaxNord*;
- Town of Chapais;
- *Commission scolaire de la Baie-James* (CSBJ);
- Town of Chibougamau;
- Municipality of Baie-James (MBJ);
- *Conférence régionale des élus de la Baie-James* (CRÉBJ);
- *Comité de développement social de la Baie-James* (CDSBJ);
- Cree School Board (CSB);
- *Chambre de commerce de Chibougamau*;
- James Bay Development Corporation (JBDC);
- Cree Nation of Mistissini;
- Cree Board of Health and Social Services of James Bay (CBHSSJB);
- Cree Trappers' Association (CTA);
- Cree Mineral Exploration Board (CMEB);
- Diane Marois, HR Consultant.

Information collected during the pre-consultation meetings completed statistics drawn from documentary sources to provide an updated, overall picture of the statistics and the reasons likely to explain statistical changes and trends observed. The meetings also contributed to gaining a better understanding of the socio-economic conditions in the area and identifying the issues of concern for local communities, their elected officials, and various local and regional organizations. In total, 31 people in Chibougamau and 14 people in Mistissini were met (Appendix 4.2.1). During the process, 25 documents of local and regional significance were collected, as they were relevant to several aspects involved in integrating the Renard Project into the regional context. The documents also served for a preliminary analysis of the conditions of the area and for identifying social and environmental issues.

Overall, the meetings generated great interest in the project and the potential socio-economic spinoffs for the region. Overall, comments were voiced on expectations with regard to the project likely to contribute to the economic development of communities in the region through the creation of jobs and the purchase of services and consumer goods. For instance, it was highlighted that some of the expected spinoffs could prove to be sustainable, if the economic activity stimulated by the project were to contribute indirectly to improving the quality of life in the area. The project appeared to raise more interest than concern among the participants met. Few questions and recommendations were formulated concerning the scope of the impact on the natural environment.

Both political representatives and organizations appreciated the opportunity to participate in the meetings and to voice and discuss their views in person on the role that the Renard Project could play in the current regional economic trend. The first face-to-face meetings set the tone for future discussions. The organizations involved asked for further discussions to be held and for the terms of cooperation to be defined at all potential levels as soon as possible.

The pre-consultation meetings held in the fall of 2010 were followed up in 2011 with six meetings of the Environment Exchange Group held at the rate of one meeting every 45 days to monitor and comment on progress of the project. A detailed analysis of comments and concerns raised during the pre-consultation and Environment Exchange Group meetings is available in section 4.4.2.

Further discussions took place on March 7 and 8, 2011. These information meetings were held in Chibougamau and Mistissini on the call for tender process for budgetary purposes as part of the Renard Project feasibility study, with the following objectives:

- Inform local contractors about the call for tender process for budgetary purposes to be made for certain construction contracts to help assess the cost of the project for the Renard Project feasibility study;
- Become more acquainted with the local contractors in terms of services offered and capacity to contract;
- Allow the contractors to register with the Stornoway contractor list and meet members of the Renard Project engineering team.

More than thirty businesses took part in the discussions.

In addition, an advisory meeting took place with representatives of the Swallow family on October 12, 2011 to discuss the closure and rehabilitation plan and eventual use of flooded pits for fishing following the shutdown of mining activities. The Cree users voiced their comments and suggestions on the rehabilitation of the site concerning waterways and revegetation. The meeting also allowed M11 trapline users to give more information on the future use of their camps and their location.

The list of consultations on the Renard Project held since 2000 is available in Appendix 4.2.2.

4.3 Consideration of Local Knowledge

Local knowledge considered for this environmental and social impact assessment covers various aspects, including the locals' knowledge about the use of the environment, knowledge related to the environment, the value of environmental elements and the foundations of the knowledge system. The Crees almost exclusively use the environment concerned. The area concerned by the project being almost exclusively used by Crees, the local knowledge considered was therefore essentially Native and commonly known as Cree traditional knowledge.

Information about the local knowledge was mostly collected during an in-depth, semi-directed meeting held September 1, 2010 with M11 trapline users and several validation and feedback meetings held later with the same users. Information was also collected informally during discussions at field surveys

and inventories in which land users participated, and during Environment Exchange Group discussions. The most documented component of local knowledge was related to the use of the environment for hunting, fishing, trapping and travel. Knowledge of the environment mainly relates to changes in the distribution of certain species, particularly moose and ptarmigan, and certain apparent climate changes.

The information collected includes the use of the land adjacent to the Renard Project site and the entire M11 trapline. Upon request by the tallymen, some data were censured to protect particular hunting grounds. Data on Cree use of the land are synthesized in Section 8.2.1 below. Additional information is available in the sectoral report on human environment in the Baseline Environmental Assessment (Roche, 2011).

4.4 Synthesis of Comments and Concerns

The comments and concerns of the M11 trapline users are available in Section 4.4.1 below, while the comments and concerns formulated respectively during pre-consultation meetings and Environment Exchange Group discussions are summarized in Section 4.4.2.

4.4.1 Land Users' Comments and Concerns

Since the exploration operations started, the Renard Project representatives have given great importance to relations with the Swallow family of Mistissini as tallymen and users of the M11 trapline (Photos 4.2.4, 4.2.5 and 4.4.1). Throughout the project, contacts have been maintained with the family every year since 2002 to establish relations of mutual respect and trust. Some members of the family were invited to take part in Renard Project operations on the mine site or during particular environmental assessment activities.



Photo 4.4.1 Tour of the Renard Project Site with the Tallymen in September 2008

The economic interests and concerns of the Swallow family have been considered throughout the design of the project and have been specifically recognized and considered in the Pre-development Agreement (PDA) and the Impact and Benefit Agreement (IBA). IBA provisions referring to M11 trapline users address training, jobs, business opportunities, involvement in environmental monitoring and mine rehabilitation work, access to the mine site, hunting, fishing and trapping activities, traffic and air transport, sites of cultural interest, knowledge sharing, and reuse of the mine site after closure.

Depending on their availability, the M11 trapline users maintained regular, active involvement in Environment Exchange Group meetings held in Mistissini throughout 2011. Their comments and concerns are included in the detailed analysis in Section 4.4.2 below. During a particular meeting held in September 2010, the M11 trapline users gave an account of their observations on land use and conveyed their concerns regarding the Renard Project since the proponent started work.

The members of the Swallow family pointed out observing a significant decline in the presence of moose in their usual hunting grounds near Camp Lagopede since 2000. They believe that noise from the camp and exploration activities scares off moose and other animals. They said that it now takes much more time for hunters to track moose and they must go further north to find the resource.

Apart from the aforementioned concerns regarding the impact of mining exploration on game, they have serious concerns about water contamination, and water quality in particular. They would like to be ensured that Lake Lagopede, in particular, will not be affected. One tallyman thinks that contamination will seep underground and that spills are unavoidable “even if they really make all the effort needed to control the situation.” Rivers and streams are also at risk of being contaminated by spills where there

will be traffic and where work will be carried out. The members of the Swallow family are convinced that this will happen.

Air fuel transport is another source of impact mentioned by one of the tallymen. He is convinced that in winter, streams are contaminated because he thinks that the barrels leak when transported by air. Out of a hundred, an airplane lost three or four barrels that seep into the ground. He explained that such contamination affects fish, and he would like to be ensured that there are no leaks at the fuel depot.

In 2007, water infiltrated into the tunnel built at Camp Lagopede to perform underground bulk sampling. Water was pumped from the tunnel into a ditch that flows into the lake. One tallyman heard that the water contained chemical compounds. He is particularly concerned about the fact that this water contaminates the lake and the impact that it may have on fish populations. He stressed that water from this lake flows into a river that in turn flows into the Eastmain River. He would like to be ensured that this problem will not occur again and that the food chain will not be affected. “Fish is eaten by the animals that we eat. Eventually, contamination also affects us.”

The tallyman mentioned the presence of an exploration camp built by another diamond exploration company[1]. That company contacted the family some years before to notify them of drilling operations to be carried out on the land. There are now metal rods in the ground and one of the tallymen thinks that they found something.

Users are concerned about the Renard Project site potentially expanding. They know that the discovered kimberlite deposit extends and they expect that more diamonds will be discovered, particularly east of Camp Lagopede. They know that gold has also been discovered further north on another trapline. One of the tallymen is particularly concerned about the cumulative impact of mining on his hunting activities.

The two tallymen wish to be consulted on the planned infrastructures and regulations to control hunting on the mine site and surrounding area.

With regard to increased access to the land, the members of the Swallow family expect to see an increasing number of camps on the land as the project develops and new access ways are built. They are not overly concerned about this, but they wish to be notified when there are new camps on the land, in the hope that they mainly serve to host relatives or acquaintances.

Another mining company has a camp further south on the trapline where the permanent camp of one of the tallymen is located. The family constantly hears helicopters throughout the entire summer and during fall. Noise has never ceased since diamonds were found in 1996. Several mining companies have drilled holes all over on the land and the family was never consulted, even when Camp Lagopede was built.

[1] According to the Cree informants, it could be Ressources Majescor.

As concerns the access route planned by the *Ministère des Transports,*although not addressed in this assessment, one member of the Swallow family said that he would have liked the route line to run about 4 km (bird's-eye view) southeast from Camp Lagopede, because he considers that part of the land as his preferred fishing ground.

This short list translates the land users' concerns regarding mining development as much as forestry or hydroelectric development.

4.4.2 Socio-economic Stakeholders' Comments and Concerns

The communication and consultation process implemented by Stornoway allowed collecting not only the comments and concerns of M11 trapline users, but also those of various socio-economic stakeholders concerned by the Renard Project. Such was the case during the pre-consultation meetings held during the fall of 2010 and Environment Exchange Group meetings held during 2011.

Comments and concerns expressed on those occasions were reported in detail. Preliminary results from the meetings are presented in Appendix 4.2.1. They are classified below (see Tables 4.4.1 to 4.4.12) based on the following topics:

- Specific technical information;
- Economic considerations;
- Social and cultural considerations;
- The proponent's relations with stakeholders;
- Environmental assessment;
- Impacts and the environment.

All the queries raised during the Environment Exchange Group discussions were answered either on the spot or at a following meeting. When required, all the relevant documents were provided to the participants. The views raised during the pre-consultation and Environment Exchange Group meetings were of great use to conduct the environmental assessment and identify mitigation and enhancement measures. Below are found, for each of the main topics addressed:

- A synthesis of issues raised;
- A table featuring the views raised;
- A table of concordance indicating the ESIA section(s) in which the main queries raised were addressed.

Specific Technical Information

Systematically, during each Environment Exchange Group meeting, Stornoway was asked to provide technical details on the project (e.g., the project calendar). Gradually, there were fewer queries on this topic as participants gained more knowledge of the project. The range of topics covered is quite wide, from diamond security procedures to electric power or drinking water supply and the type of planes to link the mine to the outside world. In addition, many questions were raised on the link between the site selection process of the mine and the extension of Route 167.

Table 4.4.1 Comments and Concerns Expressed during Pre-consultation and Environment Exchange Group Meetings regarding Certain Specific Technical Information

- Your documents show the road leading to LG-4; are you considering this as an access scenario?
- By extending Route 167, how long will it take to reach the mine from Chibougamau?
- What is the project implementation schedule?
- What is the lifespan of the project?
- Will you have to build an access road before starting the project?
- Will you pursue your exploration activities during the impact assessment?
- Does the project depend on the progress of Route 167 extension work?
- Do you know the date when work on the road extension will start?
- At which phase in the development is the Renard Project currently at?
- Is it true that you have built an underground access ramp for exploration activities?
- What type of planes will be used for the airstrip?
- How many workers will there be at the mine?
- What is the mine's life?
- Regarding power supply, do you have an alternative to an on-site thermal power plant?
- How long will exploration of the open pit mine take?
- Will all the mine sites be operated at the same time?
- If you continue to assess the quantity of resources in the kimberlite, will the scope of the project be greater than currently expected?
- Is it true that a diamond was found in a sample?
- Why not use processed kimberlite for construction?
- What will be the proportion of processed versus extracted kimberlite?
- At what time do you plan to open the mine and what is its lifespan?
- What will happen to the project if the MTQ encounters problems with the extension of Route 167?
- Are there any other areas that you have identified as potential exploration sites?
- Have you discussed about an eventual power supply line with other mining companies wishing to develop projects in the area?
- Will mining start when the extension of the road is completed?
- What will the equipment inspection procedure be to prevent losing diamonds?
- Will mine employees be able to purchase diamonds at reduced prices?
- Are there other potential sites to explore?
- What was the estimated cost of the planned dyke on Lake Lagopede? What expenditure was avoided by eliminating the dyke?
- Where will the construction work start?
- Where will you draw drinking water from?
- How long will construction take?
- Will the airstrip be in gravel?
- Technical information on ore crushing and extraction?
- What is the difference between overburden and processed kimberlite?
- What does waste rock mean?
- Could you precisely describe how pit R-65 will serve as a sedimentation pond?
- At what distance from the banks of Lake Lagopede is the domestic wastewater treatment plant located?
- Specific information on the number of tunnels, their diameter, the access ramp, the mine shaft, dense-media separation process and ore transport?
- What will hydrocarbon supplies be used for?
- Is your wastewater treatment system typical of other mine facilities or is it a particular system?

Table 4.4.2 Table of Concordance for the *Specific Technical Information* Topic

Topic	ESIA Sections
Access road	3.2.2.1, 3.2.4.1 & 3.3.5
Construction calendar	3.17
Mine lifespan	3.3.3
Importance of the resource	3.3.3
Access ramp and tunnels	1.5.2, 3.2.4.2 & 3.4.2
Air traffic	3.15
Manpower for mining	3.19.2
Power supply	3.2.5 & 3.13
Mine operation plan	3.2.4, 3.3.4, 3.3.5 & 3.3.6
Characteristics of processed kimberlite	3.7.3
Characteristics of waste rock	3.7.2
Characteristics of overburden	3.7.1
Water supply	3.9
Ore crushing	1.5.2 & 3.6.1
Ore extraction	3.4.1 & 3.4.2
Sedimentation pond at R65	3.10.5.2
Wastewater treatment	3.2.4.4 & 3.10
Use of hydrocarbons	3.2.2.1, 3.2.5, 3.12, 3.12.1 & 3.13

Economic Considerations

Concerns about project spinoffs were some of the most recurrent topics among the socio-economic stakeholders' comments and queries. Almost unanimously, they raised the need to optimize spinoffs for both the region and the Crees. In addition, the improvement of Cree training and skills were considered to be of great importance.

Table 4.4.3 Comments and Concerns Expressed during Pre-consultation and Environment Exchange Group Meetings regarding Certain Economic Considerations

- To foster regional spinoffs, contracts should be of realistic scope or reflect the capacities of the market.
- Encouraging local hiring and the purchase of regional services is an interesting approach for the region.
- Concerning hiring, does Stornoway have a policy identifying a hiring objective for the Crees (percentage out of the total number of workers)?
- Regarding hiring for jobs involving explosives, the fact that employees should not have any past judicial records should be considered.
- Municipal leaders are willing to make the necessary promotions to attract workers in the region to meet the needs of the mine.
- A maximum of spinoffs is needed for people living in the region.
- We would like all the workers to come from the region, but we know that this is impossible.
- Since workers' access to the mine will be by plane, we would like an air stopover in Chibougamau.
- We would like the mining company to be bound by a pre-determined proportion of jobs in the James Bay territory.
- Will the Crees have to speak French, even for driving a truck?
- Will Chibougamau be a transit point for staff and supplies?
- Despite the wishes of the region, we should question whether Chibougamau businesses are able to

assume a $2,000,000 contract or not.

- What Cree employment proportion are you targeting?
- Are your training development efforts aimed at all levels of mining operations?
- Will the ESIA include recommendations on ways to integrate Crees into the mining operations?
- Will recommendations be made concerning the improvement of Cree skills?
- The ESIA should include a plan to help meet manpower needs.
- For the construction of mine facilities, will you do business with Cree contractors?
- How many Crees have worked on the project to date?
- Now that the Troilus mine is closed, we should be able to find qualified staff in the region.
- The Crees who are currently being trained in drilling could eventually work at the Renard mine.
- For rehabilitation work, do you plan to encourage partnerships with Chibougamau and Mistissini?
- During the next meetings of the Environmental Exchange Groups, it would be wise to meet regional stakeholders sensitive to the project spinoffs.

Table 4.4.4 Table of Concordance for the *Economic Considerations* Topic

Topic	ESIA Sections
Purchasing policy	8.3, 8.4, 8.4.2 & 8.4.3
Hiring policy	8.3, 8.3.2, 8.3.3 & 8.4
Air stopover in Chibougamau	1.6.2 & 3.14
Capacity of regional businesses	8.4 & 8.4.1
Training	8.3, 8.3.1, 8.3.2 & 8.3.3
Cree integration	1.4, 8.5, 8.5.3.1 & 8.5.3.2

Social and Cultural Considerations

The social and cultural aspects highlighted during consultations were mainly of concern to the Crees. The need to foster the harmonious integration of the Crees into the mine labour force was emphasized, based on terms allowing their cultural specificities to be considered and their family relationships to be maintained. The importance of considering local Cree knowledge and protecting their traditional activities was also highlighted. Jamesians also had their say and insisted on the importance of considering the “James Bay territory” as a separate regional entity.

Table 4.4.5 Comments and Concerns Expressed during Pre-consultation and Environment Exchange Group Meetings regarding Certain Social and Cultural Considerations

- At the mine, there should be a program to increase the workers' awareness of different cultures.
- When we speak here of the region, we refer to the "James Bay territory".
- The Crees' work schedule will have to benefit both the needs of the mine and those of families (problem of remoteness).
- Like at Troilus, will there be recreational facilities and activities at the Renard mine for the employees (e.g., bowling)?
- In the ESIA, it would be important to not only describe Cree activities held on the land, but also what the land represents to the Crees.
- It is important to recognize that a great deal of activities take place on M11 trapline.
- Food not consumed at the camp should not be thrown out but given to elders.
- How do you integrate local knowledge into the environmental assessment?
- Will flights stop during the hunting season?
- When the mine is dismantled, will you offer the materials to M11 trapline users as a priority?

Table 4.4.6 Table of Concordance for the *Social and Cultural Considerations* Topic

Topic	ESIA Sections
Awareness-raising of Cree culture	8.5 & 8.5.3.2
Problem of family estrangement	8.5 & 8.5.3.2
Facilities for mine workers	3.15 & 8.5.3.2
Use of the M11 trapline	8.2 & 8.2.1.2
Local knowledge	4.3, 5.2.2, 5.5.1, 7.5.1.1, 7.11.1, 7.11.3 & 8.2.1
Air traffic and traditional activities	8.2.3.1
Use of facilities after closure	8.2.4.2

The Project Proponent's Relations with Stakeholders

Regional representatives insisted on the need to know all the services and manpower needs of the mine in order for the region to meet them as best as possible. They also insisted on the M11 trapline users taking an active part in the environmental assessment. The Crees also showed great interest in concluding an Impact and Benefit Agreement (IBA).

Table 4.4.7 Comments and Concerns Expressed during Pre-consultation and Environmental Exchange Group Discussions on the Project Proponent's Relations with Stakeholders

- For regional stakeholders to offer good services to the mining company, the latter must inform them regularly about its needs.
- Will the Swallow family be consulted throughout the entire assessment process?
- The best way to achieve these regional objectives is to have an agreement with the mining company.
- In outlying regions, efforts must be optimized; therefore, we must know the training needs of the mine.
- With regard to some licenses, authorizations, regulations and taxes, the MDDEP will ask the mining company to contact the MBJ.
- We have to know the needs of Stornoway to encourage regional groups to offer services and be proactive.
- To access a maximum number of jobs, the region should know the training needs in advance.
- If the region really wants to be part of the project, it is important for us to have all the information needed.
- Are the families using the land involved in the impact assessment?
- What will be the procedure for the Environment Exchange Group?
- It is important for people concerned with the topics addressed to sit at exchange group meetings.
- Who is involved in the preparation of a Pre-development Agreement?
- Public consultation and public hearings should be properly distinguished; there is a thin line between the two.
- This group discussion is quite pro-active. As suggested by the JBNQA, you should extend the process to all the community.
- You should attend the mining symposium to be held May 25.
- It would be useful for us to have your Power Point presentations to promote relevant information on the Nation of Mistissini's website.
- Communications with the communities should not be interrupted during the entire ESIA.
- In the ESIA, a vocabulary easily understood by the largest number of people should be used.
- Stornoway will have to pay attention to how the process undertaken to obtain the various licenses is published.
- Will we be able to post your information on the Nation of Mistissini's website?
- Are you willing to share the information that you will collect during the environmental monitoring?
- Will the community of Mistissini be involved in the Environmental management plan?

Table 4.4.8 Table of Concordance for the *Project Proponent's Relations with Stakeholders* Topic

Topic	ESIA Sections
Training needs	3.16
Communications with the Swallow family	1.3, 4, 7.5.1.1, 7.10.1.2, 7.11.1.2, 8.2.1 & 8.2.2.2
Goods and services needs	3.16
Communication with the community	1.3, 1.4, 4, 5.2.1, 7.11.1, 8.5.3.1, 11.1.1, 11.2.2.6, 11.4.10, 11.4.11 & 11.4.12
Cooperation of Crees in the ESIA	4.3, 4.5.1 & 8.2.1
Impact and Benefit Agreement (IBA)	1.4, 1.6.2, 8.2.2.2, 8.5.3.1, 8.3.2, 8.3.3, 8.4.2, 8.4.3, 8.7.2 & 10.8.1
Obtaining licenses	2.5
Publication of monitoring data	11.2, 11.3 & 11.4

Environmental Assessment

Several questions were raised on certain quite technical aspects of the environmental and social assessment, such as the consideration of local knowledge and the assessment of cumulative effects. There was great interest in some elements of the environmental assessment with effects beyond the completion as such of the impact assessment, for instance, environmental monitoring and emergency response management.

Table 4.4.9 Comments and Concerns Expressed during Pre-consultation and Environment Exchange Group Meetings regarding the Environmental Assessment

- How long will the environmental impact assessment last?
- Will you consider cumulative effects?
- When do you plan to submit your impact assessment to the COMEX/COFEX?
- Will the current land users be considered in your environmental impact assessment?
- Will Stornoway or an external consultant conduct the impact assessment?
- It will be important to link the traditional and scientific knowledge properly.
- We would like to have maps allowing us to see the watersheds involved in the project.
- What specifications are you following in the ESIA?
- Will there be an assessment every year? Will there be an environmental monitoring program?
- Do you have an emergency response plan?
- Will there be a water quality monitoring system?
- When do you plan to finish the environmental assessment?
- What will happen to unprocessed ore? Does it represent an additional potential? In such a case, will there be a new environmental impact assessment?
- What is your status regarding fish habitat compensation?
- Will there be nitrate monitoring?
- Be cautious when making comparisons regarding the footprint of different diamond mining projects.
- It would be relevant to have the environmental and social impact assessment (ESIA) before Christmas 2011.
- Will there be water sampling stations in the lake?
- When you analyzed the water from Lake Lagopede, did you take samples at different periods of the year?
- Who will conduct the environmental monitoring?
- Will Stornoway have funds available before the mine closure phase starts?
- Will the rehabilitation of the site start at the same time processed kimberlite is piled up? Will you use the rehabilitation funds for this work?
- Will you have an external scientific advisor?
- How will you hire the staff to be in charge of the environmental monitoring? Who will ensure the environmental monitoring is done correctly?
- It would be appropriate to integrate your environmental monitoring data into a database.

Table 4.4.10 Table of Concordance for the *Environmental Assessment* Topic

Topic	ESIA Sections
Cumulative effects	10
Consideration of current users	7.1, 7.3.1.1, 7.3.1.2, 7.3.3.1, 11.1.1 & 8.2.1
Environmental assessment process	2
Specifications to follow for the ESIA	2.1, 2.3 & 2.4
Environmental monitoring program	11.4
Emergency response plan	12.5
Fish habitat compensation	7.3.5
Lake water sampling	6.8.1
Financial guarantees for the rehabilitation	2.1 & 3.18
Site rehabilitation	3.18

Impacts and the Environment

Many queries were raised regarding project impacts, covering a wide range of topics. However, the emphasis was placed on the potential risks of contamination by processed kimberlite or any other potential source of pollution and the impacts on wildlife. There was also interest in considering innovative environmental approaches, like using alternative sources of energy and solid waste management.

Table 4.4.11 Comments and Concerns Expressed during Pre-consultation and Environment Exchange Group Meetings regarding Impacts and the Environment

- Will the project impact rivers? Will there be any diversions?
- Are you considering using alternative sources of energy like solar energy?
- Does the environmental assessment include a study of bears?
- What types of salamander were found in the study area and where?
- What are “micromammals”?
- What happens when an animal of special status or listed as an endangered species is killed during the assessment process?
- We hope that mining will not have any adverse effects on local food resources and that they will always be safe to eat.
- We hope that the impact assessment highlightsany major change noticed to the environment.
- During construction, can we expect high traffic on Route 167? Will there be a control booth?
- An individual having worked at the Troilus mine confirmed that carnivorous animals are still being found around the mine. However, the mine impacted the big game humting and vegetation within a 25-km radius.
- May the dyke planned in Lake Lagopede cause flooding?
- Will wildlife eventually come back to the processed kimberlite confinement area?
- How will the safety of rock piles be ensured to protect future generations?
- Are there any risks of the processed kimberlite confinement area impacting the water quality?
- What are the details regarding blocking or diverting streams on the mine site?
- Does kimberlite processing involve using chemical products?
- What is the main environmental issue apprehended if no chemical products are used?
- What are the long-term versus short-term impacts?
- Have you documented the benthic fauna?
- Have you tested for phosphorus or any other water component?
- When water comes into contact with extracted materials, does it become acid?
- Have you found any abnormal elements in the kimberlite?
- Will the extraction areas be filled after the end of mining operations?
- What will you do with waste oils?
- Does the rock contain traces of metals?
- Will the water pH change after the project? How can this affect the benthos and habitats? Do you anticipate changes of this type?
- Has noise near the camp disturbed woodland caribou?
- Will the crushers cause dust emissions?
- Will the processed kimberlite confinement area cause dust emissions once it dries out?
- Since the community is currently planning to set up a new landfill site, why doesn’t Stornoway consider the possibility of disposing of its solid waste at that site?
- How important is the vegetation studied in terms of biodiversity?
- If the soil is not rich, does that mean that the impact is greater?

- To revegetate the site during rehabilitation, will you use several plant varieties?
- During rehabilitation, what will the growth of plants be like at higher altitudes?
- Have you documented the presence of woodland caribou?
- What studies have you conducted on fish in Lake Lagopede and what is the biomass of the lake?
- How long will it take for the waters of Lake Lagopede to return to their natural state?
- Have you considered northern climate conditions in the design of your facilities?
- When disrupted sites will be revegetated, local or regional species should be used to avoid introducing invasive vegetation.
- What could be the influence of placing the wastewater discharge outfall deep into the lake? Could this influence the ice cover?
- How long will it take for the pits to become lakes?
- Over time, will the wastewater dispersion plume expand in the lake?

Table 4.4.12 Table of Concordance for the *Impacts and the Environment* Topic

Topic	ESIA Sections
Impacts on rivers	6.7.2 & 6.7.3
Bear study	7.11.1
Presence of salamanders	7.5.1.1
Animals species with special status	7.3.1.2, 7.5.1.2, 7.7.1, 7.8.1.2, 7.8.1.3, 7.9.1.2, 7.10.1.2, 7.11.1.1 & 7.11.1.3
Road traffic	3.5 & 8.5.3.1
Impacts on vegetation	7.4.2, 7.4.3 & 7.4.4
Impacts on big game	7.11.2, 7.11.3 & 7.11.4
Impacts on the water quality	6.8.2, 6.8.3 & 6.8.4
Study on benthic fauna	7.2.1
Presence of phosphorus and other components in water	6.8.1
Water acidification	6.8.3.2 & 7.3.2.1
Waste oil management	3.12 & 3.12.1
Impacts of noise on caribou	7.11.2 & 7.11.3
Dust emissions	6.3.2, 6.3.3 et 6.3.4
Solid waste management	3.2.7, 3.11, 3.12, 3.17.5 & 3.18.7
Vegetation and biodiversity	7.4.1
Plants used for revegetation	7.4.4 & 3.18
Presence of woodland caribou	7.11.1
Fish studies in Lake Lagopede	7.3.1
Conversion of pits into lakes	6.6, 6.7, 7.3

4.5 Public Consultation and Communication during the Project

To ensure transparency and harmonious community relations throughout the entire project, Stornoway will maintain the consultation and communication process started during the project feasibility study. Stornoway is therefore making public the results of the Environmental and Social Impact Assessment (ESIA) before being published by the government authorities.

The ESIA is to be published in French in compliance with the environmental assessment reporting requirements specified by the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP). An English version of the document will also be available. Cree administrations and the public will then have the opportunity to make representations to the Evaluating Committee (COMEV),

which may hold public hearings or any other form of consultation. Stornoway will make all the necessary audiovisual materials available to the participants for the public consultations.

Following project authorization, Stornoway will encourage Cree consultation by setting up various discussion and coordination committees in accordance with the Impact and Benefit Agreement (IBA), specifically the Renard Committee, the Education and Training Committee and the Environment Committee. The Environment Exchange Groups will also continue to convene.

Chapter 5

Scope and Boundaries of the Environmental and Social Impact Assessment

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5 Scope and Boundaries of the Environmental and Social Impact Assessment

As specified by the evaluation committee (COMEV) guideline issued in June 2010 (Appendix 2.2.1), the Fisheries and Oceans Canada (DFO) and Natural Resources Canada (NRC) guideline issued in July 2010 and its update by the Canadian Environmental Assessment Agency (CEAA) in June 2011 (Appendix 2.2.2), the components of the Renard Diamond Project described in this report were determined by the scope of the environmental assessment. The environmental effects of these components, along with environmental elements to be considered and their scope were analyzed during the assessment. Therefore, the purpose of this exercise was to determine the elements to include in or to exclude from the environmental assessment.

5.1 Scope of the Project

The scope of the project includes the activities and workings considered in the environmental assessment. For the purpose of applying the *Canadian Environmental Assessment Act* (CEAA), the scope of the project includes all project components submitted by the proponent. Any other working, temporary structure and activity directly linked to the project are included in the project scope (e.g., temporary access roads, land clearing, backfill, revegetation, etc.).

The COMEV (MDDEP) guideline issued in June 2010 for the Renard Diamond Mine Project specifies the COMEV's expectations concerning the description of the project and activities planned for its implementation (see the COMEV guideline, June 2010, pages 5 to 11; Appendix 2.2.1).

Stornoway was therefore asked to provide a description of the project mining infrastructures, the project implementation calendar, the dates and timelines scheduled to complete the work, and its duration. To comply with the COMEV guideline, the scope of the project should include the following aspects:

- Description of the deposit and facilities;
- Ore extraction facilities and operations;
- Ore processing facilities and operations;
- Tailings management;
- Water management and water balance;
- Contaminated water treatment and disposal;
- Facilities and related projects:
  - Road and airport infrastructures;
  - Accommodation infrastructures;
  - Fuel and hazardous material storage sites;
  - Borrow pits.

Chapter 3 in this environmental and social impact assessment (ESIA) provides a detailed description of the project covering all the facilities, workings and operations considered in the environmental

assessment that define the scope of the project. In the description, all the project phases are also covered, including the construction, operation, rehabilitation and closure and post-closure of the Renard Diamond Mine.

5.2 Scope of the Environmental Assessment

5.2.1 Elements to Consider

The CEEA guideline issued for the Renard Diamond Project (June 2011) specifies that the environmental assessment should include the study of the following elements, as listed in sub-paragraphs 16(1) (a) to (e) of the CEAA:

- The environmental effects of the project, including those resulting from accidents or malfunctions that may occur in connection with the project, and any cumulative environmental effects that are likely to result from the project in combination with other existing workings or other projects or activities that have been or will be carried out;
- The significance of the effects referred to above;
- Public comments in this regard received during the environmental assessment;
- Measures that are technically and economically feasible to mitigate any significant adverse environmental effects of the project;
- Any other matters relevant to the environmental assessment.

Environmental effects, as defined in subsection 2(1) of the CEAA, are any changes that the project may cause to the environment, including any changes it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*, and any effects or any changes to health and socio-economic conditions, the current use of lands and resources for traditional purposes by aboriginal persons, any structures, sites or things that are of historical, archaeological, paleontological or architectural significance, and any changes to the project that may be caused by the environment.

To meet COMEV guideline (June 2010) requirements, the following elements were also considered in this ESIA:

- The context, subject and purpose of the project;
- The technically and economically feasible alternatives and their environmental effects;
- The site selection and technology alternatives;
- The determination of the study area boundaries;
- The description of the biophysical and social environment;
- The impact analysis;
- The mitigation measures;
- A progressive rehabilitation program implemented during operations, a final rehabilitation program, and a closure plan;
- Accident management;

- The surveillance and monitoring programs;
- The results of consultations held by the proponent as part of the project planning and communication plan.

5.2.2 Scope of Elements to Consider

The CEEA guideline (June 2011) specifies that the scope of elements to consider in the environmental assessment should include, but are not limited to, the elements listed below:

- Surface and groundwater quality;
- Air quality;
- Soil quality;
- Water regime (hydrology and hydrogeology);
- Geology of the area;
- Terrestrial and aquatic vegetation;
- Wetlands;
- Fish and their habitats;
- Birds and their habitats;
- Terrestrial wildlife and their habitats;
- Flora and fauna species at risk as set out in subsection 2(1) of the *Species at Risk Act* and their habitats, particularly woodland caribou;
- The current use of lands and resources for traditional purposes by Aboriginals;
- The health of land users, particularly regarding the accumulation of metals by the flora and fauna;
- Navigation and the safety of navigators;
- The socio-economic activities and heritage, historical, cultural and archaeological resources;
- Safety related to explosive manufacturing and powder magazines.

The COMEV guideline (June 2010) specifies the relevant components that should be described in the ESIA and considered in the impact assessment (see the COMEV guideline, pages 11 to 13 inclusively, Appendix 2.2.1) as follows:

➢ *PHYSICAL ENVIRONMENT*

- Geology and topography of the study area, along with unstable or erosion-prone areas;
- Physical characteristics of streams and bodies of water (bathymetry, substrate, etc.) that may be affected by the project, along with their water regime, the physico-chemical quality of water, their uses, particularly downstream of discharge points, and the nature and characteristics of sediments;
- Shores, flood-prone areas, and wetlands, particularly string bogs/fens;
- Hydrogeological context (recharge area);
- Climatic context;
- Forest cover, particularly sensitive or exceptional stands;

- Wildlife species (mammals, birds, reptiles, amphibians) and their habitats;
- Fish species and their habitats;
- Rare, endangered or vulnerable species and their habitats.

➢ *ARCHAEOLOGICAL AND CULTURAL POTENTIAL*

- Known archaeological sites;
- Potential archaeological areas;
- Elements of heritage or cultural interest;
- Cree traditional knowledge of wildlife and medicinal plants.

➢ *SOCIAL ENVIRONMENT*

- The socio-economic picture;
- The local and regional economy;
- Community concerns, views and feedback;
- The current and planned use of the land.

All these components were considered in this ESIA. A comprehensive description of these components is presented in the Environmental Baseline Study.

For the purposes of impact analysis, a list of valued environmental and social components (VESC) was created and is available in section 5.5.

5.3 Temporal Limitations

In compliance with the guidelines received, the calendar for the environmental assessment of the project includes the timelines planned for preparation, construction, infrastructure installation and deposit mining, and mine closure and post-closure stages, in order to review the overall short-, medium- and long-term impacts.

The timeline for the preparation, construction and installation of the Renard mine infrastructures covers two to three years (2013 to 2015). Deposit mining is expected to last twenty years (2015 to 2033). Mine closure and final site rehabilitation operations should take about two years to complete (2033-2036). The timeline for mine post-closure was established at a minimum of 25 years. Post-closure refers to the limited timeframe for which the long-term impacts of the mine can be reasonably foreseen once the mine site is permanently closed after the final site closure and rehabilitation work is completed.

The environmental conditions that determined the current state of the biophysical and human environment (baseline conditions) were established based on the information available in relevant literature, land surveys and inventories conducted mainly between 2002 and 2011 over a period of approximately 10 years, with increased activity over the last years.

The characteristics of certain environmental components were determined based on data collected over longer periods of time, particularly for certain physical components of the environment. For climatic conditions (temperatures, precipitations), the calculation of averages was established based on measures taken at four stations over a period of 30 years between 1971 and 2000. With regard to winds, the most relevant data were drawn from a station operated over more than 40 years (1942-1985).

The sections of the ESIA reporting on existing conditions and the environmental effects of the project present the temporal limitations specific to each environmental component and expected impact in more detail.

5.4 Spatial Boundaries

As required by the CEAA and COMEV guidelines, the study area was delineated to include all the area covered by the planned activities and their direct and indirect effects on the biophysical and human environmental components that the project and ancillary infrastructures are likely to impact.

For the biophysical environment, the study area included the following two areas:

- The mine area (about 100 km²), encompassing all the area covered by the mine infrastructures and ancillary facilities, and the peripheral zones;
- The airstrip area that covers an extent of some 27 km².

The study area boundaries covering some 127 km² are shown on Map 5.4.1. This study area is vast enough to cover all the direct and indirect effects of the project that may affect the physical and biological components.

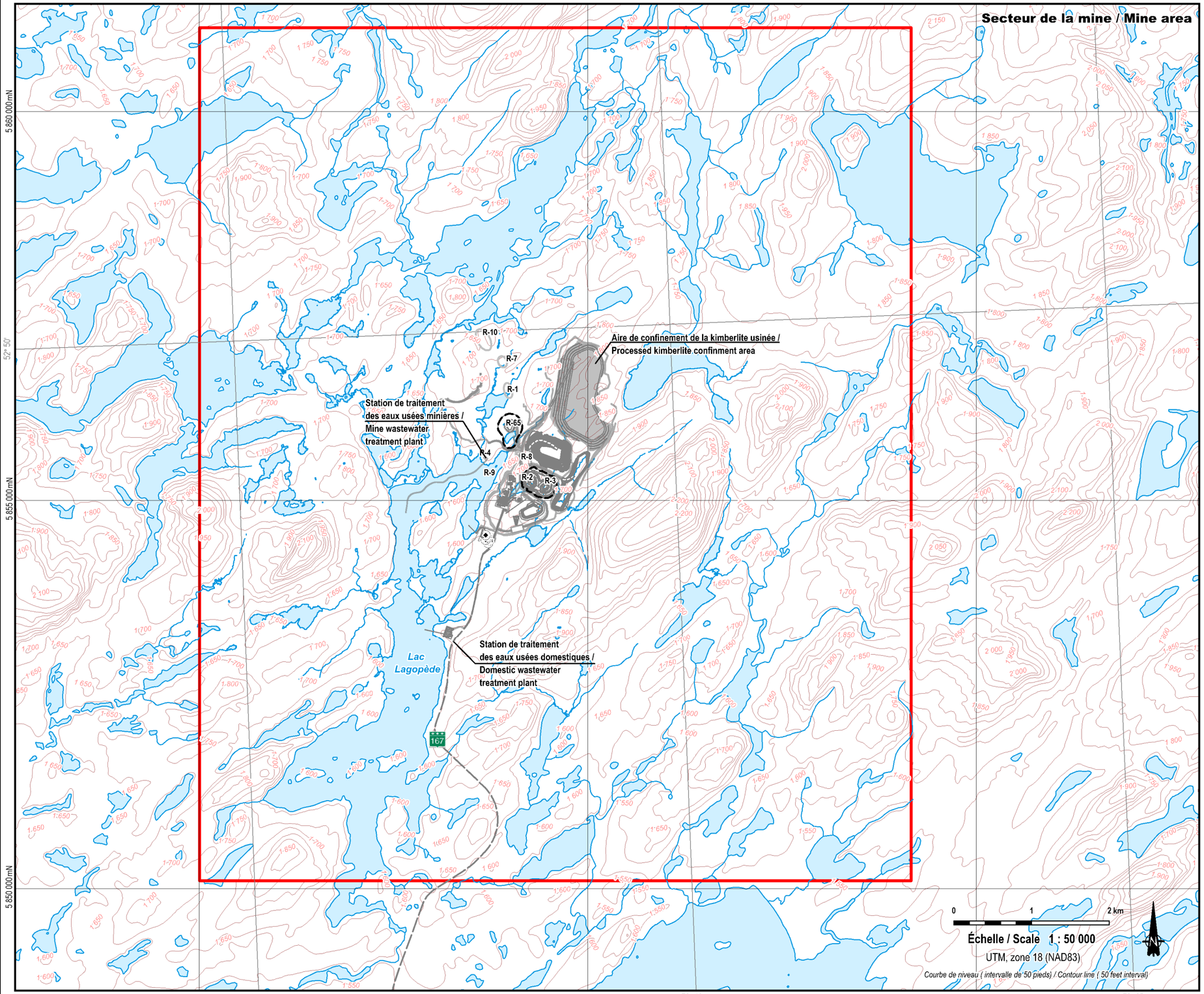
To obtain the socio-economic profile of the project and assess its effects on Cree and Jamesian communities occupying the territory, the study area includes the Cree Nation of Mistassini, the *Eeyou Istchee* region with the M11 trapline affected by the project, as well as the cities of Chibougamau and Chapais along with the Jamesian Region (Map 5.4.2).

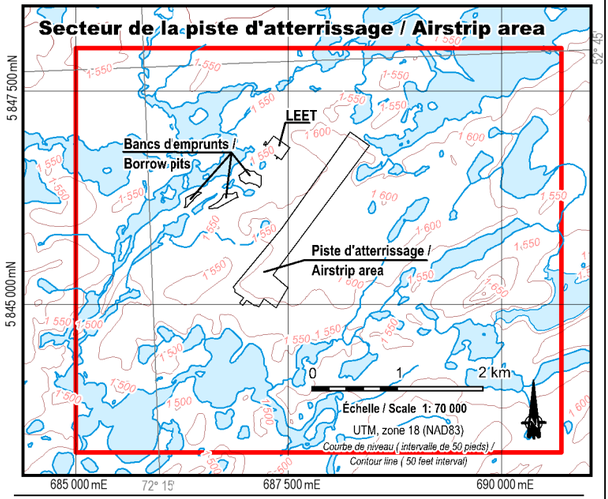
5.5 Methodological Approach

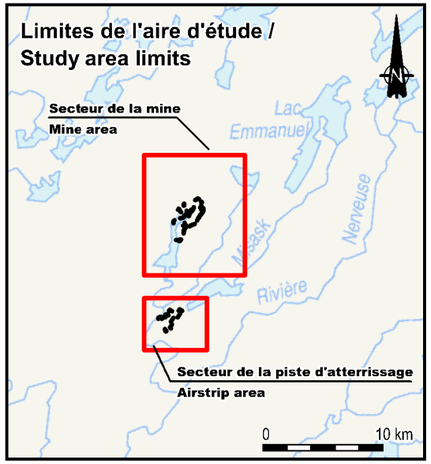
This section provides a description of the general methodological approach to the determination and assessment of the project impacts. The main steps involved in this methodological approach include the following:

- Identification of impact sources;
- Identification of valued environmental and social components (VESC);
- Development of an interaction matrix;
- Identification, description, analysis and assessment of impacts;
- Development of mitigation and compensation measures for adverse impacts and enhancement of positive impacts;

- Determination of the significance of residual impacts;
- Assessment of cumulative effects;
- Public consultations and comments at every step of the environmental assessment.







les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

- Emprise du projet / Project footprint (2011/10/26)
- R-X — Autres ressources minérales / Other mineral resources
- Fosse d'extraction à ciel ouvert / Open pit
- Aire d'étude / Study area

Limites de l'aire d'étude pour le milieu biophysique / Study area limits for the biophysical environment

ROCHE

Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_ZEBiophy_111213.WOR

Décembre 2011 / December 2011

Carte / Map 5.4.1

80° 200 000 mE 78° 400 000 mE 76° 74° 600 000 mE 72° 800 000 mE 70°

6 000 000 mN
5 800 000 mN
52°
5 600 000 mN
50°
5 400 000 mN
48°

Chisasibi
LG-1
Robert-Bourassa
Radisson
LG-2-A
Réservoir Robert-Bourassa
LG-3
Réservoir La Grande 3
LG-4
Route Transtaïga
Réservoir La Grande 4
LaForge-1
LaForge-2
Réservoir Laforge 1
Réservoir Laforge 2
Brisay
Réservoir Caniapiscau
Wemindji
Eastmain
Baie James
Eastmain-1
Réservoir de l'Eastmain 1
Route de la Baie-James
Nemaska
Waskaganish
Route du Nord
Amos
Lebel-sur-Quévillon
Géant dormant
Matagami
Persévérance
Casa Berardi
Waswanipi
Oujé-Bougoumou
Chapais
Chibougamau
Mistissini
Lac Mistassini
Lac Albanel
Lac Saint-Jean
Saguenay

Projet Renard / Renard project

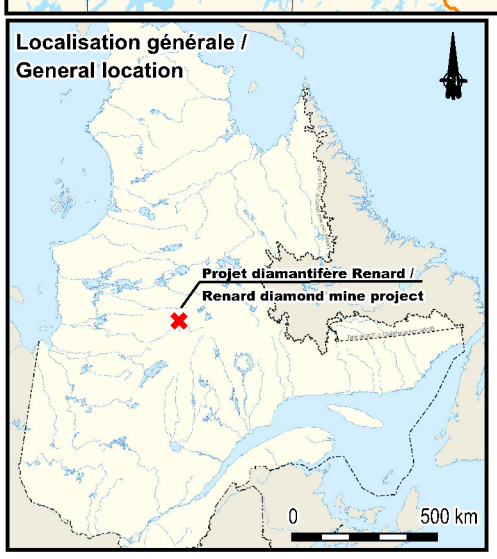
ELEONORE / Goldcorp inc.
JAMES BAY LITHIUM, Lithium One
PIVERT-ROSE, Critical Elements
WHABOUCHI, Exploration Nemaska
BRACEMAC-MCLEOD, Xstrata
VEZZA (N.A. Palladium)
LANGLOIS, Nyrstar Canada
LAC BACHELOR, Métanor
BLACKROCK / Blackrock Metals inc.
LAC MACLEOD / Western Troy Capital Resources Inc.
MATOUSH / Ressources Strateco
TROILUS

Réserve de biodiversité projetée Hirondelle
Parc national projeté Albanel-Témiscamie-Otish
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Réserve faunique Assinica

10526-07 10610-A 10511-04 10536-03 10620-01 10536-01 10611-01 10616-01 10537-02 10536-02 10609-01 10537-01 10605-01 10526-06 10612-01 10526-02 10526-03 10526-05 10613-01 10554-08 10554-09 10554-05 10554-06 10619-01 10554-03 10554-04 10554-10 10554-11 10554-07 10554-02 10554-01 10621-01 10580-04 10580-03 10580-02 10580-01 10525-01 10552-02 10552-01 10549-01 10555-01 10623-01 10565-01 10553-01 10557-01 10563-01 10556-01 10563-02 10564-01

Échelle / Scale : 1 : 2 750 000
0 50 100 km
UTM, zone 18 (NAD 83)

Localisation générale / General location



- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Pourvoirie sans droit exclusif / outfitter without exclusive rights
- Aéroport / Airport
- Hydrobase / Hydrobase
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec electricity transport lines
- Réseau routier principal / Main road network
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Mine active / Operating mine
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Mines qui pourraient être mises en exploitation à court ou moyen termes / Short and medium term potential mining projects
- Ancienne mine / Old mine
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Limites de l'aire d'étude / Study area limits
- Propriété Foxtrot / Foxtrot property

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Limites de l'aire d'étude pour le milieu humain / Study area limits for the human environment

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_ZEMHumain_111215.WOR
Source : - Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010
Pourvoiries / Outfitter, MRNF, 2010
Décembre 2011 / December 2011

Carte / Map 5.4.2

5.5.1 Impact Sources, Valued Components and Interaction Matrix

The first step consists of developing an interaction matrix to help identify the likely impacts of the project. To do so, impact sources were determined based on the description of the selected project and identification of the valued environmental components that may be affected by the project. Figure 5.1.1 presents the interaction matrix for all the project phases and activities.

Impact sources (also known as project components) identified in the matrix cover all the phases involved in the project from construction to post-closure as required by the COMEV and Canadian Environmental Assessment Agency (CEAA) guidelines. In addition, all the planned mine activities are found in the matrix, including the temporary workings and activities, and the activities indirectly related to the project. To fully understand the workings and activities incorporated into each project component, brief descriptions follow.

5.5.1.1 Description of Project Components

- *CONSTRUCTION PHASE*

Site preparation and development work includes land clearing, stripping, drilling, blasting, backfilling and cutting, drainage, along with the development of bulk material storage sites, borrow pits and secondary roads on the mine site.

Quarry and borrow pit operations include aggregate extraction, aggregate sieving and crushing on site at the quarry to be set up in the vicinity of the airstrip, and the operations of the quarry set up in Pit R-65 like crushing for concrete and aggregate production.

The component involving the use and maintenance of equipment and power generating sets along with road traffic includes the entire vehicle fleet serving the project site, such as machinery and site supply vehicles.

Lake dewatering and water and sediment management include the pumping of small lakes F3302 and F3303, pumped water treatment, the excavation of sediments on the bottom of the lake and sediment dewatering on a drying bed, if applicable. Sediment dewatering might not be required if sediment characteristics are similar to the characteristics of unconsolidated deposits, from excavation operations to stockpiling in the overburden stockpile.

Water supply includes pumping water from Lake Lagopede (North-East Bay) using a water intake, water storage and treatment, and drinking water distribution through a water distribution system to the camp and mine infrastructures.

Figure 5.1.1 Potential Impact Interaction Matrix

Project Components			Valued Environmental Components																								
			Physical Environment							Biological Environment												Human Environment				
			Air quality	Ambiant noise level	Soils	Underground waters	Hydrological flow pattern	Surface waters	Sediments	Benthos	Fish	Vegetation and wetlands	Reptiles and amphibians	Waterfowl and other aquatic birds	Birds of prey	Forest birds	Micromammals	Fur-bearing animals	Larger wildlife	Use of land and natural resources	Economy and employment	Health and well-being	Archaeological and cultural heritage	Landscape
	Construction	Site preparation and development: Land clearing, drilling, blasting, backfilling, cutting, drainage, material storage confinement sites, borrow pits, secondary roads - All facilities	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
		Quarry and borrow pit operations	X	X	X	X	X	X	X								X	X	X					
		Use and maintenance of machinery and power generating sets, and road traffic	X	X	X	X		X	X	X	X		X				X	X	X	X		X		
		Lake and stream dewatering and water and sediment management		X		X	X	X	X	X	X		X	X						X				X
		Water supply					X	X			X													
		Site water management (runoff, drinking water, process water, wastewater, etc.)		X			X	X	X	X	X		X	X										
		Solid waste storage and management and trench landfill site						X																
		Hazardous materials and fuel storage and management			X	X		X	X	X	X											X		
		Construction of mine facilities (ore processing plant, accommodation complex, airstrip, power generating sets and ancillary facilities)	X	X			X						X		X	X	X	X	X	X				X
		Manpower and procurement									X			X						X	X	X		
	Operation	Pit development: Land clearing, drilling, blasting, backfilling - All facilities	X	X	X	X	X	X	X		X	X	X			X	X	X	X				X	X
		Use and maintenance of machinery and power generating sets, and road traffic	X	X	X	X		X	X	X	X	X	X				X	X	X	X		X		
		Extraction, handling and ore storage	X	X				X			X		X			X	X	X	X	X				X
		Ore processing	X	X																				
		Mining operation material management (overburden, tailings and processed kimberlite)	X	X	X	X	X	X	X				X							X				X
		Water Supply					X	X			X													
		Site water management (runoff, mine drainage water, drinking water, process water, wastewater, etc.)		X		X	X	X	X	X	X			X										
		Solid waste storage and management and trench landfill site				X		X											X					
		Hazardous materials and fuel storage and management			X	X		X	X	X												X		
		Power generating sets	X	X																				
		Airstrip operation	X	X				X					X			X	X	X	X	X				X
		Presence of facilities																	X	X		X		X
		Manpower and procurement									X			X						X	X	X		
		Gradual site rehabilitation	X		X							X	X				X	X	X	X				X
	Closure	Water Management (runoffs, flooded pits)				X	X	X	X	X	X	X	X	X						X				
		Use and maintenance of machinery and power generating sets, and road traffic	X	X	X	X		X	X	X							X	X	X			X		
		Dismantlement and conversion of facilities	X	X		X				X					X	X				X				X
		Site rehabilitation and final revegetation	X		X		X	X	X	X		X	X	X	X	X	X	X	X	X		X		X
		Manpower and procurement																			X	X		
		Site remains				X													X	X				X

Water management on the construction site includes all the measures set out under the water management plan (see sections 3.10 and 3.17) in order to capture all runoffs in contact with the mine site and divert the waters from upstream of the mine site to prevent contact with the water. Once captured, runoffs from the mine site are transferred to various sedimentation ponds before being treated and released into Lake Lagopede. Stream waters (F3298) will be diverted westward to prevent contact with the mine site. On-site water management also includes domestic and mine wastewater treatment units that will be installed during the construction phase along with waste snow management.

Solid waste storage and management includes domestic solid waste from the accommodation and service complex, the store and offices, construction, renovation or demolition waste and packaging (ferrous and non-ferrous metals, uncontaminated wood, inert materials, other worksite waste), temporary washroom facility sludge and infirmary biomedical waste. This component also includes the management of special waste such as tires and contaminated soil that may be produced during construction.

This project component includes a storage site and the solid waste recycling and management system, along with the trench landfill site for ultimate disposal of non-hazardous solid waste.

The hazardous material and fuel management and storage system is complete from storage to transportation and ultimate off-site third-party disposal. It also includes the storage and safe management of a fuel storage area and supply stations. Products to be managed on site include oils and greases, diesel and gasoline, propane and other hazardous materials (explosives, solvents, chemical products, waste oils, oily waters, etc.).

The construction of the mine facilities includes the building of the accommodation and service complex, the ore processing plant, the airstrip, the power generating sets and the ancillary facilities.

Manpower and procurement includes employees hired for the construction of the mine, contractors and their subcontractors. This project component also includes the procurement of goods and services needed to build the mine and ancillary facilities to operate the accommodation and service complex.

- *OPERATION PHASE*

Pit development includes the land clearing, stripping, drilling, blasting, backfilling, cutting and drainage work required to develop the open pits to mine five kimberlite pipes (R-2, R-3, R-4, R-9 and R-65), a quarry developed in Pit R-65 itself and borrow pits that can be developed in an esker next to the airstrip.

The “Use and Maintenance of Machinery, Power Generating Sets, Traffic and Storage and Management of Fuel and Hazardous Materials” component involves the entire park of vehicles serving the project site, including the machinery and site supply vehicles.

Ore extraction, handling and storage includes open pits (R-65 and R-2/R-3), an access ramp to the underground mine, a 740-m deep shaft and access drifts allowing the underground extraction of the

kimberlite pipes (R-2, R-3, R-4, R-9 and perhaps R-65), underground mines, a vertical shaft and a temporary ore storage pile located south of Pit R-2/R-3.

Ore processing includes all the kimberlite processing plant operations (crushing, scrubbing, washing, screening, sieving, dense-media separation, sorting, etc.).

Mining operation materials management includes the transportation, storage and management of the overburden of Pits R-65 and R-2/R-3, tailings and processed kimberlite (processed kimberlite confinement area).

Water supply includes pumping water from Lake Lagopede (Nord-Est Bay) using a water intake, water storage and treatment, and drinking water distribution through a water distribution system to the camp and mine infrastructures.

Water management includes domestic wastewater management (collection system, pumping station, water main, wastewater treatment plant and treated wastewater outfall), runoffs from the processed kimberlite confinement area, waste rock and overburden and ore stockpiles, mine drainage water and airstrip water. Also included are the drainage wells at the bottom of the mineshaft, the ramp and Pits R-2 and R-3. This project component includes the entire water management system with sedimentation ponds and mine wastewater treatment system. The water required for the ore processing plant will be drawn entirely from re-circulated water resulting from processed kimberlite treatment, runoffs collected in the sedimentation pond of Pit R-65, and part of mine drainage waters.

Solid waste storage and management includes domestic solid waste from the accommodation and service complex (recyclable and putrescible materials, ultimate waste), the store and procurement (paper and cardboard, Styrofoam and plastic film, pallets, plastic bins and other refundable packaging), offices (paper and cardboard, used desk supplies, printer cartridges, computer equipment), construction, renovation or demolition waste (ferrous and non-ferrous metals, uncontaminated wood, inert materials, other worksite waste), domestic wastewater treatment system sludge, and infirmary biomedical waste. This component also includes the management of special waste such as tires and contaminated soil that may be produced during construction. The trench landfill site will allow the ultimate disposal of waste not salvaged for recycling. The possibility of transporting wet solid waste to a technical landfill site is an option to consider in operation.

Hazardous materials and fuel management and storage include transportation to the ultimate disposal site. This project component also includes the storage and safe management of a fuel storage area and supply stations. Products to be managed on site include oils and greases, diesel and gasoline, propane and other hazardous materials (explosives, solvents, chemical products, waste oils, oily waters, etc.).

The power generating sets include 12 diesel-powered generators of 1,880 kW output each, with an exhaust gas system equipped with a heat recovery system for industrial heating. Electricity distribution will be ensured by the two following means:

- An electric sub-station (4,160 V) and a switchgear for the primary distribution to the plant site and surroundings, including the accommodation complex;
- A secondary electrical distribution system (4,160 V), including transmission lines on poles or laying directly on the ground, when required (e.g., in extraction pit areas).

Airstrip operations include all the passenger and freight air transportation, airplane refuelling and de-icing, septic facility and water supply well, and staff safety control operations.

Manpower and procurement includes employees hired for the mine operations, contractors and their subcontractors. This project component also includes the procurement of goods and services needed to operate the mine and ancillary facilities and to operate the accommodation and service complex.

Progressive site rehabilitation includes all the mining operations to stabilize the reworked ground surfaces, restore the overburden and bare ground cover, and revegetate surfaces using indigenous species (e.g., temporary material storage sites, areas temporarily exposed to erosion, processed kimberlite confinement area) to begin with controlling erosion and restoring the plant cover.

➢ *CLOSURE PHASE*

Water management includes the flooding of Pits R-65, R-2 and R-3, the restoration of the waterways regime, the water management plan and domestic and mine wastewater treatment until no longer needed.

The “Use and Maintenance of Machinery, Power Generating Sets, and Road Traffic” component involves the entire fleet of vehicles serving the project site, including the machinery and site supply vehicles.

Facility dismantlement and conversion includes the dismantlement and, whenever possible, conversion (recovery, reuse) of all mine site facilities.

Final site rehabilitation and revegetation includes all the closure phase operations intended to stabilize the reworked ground surfaces, restore the overburden and ground cover, and revegetate surfaces using indigenous species (e.g., flat surfaces of the processed kimberlite confinement area and overburden pile, the former plant site, the accommodation and services complex, the waste rock stockpile and ancillary facilities, the quarry and borrow pits, secondary access roads and the airstrip, if not taken up by regional institutions).

Manpower and procurement includes employees hired for the mine closure operations, contractors and their subcontractors. This project component also includes the procurement of goods and services needed to operate the accommodation and services complex and wastewater treatment stations until no longer needed.

Site remains include the revegetated processed kimberlite confinement area and overburden stockpile, new lakes created by flooded open pits, infrastructures provided to ensure the safety of land users (e.g., fences, tank dykes, etc.), the trench landfill site, and buried piping and outfalls.

5.5.1.2 Valued Environmental and Social Components (VESC)

Overall, 22 valued environmental and social components (VESC) were retained to identify impact interactions and environmental assessment.

The definition of each VESC should be considered in a non-restrictive, broad sense. Vegetation and wildlife components include all their specific characteristics: characteristics of species and populations, biological life cycle, special status (unity, rarity), etc. The 22 selected VESCs meet all the COMEV and federal requirements regarding the scope of elements to consider in the environmental assessment.

The correlation of the impact sources to the VESCs of the environment using an interaction matrix allowed identifying the project's potential impacts. Each shaded field in Figure 5.1 identifies a potential impact, the description and significance of which are described in sections 6, 7, 8 and 9.

The identification of interactions (and the analysis and assessment of the resulting impacts) was conducted by a multidisciplinary working group bringing together a roster of environment specialists in all the different areas concerned, whether physical, biological, human or mining, and who also have sound experience in large-scale project environmental impact assessment. The team worked together to identify and assess impacts based on the following information:

- The technical characteristics of the project;
- Baseline data obtained on the environment and the socio-economic context;
- Feedback on experiences of similar projects or activities;
- The review of available relevant literature (scientific, technical, etc.);
- Cree traditional knowledge;
- Advices and comments collected during public consultations.

5.5.2 Description and Assessment of Impacts, Development of Mitigation and Compensation Measures, and Determination of Residual Impact

Following the identification of the interactions and potential impacts, a description and an assessment were performed. In the assessment, the project's direct effects on components of the environment (e.g., impact of mining operations on the quality of air) and indirect effects resulting from changes to another environmental component (e.g., impact on human health due to the deterioration of air quality) were considered. This analysis was as quantitative as possible, and considered the nature, intensity, duration and spatial extent of impacts. In certain cases, special tools were used to better assess the extent of impacts. Such was the case for assessing the impact on air quality, for which an atmospheric emissions dispersion model was used. Where appropriate, these assessment tools are described in detail in sections 6, 7 and 8 of the ESIA addressing existing conditions and project impacts for each

component of the physical, biological and human environments. In addition, quality criteria recognized for certain environmental components (e.g., air and water quality) were considered to assess project impacts on these components: the discrepancy observed between the actual situation or expected concentrations and recognized quality criteria served as reference to appreciate impact intensity.

Following this analysis, mitigation or compensation measures were suggested to reduce or prevent anticipated impacts or, whenever possible, implement a project or measures to compensate impacts. Enhancement measures were also suggested to optimize positive project impacts.

The next step in the assessment was to describe and assess residual project impacts referred to as impacts that persist despite the application of suggested mitigation, compensation or enhancement measures.

A specific method was developed to determine the type and significance of impacts. The method is presented and described in the next section. It was used to assess initial project impacts and applied systematically to describe and assess residual impacts.

5.5.3 Determination of the Type and Significance of Impacts

Project impacts are assessed based on their type and significance.

5.5.3.1 Type of Impacts

Impacts are either positive (improvement or enhancement of environmental components) or negative (deterioration of the environmental components).

Positive and negative impacts can also have direct (affecting directly an environmental component), indirect (affecting an environmental component through another component), cumulative (changes caused to the environment by a project combined with other past, present and future actions), deferred (effects occurring after project implementation or completion), synergic (association of several impacts taking a significant dimension when combined) or irreversible (permanent effects on the environment) effects.

5.5.3.2 Significance of Impacts

The significance of an impact refers to changes caused to an environmental component due to the project. This prediction is based on objective knowledge and three main criteria, including the intensity, extent and duration of changes. While the impacts on valued environmental components were assessed, the value of the elements was not considered in the method. For instance, interviews with tallymen confirmed the value given to the analyzed components.

- *INTENSITY*

The intensity of repercussion reflects the relative significance of consequences on the environment resulting from the alteration (or enhancement) of an element. The natural and social (context)

environment to which each component relates is considered in the assessment of intensity. The intensity can be low, moderate or high.

Low Intensity:

- Natural environment: the impact alters the component in a manner likely to slightly change its abundance or general distribution in the study area;
- Human environment: the impact alters the component and slightly limits its use by a regional community or population.

Moderate Intensity:

- Natural environment: the impact alters the component in a manner likely to change its abundance or general distribution in the study area, but without compromising its integrity;
- Human environment: the impact limits the use of the component by a regional community or population.

High Intensity:

- Natural environment: the impact destroys the component or alters the integrity of the component in a manner likely to change considerably its abundance or distribution and to provoke its decline in the study area;
- Human environment: the impact compromises the integrity of the component or limits its use considerably by a regional community or population.

➢ *EXTENT*

The extent of the repercussion depends on the scope of the impact considered and/or the number of people affected by the repercussion. It can be site specific, local or regional:

- A site-specific extent refers to a highly restricted disturbance affecting a small surface area (e.g., the mine site itself) or used or perceived by only a few individuals;
- A local extent refers to a disturbance affecting an area larger than the project footprint (for instance, the inner limits of the ESIA study area for the biophysical environment) or affecting several individuals or groups of individuals;
- A regional extent refers to a disturbance affecting vast territories or major communities, for instance the *Eeyou Istchee* region or the entire Jamesian area.

➢ *DURATION*

The duration of a repercussion specifies the temporal dimension of an impact. It refers to the period of time in which the repercussions of an impact will be felt by the affected element and their frequency (continuous or discontinuous nature). The duration of an impact can be short, moderate or long.

- An impact is considered of short duration when effects are felt during the period of construction or when the time needed for the element affected to recover or adapt is under 3 years, on a continuous or discontinuous basis;
- An impact is considered of moderate duration when effects are felt over a period of 3 to 20 years, on a continuous or discontinuous basis (mining);

- An impact is considered of long duration when effects are felt over a period of time or various periods of time extending beyond 20 years (post-closure), on a continuous or discontinuous basis.

The combination of these three criteria (intensity, extent and duration) allowed determining the significance of impacts. All the three criteria have the same weight in the assessment of impact significance. However, a score was assigned to the three classes of each criterion, as indicated between parentheses in Table 5.1.

Table 5.1.1 Impact Significance Determination Matrix

Intensity	Extent	Duration	Impact Significance (weighting)
High (3)	Regional (3)	Long (3) Moderate (2) Short (1)	High (27) High (18) Moderate (9)
	Local (2)	Long (3) Moderate (2) Short (1)	High (18) High (12) Moderate (6)
	Site specific (1)	Long (3) Moderate (2) Short (1)	Moderate (9) Moderate (6) Moderate (3)
Moderate (2)	Regional (3)	Long (3) Moderate (2) Short (1)	High (18) High (12) Moderate (6)
	Local (2)	Long (3) Moderate (2) Short (1)	High (12) Moderate (8) Moderate (4)
	Site specific (1)	Long (3) Moderate (2) Short (1)	Moderate (6) Moderate (4) Low (2)
Low (1)	Regional (3)	Long (3) Moderate (2) Short (1)	Moderate (9) Moderate (6) Low (3)
	Local (2)	Long (3) Moderate (2) Short (1)	Moderate (6) Moderate (4) Low (2)
	Site specific (1)	Long (3) Moderate (2) Short (1)	Low (3) Low (2) Low (1)

There are three classes of impact significance. Table 5.1 presents the steps involved in assessing the significance of impacts and the overall weighting scale (multiplication of scales) used to assign each significance class. For an impact to have high significance, it must obtain an overall score of 12 or above (maximum reachable is 27). To obtain this score, a synergy of factors is needed; in other words, at least one of the criteria must have a high value (score of 3) and the two other criteria must have at least an average value (score of 2 each). Impacts of moderate significance are those with an overall score between 4 and 9 inclusively, while impacts of low significance are those with an overall score of 3 or below.

In addition to the three main criteria described above (intensity, extent and duration), other characteristics were considered to better describe and qualify impacts, including the reversibility and probability of impact occurrence. Reversibility is also a factor related to effect duration. Although certain effects are irreversible, other effects can be mitigated over time and allow full (but often different) recovery of the environment affected. The probability of impact occurrence refers to the level of risk or uncertainty of an effect actually occurring. Whenever relevant, these secondary criteria were considered in the analysis and assessment of the project impacts.

5.5.4 Cumulative Effects

To comply with CEAA requirements and COMEV guidelines, an assessment of the cumulative effects of the project was conducted. This exercise consisted of identifying and assessing the cumulative effects of the Renard Diamond Project combined with past, present or future project cumulative effects occurring in the extended study area.

The methodological approach selected to identify and assess the cumulative effects is presented in section 10 of this ESIA.

5.5.5 Public Consultations and Comments

Throughout the ESIA, information and consultation meetings were held with the public concerned to collect their comments and suggestions. As much as possible, these were considered and integrated into the ESIA, particularly regarding the determination and valuation of valued environmental and social components (VESC), the implementation conditions of the mining project, and the selection of mitigation, compensation and enhancement measures to implement.

The methodology used and the results of those consultations are described in detail in section 4 of the ESIA.

Chapter 6

Current Conditions and the Impact of the Project on the Physical Environment

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6 Current Conditions and the Impact of the Project on the Physical Environment

6.1 Regional Ecological Context

- *CLIMATE AND AIR QUALITY*

The prevalent climate conditions in the Renard Project study area were defined from data measured by Environment Canada. The station that is the most representative of the mine site was in operation at Nitchequon from 1942 to 1985. The Nitchequon station is located 96 km from the Foxtrot Property. It also has the longest series of continuous data in the area. The Environmental Baseline Study (Roche 2011) provides a detailed comparison of the four weather stations within a 400 km radius of the mine site.

On average, the region receives about 500 mm of rain and about 300 cm of snow annually, with local variations. There is usually snow on the ground from October to May, although snow may fall during any month except for July and sometimes August. The lakes generally have an ice cover from November to May. The most extreme precipitation levels recorded in the region are 66 mm of rain in 24 hours, corresponding to a return period of 20 to 100 years. The Nitchequon weather station (located 96 km from the Foxtrot Property) is the only station to record wind conditions in the region where the project is located. The prevailing wind is from the west (11.70% of the time), but the strongest winds are from the west-northwest, with an average wind speed of 19.4km/h (Roche, 2011).

Air quality is generally excellent due to the rarity of human activities that may generate atmospheric emissions in the area. However, the forest fires that prevail in the region during the summer can cause smoke and fine particles (<2.5 µm) that are carried by the wind. The presence of smoke over large areas can occur a few times during the summer. Even if a forest fire is far away and poses no threat to mining infrastructure or the health of the mine workers, the smoke may cause the temporary restriction of certain activities.

- *TOPOGRAPHY AND GEOLOGY*

The territory of the Foxtrot Property is between 450 m and 550 m above mean sea level (MSL). The physiography of the region is a vast peneplain whose low topography is marked by its slightly wavy landform, speckled with a multitude of lakes and streams, wetlands, and hills with rounded crests rarely reaching an elevation higher than 100 m. The highlands of the Otish Mountains, about 100 km to the south, are the exception to this relatively featureless landform. They boast several summits of over 1,000 m above MSL in altitude, with an elevation of 200 m to 300 m above the surrounding land. The much less impressive hills located on the Foxtrot Property extend along the southwest-northeast axis and peak at a maximum altitude of 670 m above mean sea level. The main rocky hills appear one or

two kilometres to the southwest (Mount Lagopede) and to the southeast of the Lagopede exploration camp. The area of the airstrip is flat, with an altitude of around 470 m.

The James Bay territory covers the middle of the Archean Superior Province (approximately 2.5 to 4 billion years old). The Superior Province is the oldest and largest geological province in Quebec. It stretches from the southern margin of Lake Albanel to the Ungava Bay. The Foxtrot Property is on the metasedimentary sub-province of Opinaca, located in the centre of the Superior Province between the sub-provinces of Opatica and La Grande. The Foxtrot Property's bedrock is largely composed of amphibole and feldspar orthogneiss and paragneiss intruded by magnetic diabase dykes (Trudeau *et al.,* 2004). Renard's diamond-bearing kimberlite pipes are composed of volcanic rock that is generally softer than the surrounding country rock (gneiss), which can cause a differential erosion. The kimberlite rocks therefore erode more rapidly and can create depressions allowing for the formation of waterbodies. This may partially explain the presence of certain lakes over the R-65 and R-2 pipes.

- *GLACIAL HERITAGE OF THE LANDSCAPE*

Over the last 2.6 million years (the Quaternary Period), several glaciations have followed one another across Quebec, eroding the bedrock, changing the hydrographical network, and leaving unconsolidated deposits in their wake.

The most recent glacial period, the Wisconsin Glaciation, has left a significant imprint on the current landscape. Little evidence remains of previous glaciations because almost the entire landscape of Quebec was altered by the glacier's passing during the most recent glacial episode. The Laurentide Ice Sheet's[1] glacial melting period began in southern Quebec around 15,000 years cal BP[2] (12,500 years ^{14}C BP, Dyke et al., 2003), while the final phase of the glacial melting period, which took place in the central area of Nord-du-Québec, occurred between 8,000 and 7,000 years cal BP (7,000 and 6,000 years ^{14}C BP, Occhietti *et al.,* 2004).

- *SURFACE DEPOSITS AND GEOMORPHOLOGY*

The elevation and inland location of the central portion of Nord-du-Québec, where the Foxtrot Property is located, have kept it from being submerged under large proglacial (in contact with the glacier) or postglacial (following the retreat of the glacier)[3] seas or lakes. As a result, there are no vast plains of marine or glaciolacustrine deposits, but rather a landscape directly inherited from the melting of the glacier onsite.

---

1 Name of the glacier covering the area of Quebec during the most recent glaciation.

2 "Before Present:" Dates mentioned in this section are in calibrated (cal) carbon-14 years, that is, in real calendar years. The results of isotopic ^{14}C dating do not take into account "irregularities" of ^{14}C disintegration after the death of an organism, resulting in younger ages than calendar years (Richard, 2009). For reference, dates in uncalibrated ^{14}C BP years are provided in parentheses. The maps of Dyke *et. al.,* 2003 were used to establish equivalence between the calibrated and uncalibrated dates.

3 These brief marine or lacustrine episodes took place overall between 13,500 and 5,000 years BP (Dyke *et al.,* 2003).

Seen from above, the landscape is speckled with large glacial forms like drumlins (elongated glacial material that may reach a length of several kilometres), whose ridges are in line with the direction of the glacial flow, southwest in the area of the Foxtrot Property. Till (heterogeneous material ranging from clay to boulders, but predominantly sand) covers almost all surfaces except the rocky hills with exposed rock. The varied thickness of deposits, combined with the bedrock landform, contributes to the development of a vast system of irregularly shaped lakes and ponds and a dense network of small channels and larger rivers such as the Eastmain, the Misask, and the Sakami. To the north and south of the Foxtrot Property there are also very large spans of Rogen moraine (a lodgment till forming successive, discontinuous ridges that are parallel to the glacial front). This type of till greatly influences the local hydrographical network and the distribution of the wetlands that often form in the depressions that separate the well-drained ridges.

The glacial deposits, whose thickness varies from 0 m to 30 m (with an average of 7 m to 10 m) on the Foxtrot Property, have a very heterogeneous, grain size distribution that ranges from clay to metre-sized boulders. On the Foxtrot Property, surface deposits are largely composed of sand or silty sand with a variable proportion of gravel and coarser materials. On average, each of the 13 surface soil samples collected by Roche (2011) were composed of 60% sand, while half of the samples contain at least 67% of sand. Gravel was found in a proportion of 0% to 75% of each sample analyzed, while the average gravel content was 12%.

The soil is punctuated by erratic boulders shed by the retreating glacier and very prevalent on the surface in certain places. Boulders are also piled up very densely in certain low places, such as the area of the proposed airstrip, where there is a “boulder field.” In addition, there are glaciofluvial formations (eskers generally parallel to the glacial flow) composed of sand, silt, and gravel. Several small eskers are found on the Foxtrot property, less than 5 km away from Lake Lagopede. A larger esker is located along the Misask River, less than 2 km from the proposed airstrip. These deposits generally constitute good foundation material for the construction of paved roads or may be used as a source of backfill.

Photo interpretation and field surveys completed by Roche (2011) illustrate that the hydrographical network covers approximately 18% of the 127 km² study area, including the Renard mine area and the airstrip area. Rocky outcrop areas and thin till over rock account for 14%, while areas with thicker till account for about 60% of the territory. Glaciofluvial sediment (outwash and eskers) accounts for approximately 6%. Wetlands make up a little over 2% of the study area.

- *SOIL*

Soil drainage capacity generally varies from good to moderate and is occasionally excessive. There are also rocky outcrop areas and areas with poor drainage, such as topographical depressions often covered by wetlands. On a regional scale, the soil is generally composed of humoferric podzols, and less frequently composed of brunisols (Agriculture and Agrifood Canada 1998). These are typical

podzols in cold and relatively humid climates: coarse to medium-textured soils, acidic and forested (Agriculture and Agrifood Canada 1998). In several locations on the Foxtrot Property and elsewhere in the region, a thick ferruginous hardpan[4] with a cemented texture (called "ortstein") has developed in the soil. Podzols are present in areas with good drainage, therefore excluding peatlands and swamps, where organic soils from 30 cm to over 1 m thick are sometimes found.

From Lake Mistassini (around 50.40°N) to the latitude of Kuujjuarapik (around 55.16°N), there are localized patches of permafrost[5] covering less than 10% of the province's landmass between the 50th and 55th parallel (Natural Resources Canada, 2003). However, with the current rate of climate change, the areas of permafrost are quickly migrating northward (Thibault and Payette, 2009), which suggests that the permafrost patches in the regional area of the Foxtrot Property will become increasingly rare in the future. Furthermore, no permafrost patches have been discovered on the property.

- *HYDROLOGICAL REGIME*

The majority of the Foxtrot Property is located in the upper watershed of the upper Eastmain River. The regional flow pattern runs southwest in the direction of the Eastmain-1 Reservoir. Entirely located in this watershed, the 127 km² study area of the Renard Project is located in the subwatershed of the Misask River (1,510 km²), which is also subdivided into more than twenty secondary subwatersheds that, for the most part, flow into the subwatershed of Lake Lagopede, which is the largest lake in the area (16.1 km²). A short way north of the proposed Renard mine, a small portion of the property is in the watershed of the upper Sakami River, which flows northwest toward the La Grande-3 Reservoir.

The hydrological regime of the study area's streams is pluvio-nival (Schetagne *et al.,* 2005). It is characterized by heavy spring flooding in May and June, a summer low flow period of varying severity, an autumn flooding as a result of rainfall, and a winter low flow period from November to May. During the summer, thermal stratification takes place in the deepest lakes, influencing the physical chemistry of the water at lower depths. Apart from Lake Lagopede, the study area includes several medium sized waterbodies and several small waterbodies connected by small channels. The depth of the water in the streams that run through the Renard Project site varied from 0.1 m to 0.6 m in July 2010 (following a particularly dry period in May and June). The rains that fell in August and September substantially swelled water levels, according to the Roche (2011) surveys, which indicates that water flow can fluctuate significantly in one season.

An aquifer is present in the bedrock and the surface deposits. Groundwater mainly flows toward the various surface water bodies, which suggests groundwater seepage in the lakes, while aquifer recharge from topographical ridges (Roche, 2011).

[4] According to land surveys performed by Roche on the Foxtrot Property in 2010, the orstein is generally 30 cm thick, but employees of camp Lagopede attest that the thickness of this indurated layer may reach 1 m.

[5] Permafrost forms when the soil remains less than or equal to 0°C for a period of at least 2 years (Natural Resources Canada, 2003).

6.2 Climate

6.2.1 Temperature

The Renard Project region has a subarctic climate. Winters are long and cold, and extreme temperatures close to -50°C have been recorded. Summers are short and relatively warm, with extreme temperatures of over 30°C. Table 6.2.1 shows average, low, high, and extreme temperatures at the Nitchequon station, whose values are based on climate normals measured over a period of 25 years[6]. The average annual temperature is -4.2°C. The highest temperatures occur in July, with an average of 17.9°C, while the lowest temperatures occur in January, with an average of -29.4°C. Average temperatures are below 0°C from November to April.

[6] Source: Environment Canada, Canadian Climate Normals or Averages 1961-1990.

Tableau 6.2.1 Temperatures Measured at the Nitchequon Station

Temperature	Daily Average (°C)	Daily High (°C)	Daily Low (°C)	Extreme High (°C)	Date (yyyy-mm-dd)	Extreme Low (°C)	Date (yyyy-mm-dd)
January	-23.5	-17.8	-29.4	3.9	1959-01-17	**-49.4**	**1957-01-15**
February	-21.8	-15.3	-28.4	5.6	1981-02-24	-48.3	1972-02-17+
March	-15.1	-8	-22.3	10.4	1979-03-21	-45	1948-03-05
April	-6.2	-0.3	-12.2	13.9	1984-04-27	-35	1960-04-11
May	1.8	6.7	-3.1	26.1	1950-05-30	-22.8	1972-05-01
June	9.7	14.9	4.6	**32.2**	**1947-06-25**	-6.7	1956-06-08
July	13.6	17.9	9.2	31.1	1953-07-17+	-2.2	1943-07-12
August	12	16	7.9	28.9	1946-08-03	-0.6	1976-08-31
September	6.5	9.9	3	26.1	1948-09-05	-8.3	1942-09-23
October	0	2.9	-3	20	1970-10-10	-17.2	1944-10-29
November	-8	-4.7	-11.6	9.4	1977-11-11+	-35	1972-11-25
December	-19.3	-14.4	-24.3	6.7	1957-12-21	-46.7	1970-12-23+
Year	-4.2	0.6	-9.1	32.2	1947-06-25	-49.4	1957-01-15

+: Signifies that this value has been observed more than once. The date indicated is that of the first observation.

6.2.2 Precipitation

The majority of the study area's precipitation occurs as rainfall. According to data from the Nitchequon station, average rainfall is 518 mm per year. The most abundant rainfall occurs in August at Nitchequon (118 mm). Total precipitation at this station on an annual basis is 827 mm.

Precipitation as snowfall reaches 328 cm on average at Nitchequon. The heaviest snowfall occurs in November (50 cm). According to the recorded data, snow cover can be expected from October to May, and snowfall precipitation is to be expected during all months except July and sometimes August.

Extreme daily rainfall at the Nitchequon station reached 59.7 mm on October 24, 1959. This station also received 50.8 cm of snow in one day on March 25, 1947, which exceeds typical average snowfall for that entire month.

Table 6.2.2 shows the monthly average and extreme precipitation amounts occurring as rain and snow at the Nitchequon station.

The risks of extreme rainfall have been calculated based on precipitation maps in the *Rainfall Frequency Atlas for Canada* (Hogg and Carr., 1985). These maps were established based on data recorded over a period of at least seven years using 445 tipping-bucket rain gauges and 59 digital recording gauges. For extreme rainfall, the method of moments uses extreme precipitation values measured on an annual basis and the standard deviation of measured values to determine the risk of extreme precipitation from coefficients based on the required time period (5 minutes, 10 minutes, 1 hour, etc.).

Table 6.2.3 shows the values determined for the study area. According to the data measured at Nitchequon, the amount of extreme rainfall occurring over one day corresponds to a value of between 25 and 50 years.

Intensity-duration-frequency statistics for the Nitchequon station are presented in Table 6.2.4. The Nitchequon station data are considered to be the most representative of the mine site due to the proximity of the station. It is apparent that the extreme values measured at Nitchequon closely correspond to the extreme rainfall expected in a 50-year period.

Tableau 6.2.2 Precipitation Measured at the Nitchequon Station

Precipitation	Rainfall (mm)	Snowfall (cm)	Total Precipitation (mm)	Extreme Daily Rainfall (mm)	Extreme Daily Snowfall (cm)	Extreme Daily Precipitation (mm)
January	0	41.7	38.5	6.1	19.8	22.9
February	0.6	34.4	30.9	6.2	25.4	25.4
March	3.3	45	44.9	18.5	**50.8**	50.8
April	7.7	34.2	40.8	13	34.2	34
May	39.2	18.5	57.5	45.7	18.3	45.7
June	81.7	5	87.7	37.3	24.9	37.3
July	112.4	0	112.4	58.2	1	58.2
August	**117.7**	1.9	**119.6**	49.4	25.9	49.4
September	97.8	10.2	107.7	34.5	28.2	54.9
October	41.8	41.4	82.1	**59.7**	32.3	**59.7**
November	13.4	**50.3**	60.6	20.3	35.7	36.4
December	2.1	45.6	44.4	29.2	37.8	38.1
Annual	517.6	328.2	827.2	59.7	50.8	59.7

Table 6.2.3 Assessment of the Risk of Extreme Rainfall (mm) at the Mine Site

	Frequency (years)								
Duration	**2**	**5**	**10**	**15**	**20**	**25**	**50**	**100**	**1000**
24 hours	34.3	43.6	49.7	53.2	55.6	57.5	63.2	68.9	87.8
12 hours	28.9	35.0	39.1	41.4	43.1	44.3	48.1	52.0	64.5
6 hours	23.1	28.0	31.2	33.0	34.3	35.2	38.3	41.3	51.1
2 hours	17.1	21.7	24.8	26.5	27.7	28.6	31.5	34.3	43.7
1 hour	12.9	17.3	20.2	21.9	23.0	23.9	26.7	29.4	38.4
30 minutes	10.0	13.7	16.2	17.6	18.5	19.3	21.6	23.9	31.4
15 minutes	7.9	11.0	13.1	14.2	15.0	15.7	17.6	19.5	25.8
10 minutes	7.0	9.9	11.8	12.9	13.7	14.2	16.1	17.9	23.8
5 minutes	5.2	7.9	9.6	10.6	11.3	11.8	13.5	15.1	20.5

Table 6.2.4 Rainfall Intensity-Duration-Frequency Statistics from the Nitchequon Station

Year	**5 min**	**10 min**	**15 min**	**30 min**	**1 h**	**2 h**	**6 h**	**12 h**	**24 h**
1968	5.6	7.6	7.9	7.9	9.9	16.5	30.5	36.1	36.6
1969	5.1	9.1	13.7	15.5	15.5	15.5	34.3	41.1	41.1
1970	3.8	5.6	6.6	8.4	10.9	19.6	22.6	24.1	31.5
1971	2.5	3.6	4.8	7.6	11.7	18.8	20.8	21.1	23.1
1972	7.6	7.9	8.4	9.7	12.2	17.0	25.7	31.0	39.9
1973	6.9	8.9	10.4	11.7	16.8	23.6	27.9	30.0	36.3
1974	2.3	3.3	4.3	5.3	6.3	9.1	23.4	29.5	41.9
1975	6.3	9.7	10.2	10.9	15.5	16.8	28.4	28.4	33.8
1976	2.8	3.8	5.6	8.4	10.2	13.5	19.3	20.3	20.3
1977	6.3	6.3	6.3	9.9	14.0	15.5	18.3	33.3	33.3
1978	**14.5**	**15.6**	**17.8**	**24.8**	**27.3**	**27.3**	27.3	36.3	50.7
1979	3.9	4.8	5.4	7.5	8.1	13.4	158	22.2	26.1
1980	4.6	6.9	7.4	8.2	13.3	19.3	**39.1**	**46.4**	56.2
1981	N/A	N/A	N/A	14.6	22.0	23.6	24.0	30.4	49.4
1982	3.0	5.5	7.1	11.1	15.0	18.8	34.5	41.2	**65.4**
1983	5.8	6.6	8.6	10.5	12.1	18.2	22.0	24.2	43.6
1984	3.5	4.5	5.1	5.7	8.8	14.1	24.2	32.8	32.8
1985	2.2	4.2	6.3	8.1	9.3	12.9	13.8	17.8	24.4
Number of Years	**17**	**17**	**17**	**18**	**18**	**18**	**18**	**18**	**18**
Average	**5.1**	**6.7**	**8.0**	**10.3**	**13.3**	**17.4**	**25.1**	**30.3**	**38.1**
Standard Deviation	**3.0**	**3.0**	**3.5**	**4.5**	**5.1**	**4.4**	**6.7**	**7.9**	**11.9**

6.2.3 Evapotranspiration and Lacustrine Evaporation

Lacustrine evaporation is the evaporation calculated for a small, open waterbody characterized by negligible heat storage and very little heat transfer through the bottom and sides. It refers to water loss in ponds and small reservoirs, but not that of large lakes with significant heat storage capacity. Lacustrine evaporation is calculated using daily water loss observed in an evaporation pan, average temperatures in the pan and the surrounding air, and the wind passage above the pan.

Normals for lake evaporation for the period of 1971 to 2000 were calculated as monthly averages of the daily averages obtained at the Bonnard station, located 244 km from the Foxtrot Property, the only station in the region with available data. These data are presented in Table 6.2.5.

Table 6.2.5 Lacustrine Evaporation at the Bonnard Station (1971-2000) (mm/month)

Station	June (mm)	July (mm)	August (mm)	Annual Total (mm)
Bonnard	96.0	83.7	71.3	251.0

Source: Climate data from the Atmospheric Environment Service of Environment Canada (http://climate.weatheroffice.gc.ca/climate_normals/index_e.html?&).

6.2.4 Wind

An analysis of wind speed and direction was completed for the station closest to the study area with available hourly data (Nitchequon). At Nitchequon, the prevailing winds are from the west (11.70% of the time), but the strongest winds are from the west-northwest, with an average wind speed of 19.4 km/h. Winds from the north to east-southeast are the least intense, with speeds ranging from 12.8 to 14.9 km/h. Table 6.2.6 presents the wind frequency and average wind speed for the Nitchequon station. Figure 6.2.1 indicates wind frequency at Nitchequon and Figure 6.2.2 presents the average wind speed by direction at the same station.

Table 6.2.6 Wind Frequency and Average Speed at the Nitchequon Station (1942-1985)

Direction	Wind Frequency (%)	Average Wind Speed (km/h)
N	5.43 %	14.18
NNE	3.57 %	13.86
NE	3.86 %	12.83
ENE	2.60 %	13.46
E	4.01 %	12.92
ESE	2.94 %	14.91
SE	4.94 %	16.09
SSE	5.97 %	17.32
S	8.76 %	16.65
SSW	6.29 %	17.47
SW	6.59 %	17.20
WSW	5.90 %	18.66
W	11.70 %	19.03
WNW	8.77 %	19.36
NW	7.61 %	17.18
NNW	5,44 %	17.06
Calm	5.61 %	

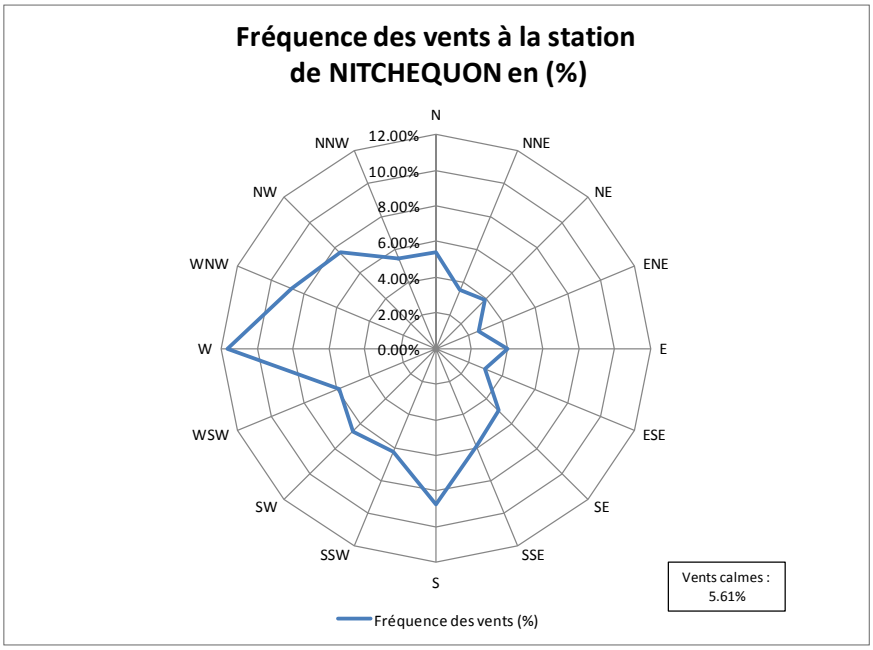


Figure 6.2.1 Wind Frequency at the Nitchequon Station (1959-1985)

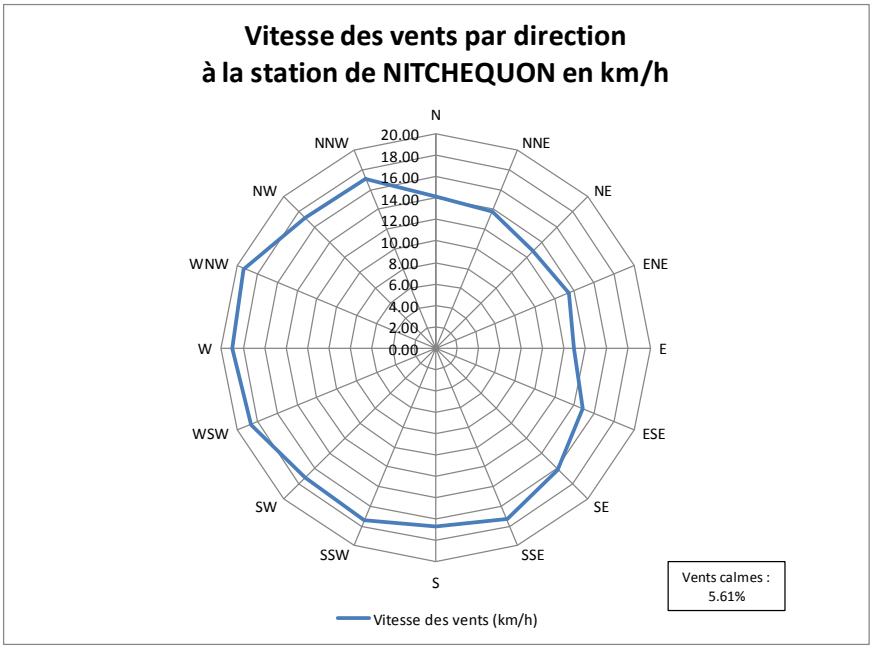


Figure 6.2.2 Average Wind Speed by Direction at the Nitchequon Station (1959-1985)

6.3 Air Quality

6.3.1 Current Conditions

The information in this section is from the Environmental Baseline Study for the Renard Project (Roche, 2011) and is based on data from the National Air Pollution Surveillance Program and the impact assessment of the Matoush Project (Strateco Resources, 2009), which was conducted in the same region as the Renard Project.

Apart from the mining exploration carried out on the site, the Renard Project is located in a relatively pristine area where land use intensity is low and mainly limited to the activities of tallymen and certain other users of trapline M11. In addition, the project is located far from any permanent or temporary dwellings that could be affected by noise or dust. The closest Cree camps are relatively distant from the area of the project, along the shores of the Misask Lake.

As a result, the ambient air quality is mainly affected by forest fires, dust from wind erosion, and the current exploration activities. The objective of this section is to establish, given the available data, a baseline for ambient air quality.

In Quebec, the *Regulation respecting the Quality of the Atmosphere* (RQA) (Q-2, r.38), adopted in 1979, regulates air quality and deals with a limited group of contaminants. In the case of the Renard Project, the regulated contaminants for ambient air are airborne particles, dustfall, carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen dioxide (NO_2). However, health concerns have led the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP) to propose a complete overhaul of

the Regulation. The proposed Clean Air Regulation (CAR) was published in the *Gazette officielle du Québec* in November 2005. While the RQA only regulates a limited number of contaminants by concentration in ambient air, the PCAR adds standards for nearly 100 new contaminants. This proposed Regulation has not yet taken effect.

Additionally, the MDDEP may impose ambient air criteria when deemed necessary for an individual project. A list of 106 contaminants, most of which are included in the proposed CAR, appears in a document entitled *Mise à jour des critères québécois de qualité de l'air*[7] [updated Quebec air quality criteria] (CQA), which was published in March 2010.

Table 6.3.1 presents the current standards and those proposed in the CAR and the CQA updates.

The baseline for air quality in the study area was completed based on sites where comparable mining projects were studied in the same area. A comparison was also made of the monitoring stations of the National Air Pollution Surveillance Program most representative of the project site. In the latter case, it is difficult to obtain sample data for contaminants other than airborne particles. Most of the monitoring stations for sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds are located in areas where these contaminants are likely to be emitted (near industrial parks or traffic lanes), and data collected in these environments cannot be directly compared to that of the Renard Project. Consequently, to obtain an accurate idea of air quality for these contaminants, it is recommended to take measurements on site before construction, even if the sampling duration is shorter than that of the permanent surveillance network.

[7] http://www.mddep.gouv.qc.ca/air/criteres/fiches.pdf (French only)

Table 6.3.1 Ambient Air Quality Standards and Criteria

Contaminant	Time Period	Regulation respecting the Quality of the Atmosphere	Proposed Clean Air Regulation	CQA Updates
Total airborne Particles	24 hours	150 µg/m³	Replaced by $PM_{2.5}$ Standard	Replaced by $PM_{2.5}$ Standard
	1 year	70 µg/m³		
Airborne Particles under 2.5 Microns ($PM_{2.5}$)	24 hours	None	30 µg/m³ (98th percentile value)	30 µg/m³ (98th percentile value)
Nitrogen Dioxide (NO_2)	1 hour	414 µg/m³	414 µg/m³	414 µg/m³
	24 hours	207 µg/m³	207 µg/m³	207 µg/m³
	1 year	103 µg/m³	103 µg/m³	103 µg/m³
Carbon Monoxide (CO)	1 hour	34,000 µg/m³ (30 ppm)	34,000 µg/m³	34,000 µg/m³
	8 hours	15,000 µg/m³ (13 ppm)	12,700 µg/m³	12,700 µg/m³
Sulphur Dioxide (SO_2)	1 hour	1,310 µg/m³ (0.50 ppm)	525 µg/m³	1,050 µg/m³ (May exceed this value 0.5 % of the time on an annual basis)
	24 hours	288 µg/m³ (0.11 ppm)	228 µg/m³	288 µg/m³
	1 year	52 µg/m³ (0.02 ppm)	52 µg/m³	52 µg/m³

Sources: *Regulation respecting the Quality of the Atmosphere* (Q-2, r.38)

Proposed Clean Air Regulation (*Gazette officielle du Québec*, November 16, 2005) (http://www.mddep.gouv.qc.ca/air/atmosphere/reg-assain-air.pdf)

In the area surrounding the project site, an environmental impact assessment was completed for the Matoush Project underground exploration program (Strateco Resources, 2009). The uranium mine project is located approximately 95 km south of the Renard Project site (Figure 6.3.1). An air quality characterization was carried out as part of this impact assessment. Three sampling stations were installed to measure the concentration of airborne particles, metals, nitrogen oxides (NO_x and NO_2) and sulphur dioxide (SO_2). These stations were established at the base camp of the proposed mine site (AIR1), approximately 1.5 km southwest of the base camp (AIR2), and 1.5 km north of the base camp (AIR3), respectively.

6.3.1.1 Airborne Particles

Concentrations of airborne particles were measured on the Matoush Project property (95 km south of the Renard Project) over 12 to 24-hour periods. A total of 35 samples were analyzed at the three stations, that is, 12 at the base camp station (AIR1), 12 at the AIR2 station, and 11 at the AIR3 station. Two samples taken at the AIR1 station and three samples taken at the AIR3 station showed concentrations below the limit of detection of the devices. The highest concentration was 34.7 µg/m³ at the AIR1 station. This result is well below the standard set out in the *Regulation respecting the Quality of the Atmosphere* (Q-2, r.20), which is 150 µg/m³ in 24 hours. The averages of the results obtained

were 13.6 µg/m³ at the AIR1 station, 8.6 µg/m³ at the AIR2 station, and 7.5 µg/m³ at the AIR3 station. Due to the short duration of the sampling campaign (36 days), it is not possible to obtain average annual concentrations in the area. However, the daily average results are well below the current standard of 70 µg/m³, which strongly suggests that the standards are probably met on an annual basis.

6.3.1.2 Particles under 2.5 microns ($PM_{2,5}$)

The sampling campaign conducted at the Matoush Project site did not include characterization of particles under 2.5 microns ($PM_{2,5}$). This contaminant is not currently regulated in Quebec. However, a standard of 30 µg/m³ on a daily basis is included in the proposed Clean Air Regulation, published in the *Gazette officielle du Québec* in November 2005. To estimate the concentration of $PM_{2.5}$ that could be measured at the Renard Project site, results obtained at two sampling stations located in a forest environment were consulted. The Pemonca station (located at La Doré in Lac-Saint-Jean, 450 km from the Renard Project) and Bell station (located at Senneterre, in Abitibi, approximately 600 km from the project) are established in forest zones and most closely resemble the environment in which the Renard Project will be carried out. Only $PM_{2.5}$ and tropospheric ozone concentration are measured at these stations. Their locations relative to the Renard Project site are shown in Figure 6.3.1. Table 6.3.2 presents concentrations of $PM_{2.5}$ measured at the two stations from 2004 to 2006. In 2005, exceptionally high concentrations of $PM_{2.5}$ were observed at the Pemonca station, with a maximum value of 185 µg/m³. Average monthly concentrations in June and July 2005 were 17 µg/m³ and 9 µg/m³ respectively, while for the other months, the highest average monthly concentration was only 4 µg/m³.



Figure 6.3.1 Location of Ambient Air Sampling Stations

These elevated values can be explained by the fact that there were several large forest fires that year. In 2005, 1,258 fires destroyed close to 387,000 hectares of forest, making that the fourth most destructive year for forest fires since data has been recorded. These fires took place in particular north of Lac-Saint-Jean and in northern zones, with maximum observed intensity from May 30 to June 19 and July 10 to August 20. The phenomenon was not noted at the Bell station, since it was only put into operation as from September 2005.

Table 6.3.2 Daily Concentrations of $PM_{2.5}$ Measured at Two Stations Located in Forest Zones

Year	Pemonca – La Doré (Station 053201)		Bell – Senneterre (Station 055101)	
	Maximum (µg/m³)	Annual Average (µg/m³)	Maximum (µg/m³)	Annual Average (µg/m³)
2004	43	4	N/A[1]	N/A
2005	185	5	20	N/A[2]
2006	29	4	32	4

[1] *N/A: Not available (station not in operation in 2004).*

[2] *N/A: Not available (station not in operation for the entire year).*

6.3.1.3 Metals

Analyses of metal content observed in particles were conducted during air sampling at the two stations established for the Matoush Project (Strateco Resources, 2009), located 95 km south of the Renard Project. However, it is likely that the geological structure of the two sites is very different as the Matoush Project concerned uranium mine operation and the Renard Project consists of a diamond mine, so these analyses cannot be used for the Renard Project. An air sampling campaign conducted before the construction of the Renard Project would allow a baseline to be established.

6.3.1.4 Nitrogen Oxides

Measurements of nitrogen oxide (NO_x) concentrations in the atmosphere were carried out for the Matoush Project (Strateco Resources, 2009). These measurements were taken over a relatively short period, that is, from June 11 to July 22, 2009. The results of the measurements showed average values of 0.4 µg/m³ to 4.3 µg/m³ (0.2 ppb[8] to 2.3 ppb), which is well below the annual standard of 103 µg/m³. Ambient levels of nitrogen oxides in the area of the Renard Project should be on the same order of magnitude.

6.3.1.5 Sulphur Dioxide

Measurements of sulphur dioxide (SO_2) concentration were taken at the Matoush Project site (Strateco Resources, 2009) during the same period as the measurements of nitrogen oxides. The results of these measurements show concentrations of 0.26 µg/m³ to 0.78 µg/m³ (0.1 ppb to 0.3 ppb), less than 1.5% of the annual standard of 52 µg/m³. Ambient levels of sulphur dioxide in the area of the Renard Project should be on the same order of magnitude.

6.3.1.6 Conclusion

The atmospheric contaminants likely to be emitted during the eventual operation of the Renard mine are currently recorded at very low concentrations 95 km south of the Renard Project (in the area of the Matoush Project). Observed levels are well below the current and proposed standards for ambient air quality. The only contaminants whose concentrations may approach the standards set out in the

[8] ppb: parts per billion

proposed Clean Air Regulation are airborne particles under 2.5 microns ($PM_{2.5}$), which may be present in ambient air at high concentrations when forest fires occur.

6.3.2 Impacts during the Construction Phase

6.3.2.1 Identification of Main Sources of Impact

The gas contaminant and dustfall concentration calculations that allowed for impact assessment were carried out using air contaminant dispersion modelling. The methodology used for the calculations and a more detailed description is provided in Appendix 6.3.1, which presents the sectoral report on air quality.

The software used as a contaminant dispersion model for the calculations is version 11103 of the AERMOD model. This program was developed by the American Environmental Protection Agency (US EPA). It is a general purpose software allowing for the simulation of four types of air emission sources relevant to the Renard Project, that is, fixed-location sources, mobile sources, area sources, and quarries (for definitions, see Appendix 6.3.1).

During the construction phase, various sources will emit contaminants into the air. Site preparation and development (including the airstrip and terminal) will require the use of machinery that will emit combustible gases and raise airborne particles.

The deforested area will be about 300 ha. Clearing and stump removal activities will mainly generate particle emissions. The proportion of fine particles generated by these activities will be low, and the majority of particulate matter generated by these activities will typically land close to the source of generation. Due to the low height of the exhaust outlets of the machinery to be used, maximum concentrations of combustible gases generated by the machinery will be observed at a distance of less than 100 m from the equipment and will therefore not affect areas located beyond the limits of the mine property. Concentrations of nitrogen oxides and particles generated by the machinery will be below the limits set out in the *Regulation respecting Occupational Health and Safety*. However, the workers involved in these activities should have access to appropriate personal protection equipment as a precautionary measure.

Surface overburden and waste rock excavation and site grading where the facilities will be constructed will also generate dust and exhaust gas. The main source of dust will be the transshipment of removed material and its transportation to storage areas. Due to the nature of these activities, concentrations of dust generated and exhaust gas emitted will be greatest on site and will be dispersed rapidly. Beyond 250 m from the work sites, concentrations will be below the air quality standards specified in the Clean Air Regulation (Q-2, r.4.1).

Drilling required for placing explosive charges and blasting of waste rock layers will mainly generate dust emissions. Due to the remoteness of the areas where these activities will take place and the fact

that the vast majority of the particles released by blasting will be over 100 microns, maximum concentrations of fine particles in the ambient air will be observed within a 250 m radius of the work areas.

Dust and exhaust gases will also be emitted during the construction of the roads and airstrip, quarry operation (R-65), and the transportation of materials between the quarry and the mine infrastructure construction sites. Dust generated by these activities will land within a distance of 150 m from the work area and will not affect areas beyond the mine area.

The last source of air contaminant emissions during construction will be the generator sets that will provide electricity for the various sites where mine infrastructure will be constructed and the camp and services provided for the workers during construction. The main gas contaminant emissions will be nitrogen oxides (NO_x), sulphur dioxide (SO_2), and carbon monoxide (CO). To ensure acceptable air quality for the workers while they are resting, the generators must be as far as possible from the workers' temporary residence.

6.3.2.2 Description and Assessment of Impacts

Air quality will be affected by the construction activities, but the impact of these activities on air quality will be limited to the construction sites and will not affect areas beyond the limits of the land project site. The intensity of the impacts of construction activities on air quality can therefore be qualified as medium because current concentrations of contaminants in the air are well below the standards currently in force. The construction activities will temporarily increase concentrations in the areas where construction will be carried out, but will not have a significant influence outside of the area of the project footprint.

The impact of vehicle emissions and dustfall will be limited to the construction areas and will not extend beyond the edges of the project footprint. Since the construction activities will be carried out within the boundaries of the mine area, the scope of the activities can be qualified as limited. Since the activities carried out during the construction phase will take place over a limited time period (about two years), the duration of the construction activities can be qualified as short term.

The temporary buildings located near the eventual accommodation and services complex will be the closest inhabited areas to the construction site. Simulations involve the period during which the equipment will be located at the highest level of the existing rock. For the overburden stockpile, operation will occur at lower levels.

6.3.2.3 Mitigation Measures

The main sources of ambient air contaminants will be the machinery used for construction activities, which will generate exhaust gases and dustfall while construction is being carried out, and the power generating sets used to produce electricity for the temporary workers' accommodation and for purposes

related to infrastructure and facilities construction and equipment installation. The main mitigation measures that may be applied are the following:

- The use of dust control agents on roads constructed to limit the re-entrainment of particles due to vehicular activity;
- The use of blankets to limit the height of dust emissions generated during surface blasting and confine dust emission to the sites where these operations will take place;
- The placement of generators as far as possible from the temporary workers' accommodation to minimize exhaust gas concentrations in the workers' rest areas.

6.3.2.4 Residual Impacts

During the construction phase, following the implementation of mitigation measures, impact intensity is considered low, with a site specific spatial extent. Considering the short duration of the construction phase, the impact level can be qualified as low.

6.3.3 Impacts during the Operation Phase

6.3.3.1 Identification of Main Sources of Impact

During the operation phase, the main sources of atmospheric contaminant emission will be the power generating sets, that is, 12 diesel 1,800 kW generators, 10 of which, on average, will be in operation for the entire duration of mine operations. Emissions from these sources will include exhaust gas (nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and fine particles). The results of modeling calculations for the generators show that the highest concentrations observed would be those of nitrogen oxides (NO_x). Maximum concentrations to the order of 1,400 µg/m³ will be observed on the plant site. This level is well below 5,600 µg/m³, which is the standard for work areas. However, the maximum concentration observed in the closest inhabited area, the workers' camp, will be below the ambient air standard of 414 µg/m³ set out in the *Clean Air Regulation* 99,9% of the time.

Other sources of air contaminants will be the processed kimberlite confinement area, the open-pit mines (R-2/R-3 and R-65), the ore processing plant, the conveyors transfer points, and road traffic: ore haul trucks, machinery required for operation, and trucks supplying the mine with fuel, food, and other supplies necessary for the operation of the mine.

Emissions from mobile sources (ore and processed kimberlite haul trucks, equipments such as drillers, graders, bulldozers, and mine supply trucks) consist of exhaust gas and dust raised by the passage of vehicles. As will be the case during construction activities, air contaminant emissions will be limited to an area not exceeding 100 m from the emission point. Their impacts will therefore be limited to the mine area.

Surface blasting activities, including drilling, will mainly generate dustfall and nitrogen oxide (NO_x) emissions. These emissions will also be confined to an area not exceeding 250 m from the mining area and will not affect air quality beyond the limits of the mine footprint.

Emissions from ore processing sources, that is, crushers, rock conveyors and breakers, the processing plant, stone crushers and grinders for the underground mine, and ventilation and exhaust of emissions from the underground mine, will mostly consist of fine dust because the emission points of these sources are treated with dust extractors limiting emissions to under 30 mg/m³. The global contribution of all of these sources is 4.7 µg/m³ and the maximum impact point is located near the ore processing plant.

Emissions from the processed kimberlite confinement area will be due to transportation of the kimberlite from the process plant to this site, on-site handling of the kimberlite to organize and compact it, and wind erosion that may occur during dry weather. The impacts of kimberlite transport to the confinement area, refuelling, and handling on site will be limited to a distance of 100 m from emission points.

Modeling calculations of dispersion and deposition of particles from the processed kimberlite confinement area have allowed for the determination of the wind erosion impacts on the adjacent areas. The probability of particle transport from the processed kimberlite confinement area related to wind erosion is limited to the periods of the year during which temperatures are above freezing. The mix of precipitation with the processed kimberlite in autumn and winter will ensure particle cohesion such that wind erosion probability will be minimal. Processed kimberlite consists of 80% relatively large particles (over 1 mm in diameter) and 20% fine particles (under 1 mm in diameter), with a consistency similar to silt. It is the finer portion that may be carried by the wind. Site configuration will in large part ensure the protection of the confinement area from wind erosion during the first years of mine operation. The presence of hills to the east and south of the site will slightly reduce the winds that will pass over the confinement area. When the wind blows from these directions, the risk of particle entrainment will be reduced because a minimum wind speed is required to pull particles from the soil. Winds from the north will push the particles toward the mine area, where the entrained particles will land near the overburden and waste rock stockpiles. Winds from the west, which are the most frequent in the area, will have a tendency to push particles carried by the wind toward the hills located to the east of the area, which will form a natural barrier limiting particle dispersion.

The gradual elevation of the level of the processed kimberlite confinement area will ensure that areas where particles land will change slightly over time, with entrained particles landing a bit further as the altitude of the emission point increases. However, the impact of the confinement area's elevation will only have the effect of moving the maximum landing areas a few metres and therefore widening the area over which particles carried due to wind erosion may land. Stornoway's intention to carry out progressive revegetation of the areas where the kimberlite will be confined will also help limit emissions caused by wind erosion.

Globally, particle deposition from the processed kimberlite confinement area caused by wind erosion will not exceed 2.2 tons/km²/month. This figure is below the standard of 7.5 tons/km²/month, which was in force in the *Regulation respecting the Quality of the Atmosphere* but no longer appears in the *Clean Air Regulation*. The point where deposition is greatest is located within the mine footprint, at a distance of

150 m east of the limits of the processed kimberlite confinement area. Deposition rates decrease rapidly, becoming almost negligible at 300 m from the limits of the confinement area.

6.3.3.2 Description and Assessment of Impacts

The impacts of the Renard mine operation activities on air quality will be limited to the mine area and will be barely noticeable beyond the limits of the mine footprint. Concentrations of nitrogen oxides (NO_x) on the mine site due to use of the generator sets will have the most significant impact of the mine operation activities. Nitrogen oxide concentrations around the generators and the ore processing facilities will be at least one order of magnitude higher than current concentrations. However, the increases will be concentrated within an area where only the workers will be present in order to perform their duties, and they can be provided, if necessary, with appropriate personal protection equipment. Beyond the limits of the mining site, concentrations of nitrogen oxides will be below the air quality standards set out in the *Clean Air Regulation*. However, air quality will decrease slightly as compared with current conditions as a result of mine operation. Map 6.3.1 shows the distribution of maximum NO_2 concentration in the study area on an hourly basis. Concentrations of NO_2 on a daily basis and an annual basis will also be below the standards set out in the *Clean Air Regulation* outside of the mine footprint. These concentrations are illustrated in Map 6.3.2 in the case of concentrations on a daily basis and Map 6.3.3 in the case of concentrations on an annual basis.

Concentrations of carbon monoxide (CO) will be below applicable standards according to the regulation cited above. Map 6.3.4 presents the isocontours of CO concentrations on an hourly basis, and Map 6.3.5 shows concentrations obtained on an eight-hour basis. Annual global greenhouse gas (GHG) emissions anticipated for the project are around 75,000 tons of $CO_{2\,eq}$ per year, 35,000 tons of which will be from generator sets.

Concentration of airborne particles will be increased at the mine site, but should not have a significant impact beyond the operating limits of the mine. Supplying the mine with fuel and supplies and using the airstrip are emission sources that will affect the areas immediately surrounding the airstrip and the road that connects the airstrip and the mine site, but these sources will not significantly affect air quality.

Use of mine pits R-2/R-3 and R-65 during the first years of the mine's operation will have an impact on air quality that will be limited to the footprint of the mine site and will not influence air quality outside of this area. In addition, as mining activities gradually take place further and further below the surface, concentrations in the surrounding areas will gradually decrease. When operations move to the underground mine, their impact on air quality will be reduced because emissions will be directed toward the ventilation ducts of the underground mine, and sources there will be equipped with dust extractors.

Transport of ore to the ore processing plant and processed kimberlite to the confinement area will only generate emissions in a very limited area on the mine site and will not have an influence outside of the affected area. Concentrations of fine particles ($PM_{2.5}$) in the project area will increase as compared to

current levels, but the increase will largely be limited to the mine site. Map 6.3.6 shows the distribution of concentrations of this contaminant on a daily basis.

Particle deposition around the emission sources, particularly around the processed kimberlite confinement area, is illustrated in Map 6.3.7.

Concentrations of sulphur dioxide (SO_2) from diesel combustion by the generator sets and rolling stock (mine trucks, loaders, graders, etc.) will be relatively low at the mine site. Concentration levels on an hourly, daily, and annual basis are shown respectively on Maps 6.3.8, 6.3.9, and 6.3.10.

6.3.3.3 Mitigation Measures

The main mitigation measure that could be applied to improve air quality on the mine site would be to connect a power supply line from Hydro-Québec instead of using generator sets to supply electricity to the mine. This measure would improve air quality for the workers operating in the ore processing area and, as a result, in the worker accommodation and services complex, in addition to reducing the mine's greenhouse gas emissions.

Use of dust control on the mine's roads will limit dus emissions from the passage of ore and processed kimberlite transport vehicles and mine supply vehicles.

For the processed kimberlite confinement area, watering during dry weather of places where kimberlite has been deposited would reduce the probabilities of emission due to wind erosion.

6.3.3.4 Residual Impacts

During the operation phase, following implementation of the mitigation measures, air quality will only be affected on the mine site, such that the intensity of the impacts can be qualified as low, as concentrations observed outside of the mine site will not be significantly affected by mine operation. The spatial extent of the impacts will only involve the mine site and can be qualified as site specific, and the duration of the impacts is considered moderate since, once operation is completed, air quality will return to current levels. Residual impact significance can therefore be considered low.

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

Complexe d'habitation et de services /
Accommodation complex

R-65

1210

2060

5210

3210

3110

5310

Lac Lagopède

Concentrations en µg/m³ / Concentrations in µg/m³

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 414
- 414 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1250
- 1250 - 3733
- 3733 et plus / over 3733

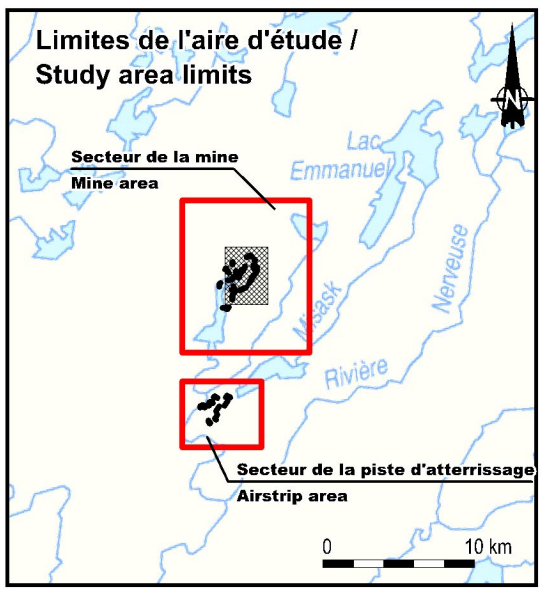
Critère de qualité de l'air ambiant applicable en milieu de travail (Règlement c.5-2.1, r. 13) : 5 600 µg/m³ par quart de 8 heures
3 733 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas (Regulation c.5-2.1, r.13) : 5 600 µg/m³ per 8 hours shift
3 733 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude / Study area limits



- Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)
- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
- Écoulement souterrain / Underground flow
- Source d'émission atmosphérique fixe principale / Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 414 µg/m³*

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Concentrations horaires de NO_2 les plus élevées obtenues par calcul de modélisation / Highest NO_2 concentrations computed by dispersion modeling on an hourly basis

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_NO² horaire_111223.WOR

Décembre 2011 / December 2011

Carte / Map 6.3.1

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

Complexe d'habitation et de services /
Accommodation complex

R-65

1210

2060

5210

3210

3110

5310

Lac Lagopède

50

100

150

207

250

Concentrations en µg/m³ /
Concentrations in µg/m³

0 - 50	
50 - 100	
100 - 150	
150 - 207	
207 - 250	
250 - 300	
300 - 500	
500 - 3733	
3733 et plus / over 3733	

Critère de qualité de l'air ambiant applicable en milieu de travail
(Règlement c.5-2.1, r. 13) : 5 600 µg/m³ par quart de 8 heures
3 733 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas
(Regulation c.5-2.1, r.13) : 5 600 µg/m³ per 8 hours shift
3 733 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

**Limites de l'aire d'étude /
Study area limits**

Secteur de la mine
Mine area

Secteur de la piste d'atterrissage
Airstrip area

Lac Emmanuel

Rivière Nerveuse

0 10 km

Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale /
Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) /
Applicable air quality standard (Regulation Q-2, r. 4.1) : 207 µg/m³*

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Concentrations quotidiennes de NO_2 les plus élevées obtenues par calcul de modélisation / Highest NO_2 concentrations computed by dispersion modeling on an daily basis

ROCHE

*Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_NO² quotidien_111223.WOR*

Décembre 2011 / December 2011

Carte / Map 6.3.2

688 000 mE

690 000 mE

5 856 000 mN

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

R-65

1210

2060

5210

3210

3110

5310

Complexe d'habitation et de services /
Accommodation complex

Lac Lagopède

20
25
30
40
75
79,5
15
10
5
3

Concentrations en µg/m³ /
Concentrations in µg/m³

- 0 - 0,5
- 0,5 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 40
- 40 - 50
- 50 - 75
- 75 - 103
- 103 - 3733
- 3733 et plus / over 3733

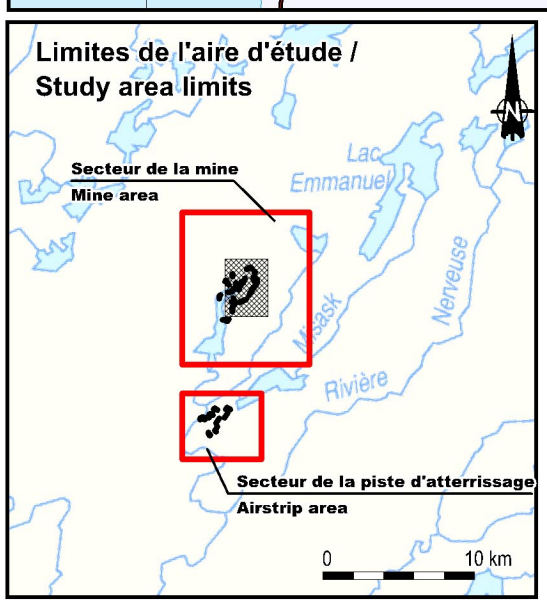
Critère de qualité de l'air ambiant applicable en milieu de travail
(Règlement c.5-2.1, r. 13) : 5 600 µg/m³ par quart de 8 heures
3 733 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas
(Regulation c.5-2.1, r.13) : 5 600 µg/m³ per 8 hours shift
3 733 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude /
Study area limits



Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale /
Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 103 µg/m³*

les diamants stornoway (canada) inc.

Projet diamantifère Renard /
Renard diamond mine project

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Concentrations annuelles de NO_2 les plus élevées obtenues par calcul de modélisation / Highest NO_2 concentrations computed by dispersion modeling on an annual basis

ROCHE

Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_NO² annuel_111223.WOR

Décembre 2011 / December 2011

Carte / Map 6.3.3

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

R-65

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

1210

2060

5210

3210

3110

5310

Complexe d'habitation et de services /
Accommodation complex

Lac Lagopède

**Concentrations en µg/m³ /
Concentrations in µg/m³**

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 600
- 600 - 26 667
- 26 667 - 34 000
- 34 000 et plus / over 34 000

Critère de qualité de l'air ambiant applicable en milieu de travail
(Règlement c.5-2.1, r. 13) : 40 000 µg/m³ par quart de 8 heures
26 667 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas
(Regulation c.5-2.1, r.13) : 40 000 µg/m³ per 8 hours shift
26 667 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

**Limites de l'aire d'étude /
Study area limits**

Secteur de la mine
Mine area

Secteur de la piste d'atterrissage
Airstrip area

Lac Emmanuel

Rivière Nerveuse

0 10 km

Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale /
Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) /
Applicable air quality standard (Regulation Q-2, r. 4.1) : 34 000 µg/m³*

les diamants stornoway (canada) inc.

**Projet diamantifère Renard /
Renard diamond mine project**

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Concentrations horaires de CO les plus élevées obtenues par calculs de modélisation / Highest CO concentrations computed by dispersion modeling on an hourly basis

ROCHE

*Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_CO horaire_111223.WOR*

Décembre 2011 / December 2011

**Carte / Map
6.3.4**

688 000 mE

690 000 mE

5 856 000 mN

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

R-65

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

1210

2060

5210

3210

3110

5310

Complexe d'habitation et de services /
Accommodation complex

Lac Lagopède

Concentrations en µg/m³ /
Concentrations in µg/m³

- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 145
- 150 - 12 700
- 12 700 - 26 667
- 26 667 et plus / over 26 667

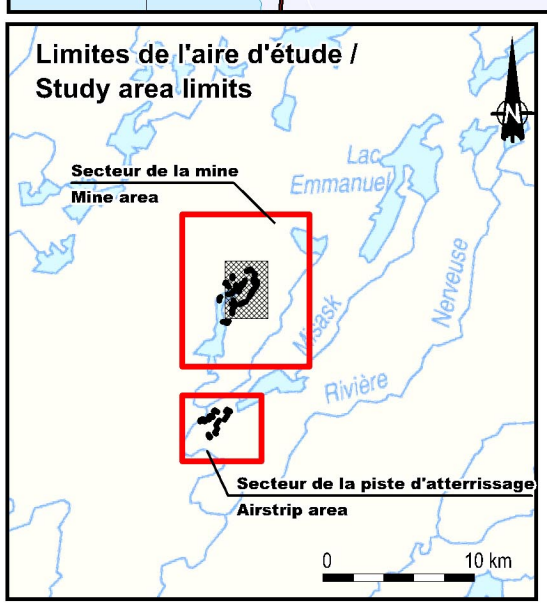
Critère de qualité de l'air ambiant applicable en milieu de travail
(Règlement c.5-2.1, r. 13) : 40 000 µg/m³ par quart de 8 heures
26 667 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas
(Regulation c.5-2.1, r.13) : 40 000 µg/m³ per 8 hours shift
26 667 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

**Limites de l'aire d'étude /
Study area limits**



Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale /
Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 12 700 µg/m³*

les diamants stornoway (canada) inc.

**Projet diamantifère Renard /
Renard diamond mine project**

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Concentrations sur 8 heures de CO les plus élevées obtenues par calculs de modélisation / Highest CO concentrations computed by dispersion modeling on a 8-hours basis

ROCHE

*Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_CO 8 heures_111223.WOR*

Décembre 2011 / December 2011

Carte / Map 6.3.5

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée / Processed kimberlite confinement area

Halde de stériles / Waste rock stockpile

Halde de mort-terrain / Overburden stockpile

Complexe d'habitation et de services / Accommodation complex

R-65

1210

2060

5210

3210

3110

5310

Lac Lagopède

Concentrations en µg/m³ / Concentrations in µg/m³

- 0 - 0,5
- 0,5 - 1,0
- 1,0 - 1,5
- 1,5 - 2,0
- 2,0 - 2,5
- 2,5 - 3
- 3 - 5
- 5 - 10
- 10 - 30
- 30 et plus / over 30

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude / Study area limits

Secteur de la mine / Mine area

Secteur de la piste d'atterrissage / Airstrip area

Lac Emmanuel

Rivière Nerveuse

0 10 km

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale / Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 30 µg/m³*

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Concentrations quotidiennes de $PM_{2.5}$ les plus élevées obtenues par calculs de modélisation / Highest $PM_{2.5}$ concentrations computed by dispersion modeling on a daily basis

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_PM25 quotidien_111223.WOR

Décembre 2011 / December 2011

Carte / Map 6.3.6

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

Complexe d'habitation et de services /
Accommodation complex

R-65

1210

2060

5210

3210

3110

5310

Lac Lagopède

2,5 2 1 0,5 0,4 0,2 0,3 0,2 0,1 0,5 0,1 0,5 0,1 0,5 0,2

**Concentrations en g/m²/mois /
Concentrations in g/m²/month**

- 0 - 0,1
- 0,1 - 0,2
- 0,2 - 0,3
- 0,3 - 0,4
- 0,4 - 0,5
- 0,5 - 1,0
- 1,0 - 1,5
- 1,5 - 2,0
- 2,0 - 7,5
- 7,5 et plus / over 7,5

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

**Limites de l'aire d'étude /
Study area limits**

Secteur de la mine
Mine area

Secteur de la piste d'atterrissage
Airstrip area

Lac Emmanuel
Nerveuse
Rivière
0 10 km

- Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)
- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
- Écoulement souterrain / Underground flow
- Source d'émission atmosphérique fixe principale / Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r.38)*
Applicable air quality standard (Regulation Q-2, r.38) : 7,5 g/m² / mois
7,5 g/m² / month

les diamants stornoway (canada) inc.

**Projet diamantifère Renard /
Renard diamond mine project**

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Taux de déposition de particules les plus élevés obtenues par calculs de modélisation / Highest deposition rates of particules computed by dispersion modeling on a monthly basis

ROCHE

Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_particules mensuelles_111223.WOR

Décembre 2011 / December 2011

Carte / Map 6.3.7

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

R-65

Halde de stériles /
Waste rock stockpile

1210

Halde de mort-terrain /
Overburden stockpile

2060

5210

3210

3110

5310

Complexe d'habitation et de services /
Accommodation complex

Lac Lagopède

**Concentrations en µg/m³ /
Concentrations in µg/m³**

- 0 - 0,5
- 0,5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 1050
- 1050 - 3467
- 3467 et plus / over 3467

Critère de qualité de l'air ambiant applicable en milieu de travail
(Règlement c.5-2.1, r. 13) : 5 200 µg/m³ par quart de 8 heures
3 467 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas
(Regulation c.5-2.1, r.13) : 5 200 µg/m³ per 8 hours shift
3 467 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

**Limites de l'aire d'étude /
Study area limits**

Secteur de la mine
Mine area

Secteur de la piste d'atterrissage
Airstrip area

Lac Emmanuel

Rivière Nerveuse

0 10 km

Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale /
Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 1050 µg/m³*

les diamants stornoway (canada) inc.

**Projet diamantifère Renard /
Renard diamond mine project**

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Concentrations horaires de SO_2 les plus élevées obtenues par calcul de modélisation / Highest SO_2 concentrations computed by dispersion modeling on an hourly basis

ROCHE

*Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_SO² horaire_111223.WOR*

Décembre 2011 / December 2011

Carte / Map 6.3.8

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée / Processed kimberlite confinement area

R-65

Halde de stériles / Waste rock stockpile

Halde de mort-terrain / Overburden stockpile

1210

2060

5210

3210

3110

5310

Complexe d'habitation et de services / Accommodation complex

Lac Lagopède

Concentrations en µg/m³ / Concentrations in µg/m³

- 0,1 - 0,3
- 0,3 - 0,5
- 0,5 - 1,0
- 1,0 - 2,0
- 2,0 - 3,0
- 3,0 - 5,0
- 5,0 - 10,0
- 10,0 - 288
- 288 - 3467
- 3467 et plus / over 3467

Critère de qualité de l'air ambiant applicable en milieu de travail (Règlement c.5-2.1, r. 13) : 5 200 µg/m³ par quart de 8 heures
3 467 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas (Regulation c.5-2.1, r.13) : 5 200 µg/m³ per 8 hours shift
3 467 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude / Study area limits

Secteur de la mine / Mine area

Secteur de la piste d'atterrissage / Airstrip area

Lac Emmanuel

Rivière Nerveuse

0 10 km

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale / Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 288 µg/m³*

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Concentrations quotidiennes de SO_2 les plus élevées obtenues par calculs de modélisation / Highest SO_2 concentrations computed by dispersion modeling on a daily basis

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_SO² quotidien_111223.WOR

Décembre 2011 / December 2011

Carte / Map 6.3.9

688 000 mE

690 000 mE

5 856 000 mN

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

R-65

Halde de stériles /
Waste rock stockpile

Halde de mort-terrain /
Overburden stockpile

1210

2060

5210

3210

3110

5310

Complexe d'habitation et de services /
Accommodation complex

Lac Lagopède

0,3

0,2

0,4

0,5

0,1

0,04

0,03

Concentrations en µg/m³ /
Concentrations in µg/m³

0 - 0,01
0,01 - 0,02
0,02 - 0,03
0,03 - 0,05
0,05 - 0,10
0,10 - 0,20
0,20 - 0,30
0,30 - 0,40
0,40 - 0,50
0,50 - 1,0
1,0 - 52
52 - 3467
3467 et plus / over 3467

Critère de qualité de l'air ambiant applicable en milieu de travail
(Règlement c.5-2.1, r. 13) : 5 200 µg/m³ par quart de 8 heures
3 467 µg/m³ par quart de 12 heures /
Applicable air quality standard for work areas
(Regulation c.5-2.1, r.13) : 5 200 µg/m³ per 8 hours shift
3 467 µg/m³ per 12 hours shift *

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude /
Study area limits

Secteur de la mine
Mine area

Secteur de la piste d'atterrissage
Airstrip area

Lac Emmanuel

Rivière Nerveuse aux Basques

0 10 km

Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Source d'émission atmosphérique fixe principale /
Main atmospheric emission source

* *Critère de qualité de l'air ambiant applicable (Règlement Q-2, r. 4.1) / Applicable air quality standard (Regulation Q-2, r. 4.1) : 52 µg/m³*

les diamants stornoway (canada) inc.

**Projet diamantifère Renard /
Renard diamond mine project**

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment

Concentrations annuelles de SO_2 les plus élevées obtenues par calcul de modélisation / Highest SO_2 concentrations computed by dispersion modeling on an annual basis

ROCHE

*Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_SO² annuel_111223.WOR*

Décembre 2011 / December 2011

Carte / Map 6.3.10

6.3.4 Impacts during the Closure Phase

6.3.4.1 Identification of Sources of Impact

During the closure phase, the main sources of impact will be road traffic and the use and maintenance of machinery. Considering the reduced fleet of vehicles necessary to carry out dismantling of facilities and site restoration, impacts will be less important than those experienced during operation.

During the closure phase, the main sources of air contaminants will be the following:

- Use of trucks (40 t) that will transport overburden and waste rock in the processed kimberlite confinement area (PKC) for hydroseeding preparation;
- Dismantling activities (power shovels, percussion drill for concrete surfaces, trucks, etc.);
- Road and airstrip scarification activities (graders);
- Digging of ditches to restore the hydrographical network (excavator, trucks).

Concentrations of contaminants emitted by this machinery, as well as dust raised by the passage of machinery, will be limited to an area not exceeding 100 m of the emission point.

Generators will also be used to supply the facilities and the camp for the workers carrying out the dismantling of mine equipment.

6.3.4.2 Description and Assessment of Impacts

Equipment dedicated to the rehabilitation of the site will be mainly located on the surface of the mining area, in the processed kimberlite confinement area, and in the overburden stockpile.

Concentrations of dust and exhaust gas during these activities will be lower than during the operation phase and will respect applicable work environment standards.

6.3.4.3 Mitigation Measures

Unless acts and regulations governing air quality undergo major changes before mine closure, no additional mitigation measures will be required. If necessary, measures will be put in place to meet applicable concentration levels under the acts and regulations that will be in force at the time of the final dismantling of the facilities.

6.3.4.4 Residual Impacts

The intensity of the facilities dismantling activities will be lower than that of mine operation, such that air quality should improve relative to the period of the mine's operation. As dismantling activities will concern only the mine facilities and the airstrip, the extent of these activities will be site specific, and the duration will be short. As a result of these factors, the residual impacts of closure activities will be low.

6.4 Sound Levels

6.4.1 Current Conditions

No measurements of current sound levels (residual noise) have been carried out in the Renard Project study area due to the relative isolation of the site and the absence of significant sources of noise that could influence ambient sound levels. The project is located in a territory with no residential or sensitive areas, as described in the Guideline 98-01 from the MDDEP. There is, however, the tallymen's camp for trapline M11, which is located 1.5 km from the northeast end of the airstrip. Following the start of operations, only the area containing the mine's accommodation and services complex will be subjected for noise disturbance. For the moment, the background noise levels in these areas are likely between 25 dBA and 35 dBA based on measurements taken at comparable sites over the past 40 years. These are the noise levels generally measured in a natural environment. They result mainly from wind moving branches and high grass.

The only notable sources of noise are from wind, airplanes, and the wildlife that use the study area, as well as the trapping and exploration activities carried out on the site. Occasionally, while the tallymen are using the site, the sound of a snowmobile (winter) or small craft may be heard. However, these sources of noise are limited and produced at random intervals. They cannot be considered permanent sources of noise affecting the area's equivalent noise levels (L_{Aeq}).

6.4.2 Impacts during the Construction Phase

6.4.2.1 Analysis Methodology for Sound Level Impacts

The calculation method used for simulations relating to point sources is in accordance with the procedure described in the ISO-9613 standard. To obtain a representative idea of the noise levels resulting from construction, the method includes the calculation of attenuation due to distance and ground and screen effects.

With this calculation method, distance attenuation is calculated for a hemispheric propagation according to the following relation:

$$A_{dist} = 20 \times \log\left(\frac{d_1}{d_2}\right)$$

Where d_2 is the distance between the source and the evaluation point considered and d_1 is the distance between the source and the measurement point in a coherent unit.

For the calculation of screen effects, the Meakawa theory, brought into general use by Kurze, is used according to the following relation:

$$A_{écran} = -10 \times \log\left(\frac{40\Delta}{\lambda}\right)$$

In this relation, Δ is the difference of the acoustic path between the direct route of the wave and the passage over the screen, and λ is the wave length considered as a coherent unit.

Screens considered for the calculations include buildings present between the sources and receptors and all of the natural and constructed difference in ground levels. In addition to screen effects, the modeling also takes into account the effects of soil type (porous, hard, mixed), the effects of atmospheric conditions, and distance. Levels are also calculated for each source at different locations and compiled to obtain the global level. The tables of Appendix 6.4.1 provide the attenuations considered and the resulting noise levels in the sensitive zone.

6.4.2.2 Identification of Main Sources of Impact

Sources of noise will vary according to the development phases of the project. During the construction phase, the main sources of noise will be related to mobile equipment on the site. Mobile equipment refers to drillers, graders, loaders, etc. This equipment will collectively generate sound levels at source in the order of 95 dBA at 15 m.

For simulations, noise levels at source, produced by exterior equipment, have been established based on values measured for identical equipment. A list of equipment is presented in Table 3.6.8. According to the information obtained, the equipment will be operated 24 hours a day, 7 days a week.

6.4.2.3 Description and Assessment of Impacts

The temporary buildings located near the future accommodation and services complex area will be the closest inhabited areas to the construction site. The simulations involve the period during which the equipment will be located at the highest level of the existing rock. For the overburden stockpile, operation will occur at lower levels.

According to the simulations, noise levels during the construction phase will be $L_{Aeq,1h}$ 50 dBA to 60 dBA in the area of the temporary accommodations located to the south of the mine site. These levels correspond to values measured on residential streets.[9]

In the areas beyond the project's footprint, noise levels of the order of 60 dBA should be expected during construction according to the location considered. At a distance of ± 6 km from the site, noise levels will be at the area background levels. However, depending on location, the topography of the site may lower the extent of this potential impact zone.

As an example, a noise level of 60 dBA corresponds to a level equivalent to a conversation between two people at a distance of 1 m apart.

[9] *Le bruit et ses effets sur la santé*, Ministère de la Santé, Édition ADHEB, Rennes, 1990.

6.4.2.4 Regulatory Framework

The Ministère du Développement durable de l'Environnement et des Parcs uses Guideline 98-01, created in February 1998 and revised in June 2006, for handling complaints and requirements for enterprises whose operation generates noise and who perform activities that are not regulated for this contaminant. This guideline advocates two prescriptive approaches. The first is based on the maximum level permitted based on zoning category (Table 6.4.1).

Table 6.4.1 Noise Levels Permitted based on Zoning Category

Zoning Category	Night-time (7:00 p.m. to 7:00 a.m.)	Daytime (7:00 a.m. to 7:00 p.m.)
I	40	45
II	45	50
III	50	55
IV	70	70

Note: All levels are $L_{Aeq,1h}$ in dBA.

Definitions of zoning categories are as follows:

- Zone I—Area set aside for detached or semi-detached single-family homes, schools, hospitals, or other establishment for educational, health, or convalescence services. Land with an existing dwelling in an agricultural zone;
- Zone II—Area set aside for multiple-unit housing, mobile housing parks, institutions or campgrounds;
- Zone III—Area set aside for commercial use or recreational parks. However, night-time noise levels only apply within the boundaries of establishments used for residential purposes. In all other cases, the maximum daytime noise level also applies at night;
- Zone IV—Area zoned for industrial or agricultural purposes. However, for an existing dwelling in an industrial zone and established in accordance with municipal regulations in force at the time of construction, the criteria are 50 dBA at night and 55 dBA during the day.

It is important to specify that the zoning category is established based on use permitted by municipal zoning. When an area or part of an area is not zoned as planned, within a municipality, usage determines the zoning category.

The second prescriptive approach is based on ambient noise $L_{Aeq,1h}$ at the affected assessment point. This approach applies if the area's ambient noise level $L_{Aeq,1h}$ is higher than in the zoning-based approach. In that case, the source of noise in question may produce a level of noise that is equal to or lower than the ambient noise level $L_{Aeq,1h}$ existing in the environment.

Concerning the sound limits above, no identified zone covers the type of area where the project site is located. Although the areas are not identified as such, admissible sound level limits could approach those of dwellings in an agricultural environment, that is, $L_{Aeq,1h}$ 45 dBA during the day and 40 dBA at night. However, since the noise level is related to the project and the impacts could be experienced in an area related to the project (accommodation and services complex), the admissible sound levels

would also be those applicable to housing in industrial environments, that is, $L_{Aeq,1h}$ of 55 dBA during the day and 50 dBA at night.

The background noise of the project's environment is generally very low. As a result, the ideal standard in the accomodation and services area would be that of category I, that is, 45 dBA during the day and 40 dBA at night.

6.4.2.5 Mitigation Measures

Considering the above results, it is possible to consider that sound levels near the accommodation and services areas will exceed the ideal night-time value of 40 dBA by about 5 dBA to 10 dBA. Various noise mitigation measures will be used to mitigate sound levels at source, and noise measurements will be taken at the site of the accommodation and services complex to ensure that measured levels do not pose problems. If residual noise levels disturb the workers at the accommodation and services complex, the installation of an acoustic barrier of about five metres will be considered.

6.4.2.6 Residual Impacts

During the construction phase, sound levels will be below 40 dBA at all times. The intensity of this impact is therefore considered low, with a limited spatial extent. Considering the short duration of the construction phase, the significance of the impacts can be qualified as low.

6.4.3 Impacts during the Operation Phase

6.4.3.1 Identification of Main Sources of Impact

During the open pit mine operating phase, noise will be produced by various external sources related to the project, including mobile sources (trucks, loaders, etc.) and fixed sources (plant, fixed exterior equipment, etc.). Although there will be elevated peak sound levels due to blasting noise, blasting will have little effect on equivalent sound levels ($L_{Aeq,1h}$) because of the very short duration of the events. The most significant sound levels will occur at the beginning of the open pit mine operation phase (the first two years) while equipment will be located on the surface of the mining area. As mining operations progress, noise levels will decrease due to screen effects resulting from the sides of the open pits.

During operation of the underground mine, noise will be produced by surface facilities, mine ventilation systems, transportation of light agglomerated ore extracted from pit R-65, etc. Sound levels will be lower than during the construction phase. Map 6.4.1 presents the main fixed sources of noise related to the operation phase.

6.4.3.2 Description and Assessment of Impacts

At the start of mine operation, equipment will be at the highest position on the rock. Sound levels in the accommodation and service areas will be at a maximum. Noise will mainly occur as a result of drilling and agglomerate handling and transportation. The main sources of noise will be concentrated around the open pits, at the primary crusher's discharge point, at the various stockpiles (waste rock, overburden, ore), and in the processed kimberlite confinement (PKC) area. The resulting noise levels in the accommodation and services complex area will reach 49 dBA and will mainly be due to agglomerate transportation.

Despite the acoustic isolation of the ore processing plant, some of the noise may be emitted through the walls of the plant building. However, since these emissions will be over 10 dBA lower than other exterior sources, they will not affect the global sound level. This source will, however, represent background noise in the accommodation and services area on the order of 25 dBA.

During the underground operation of the mine, noise will largely be due to the transportation of agglomerates on site. During this phase of operation, the stockpiles (waste rock, overburden, and ore) and the processed kimberlite confinement area will be the sources producing the highest levels of noise. Sound levels in the accommodation and services area will reach levels approaching 45 dBA.

6.4.3.3 Mitigation Measures

Concerning the above results, it is possible to consider that sound levels near the accommodation and services area will exceed the ideal night-time value of 40 dBA by 5 dBA to 10 dBA. To reduce expected sound levels, the construction of an acoustic barrier of about five metres in height would be possible.

6.4.3.4 Residual Impacts

During the operation phase, impact intensity can be qualified as low. The spatial extent of the impacts is site specific and the duration is moderate. The significance of residual impacts can be considered low.

688 000 mE

690 000 mE

5 856 000 mN

Aire de confinement de la kimberlite usinée /
Processed kimberlite confinement area

Dynamitage / Blasting (R-65)

Halde de stériles /
Waste rock stockpile

Système de ventilation de la mine /
Mine ventilation system (2060)

Dynamitage / Blasting (1210)

Système d'air compressé /
Compressed air system (5610)

Dynamitage / Blasting (1210)

Génératrices /
Gen sets (5210)

Halde de mort-terrain /
Overburden stockpile

Convoyeurs et concasseurs de l'usine
de traitement du minerai /
Conveyor and crusher at mineral
processing plant (3110)

Briseurs de roche en surface /
Rock breaker (3210)

Système de ventilation de l'usine
de traitement du minerai /
Mineral processing plant
ventilation system (3110)

Complexe d'habitation et de services /
Accommodation complex

Lac Lagopède

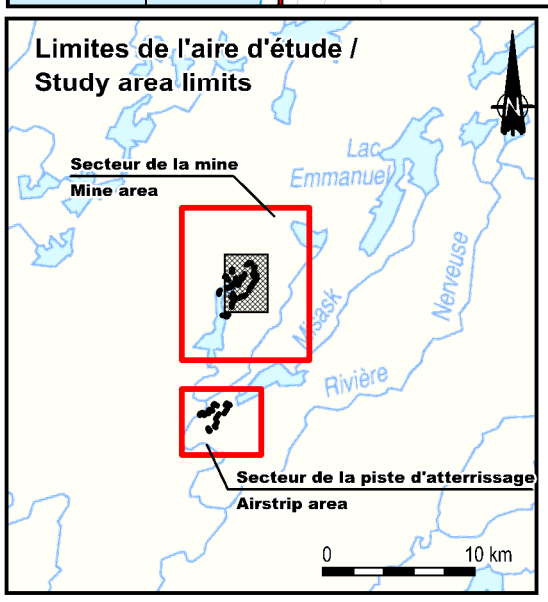
Suppresseurs de la station de traitement des eaux usées /
Suppressors at domestic watewater plant (5831)

0 250 500 m

Échelle / Scale 1 : 12 500

UTM, zone 18 (NAD83)

Limites de l'aire d'étude / Study area limits



Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Sources fixe de bruit / Main fixed noise sorces

Note : Le transport du minerai et des résidus miniers entre les aires d'extraction et de stockage constitue une source de bruit mobile répandu sur le site minier / Kimberlite, waste rock and overburden transport is a mobile source of noise throughout the mine site

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Principales sources fixes de bruit liées à la phase d'exploitation / Main fixed noise sources during the exploitation phase

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_Bruit_111222.WOR

Décembre 2011 / December 2011

Carte / Map 6.4.1

6.4.4 Impacts during the Closure Phase

During the closure phase, the main sources of impact will be the road traffic and the use and maintenance of machinery. Considering the reduced fleet of vehicles necessary to carry out dismantling of facilities and site restoration, the impacts will be less important than those occurring during operation.

During the closure phase, the main sources of noise will be the following:

- Use of trucks (40t) that will transport overburden and waste rock in the processed kimberlite confinement area (PKC) for hydroseeding preparation;
- Dismantling activities (power shovels, percussion drills for concrete surfaces, trucks, etc.);
- Road and airstrip scarification activities (graders);
- Digging of ditches to restore the hydrographical network (excavator, trucks).

Noise levels caused by this machinery will be lower than those occurring during the operation phase and should be on the order of 90 dBA at 15 m from the equipment.

6.4.4.1 Description and Assessment of Impacts

Equipment dedicated to the rehabilitation of the site will mainly be located on the surface of the mining area, in the processed kimberlite confinement area, and in the overburden stockpile.

According to the simulations carried out, sound levels during the site's closure phase will be $L_{eq,1h}$ 54.5 dBA in the area of the accommodation and services complex located to the south of the mine site. However, as a result of the implementation of the required mitigation measures during the operation phase, sound levels will be limited to 45 dBA.

6.4.4.2 Mitigation Measures

No additional mitigation measures will be required for the site's closure phase. Those already implemented during the operation phase will ensure acceptable sound levels at the accommodation and services complex until its final dismantling.

6.4.4.3 Residual Impacts

Sound levels will be 45 dBA in the accommodation and services complex until its final dismantling. The residual impact is therefore considered low (low intensity, site specific, and short duration).

6.5 Soil

6.5.1 Current Conditions

Soil characteristics, in particular the surface deposits on the site of the future Renard Project facilities, were considered in the present study. Surface and underground mineral excavation can have an impact on soil, and certain activities on the surface of the mine sites such as storage of waste rock and processed kimberlite, fuel depots, the ore processing plant, etc. can be potential sources of soil contamination, which makes it important to characterize soil quality prior to mining operations.

A complementary study program was therefore undertaken to meet the ESIA requirements for available information on current soil conditions and to bridge data gaps in order to assess soil quality baseline conditions in the project area. This program takes into account the design of the facilities planned for the site and information already available.

➢ *AVAILABLE DATA SOURCES*

The soil characteristics at the Renard Project site were examined several times as part of previous studies. These studies had different objectives for the needs of the project, as in the following examples:

- Preliminary study of surface soil quality for the Environmental Baseline Study (EBS) (Roche, 2003);
- Environmental characterization study conducted to evaluate surface soil quality at the location of proposed facilities (Stantec, 2010a);
- Detailed study on the types of surface deposits and further information on soil quality collected as part of the Environmental Baseline Study (EBS) (Roche, 2011a);
- Geochemistry study and various leaching tests undertaken on kimberlite, country rock, and surface deposit samples (Golder, 2011b, c).

The results of these studies have allowed the descriptions of the types of formations present in the project area, determination of the natural background levels of those formations, and identification of the issues and impacts that could be associated with them.

6.5.1.1 Geological Context

The various geological formations observed in the region of the project have been examined in several studies, mostly for mineral exploration purposes. Lithological and stratigraphic data were collected from Stornoway's exploratory drilling database, other previous studies, and government maps and reports.

The description of the regional geological context was introduced in Section 3.3 of this study. In summary, the project area lies predominantly in an area of Archean bedrock covered with surface deposits of glacial origin. These various formations present highly variable geological characteristics.

➢ *ROCK FORMATIONS*

The bedrock in the Renard Project region is associated with two geological provinces belonging to the Canadian Shield, that is, the Superior Province dating from the Archean era (4 to 2.5 Ga) and the Grenville Province Front dating from the Proterozoic period (1.2 Ga to 0.950 Ga). The Otish and Mistassini basins from the Paleoproterozoic era (2.5 Ga to 1.6 Ga) lie in discordance on the Superior Province bedrock (Crevier, 1981). The project site is entirely in the Superior Province. Map 6.5.1 presents the regional geological context.

The geological Superior Province is made of igneous and metamorphic rock. It mainly contains volcaniclastic rock with a shaly facies, quartzofeldspathic gneisses, granite, and mafic (rich in iron and magnesium) and ultramafic rocks (including kimberlite). These rocks are intersected by metavolcanic

and metasedimentary rocks (Beaudry et Prichonnet, 1995). They include major fault systems developed due to tectonic, permitting the intrusion of proterozoic rocks consisting of gabbros and diabases, which form dykes that sometimes reach a width of 30 m (Clements and O'Connor, 2002).

The Mistassini and Otish basins consist of rocks of sedimentary origin. The Mistassini basin is composed mainly of rocks resulting from the disintegration of biogenic calcium carbonate, such as dolomite. The conglomerates, sandstones, quartzites, and iron formations also present in these formations are of terrigenous origin. The rocks of the Otish basin are constituted of fluviatile and lacustrine continental deposits. These rocks are mainly represented by sandstones, conglomerates, shales, and stromatolitic dolomites (Hébert, 2006). At the project site, fault zones have been identified in some drill holes. Since the fracturing patterns in the rock are generally random, their characterization requires detailed studies to examine specific areas.

- *SURFICIAL GEOLOGY*

In the region under study, the surficial geology is largely a result of the most recent glaciation. Glacial and glaciofluvial deposits covered the area following the retreat of glaciers. Map 6.5.2 (in Volume 3) illustrates the spatial distribution of the surficial deposits in the project study area.

As Map 6.5.2 (in Volume 3) shows, the predominant geological units in the region of the project, overlying the bedrock, is a compact lodgement till. The till can include various facies (lodgement, ablation, and undifferentiated till). In the project study area, till is essentially composed of a diamicton with a loose, sandy to silty matrix, from brownish beige to grey in colour, with a bit of gravel. The surface is often punctuated by several metre-sized boulders.

The glaciofluvial deposits are composed of a diamicton from glacial meltwater or stagnant water near the glacier. The major deposits are relatively small in the region of the project, except in the area of the airstrip, where there are larger glaciofluvial and fluvial deposits. These deposits are generally composed of a variable proportion of sand and gravel with an often smaller proportion of silt. The glaciofluvial deposits are in the form of eskers or outwash.

The eskers in the project region are oriented southwest. With a few exceptions, the eskers are typically relatively small in size, with an elevation of about 10 m and a width less than 50 m. The space between patches of esker forms depressions often occupied by small wetlands with no surface hydrological connections. It has been reported that many of these deposits are located above the water table (Roche, 2011a).

Outwash can be observed near larger streams and water bodies and at the bottom of the valley. These deposits are sandy silty to gravelly, generally distinguished by flat landforms. In the project region, the most significant outwash is found to the west of Lake Lagopede, on either side of a stream that crosses the bottom of a northwest-southeast running valley. A small esker is found there. The area of this esker and the sandy-gravelly deposits adjacent to it is about 54 ha, but the total extent is much larger. Other

outwash or glaciolacustrine sediments are found on the embankments to the southwest of Lake Lagopede.

Organic deposits that form bogs can also be observed in several places in the area. These bogs typically develop on the surface of soil with low permeability or poor drainage (Roche, 2011).

The thickness of surficial deposits in the area is highly variable. Available data indicate thickness from 0 m to 24 m. The Renard kimberlites lie under a maximum of 30 m of quaternary deposits (Fitzgerald *et al.,* 2010). For example, drilling conducted in the area of Renard-2 shows that surficial deposits have a thickness ranging from 7 m to 20 m (Genivar, 2006), which corresponds to the assessment carried out for the present study.

- *NATURAL BACKGROUND LEVELS*

Analysis of results obtained during the soil sampling campaigns conducted by Roche in 2003, by Stantec in 2010, and by Golder in 2011j has allowed for the determination of natural background levels of metals and other elements for various parameters (Map 6.5.3). The 98th percentiles of concentrations measured in the soil samples collected by Roche (2003), Stantec (2010), and Golder (2011) were calculated and compared to criterion A of the MDDEP Policy (1998)[10] for the geological Superior Province. The 98th percentile of the concentrations of the various elements analyzed represents the values considered as natural background levels for the Renard Project study area. The background levels calculated for each of the elements are, for the most part, under thecriterion A of the MDDEP Policy, except for chromium and sulphur, as shown in Table 6.5.1.

[10] MDDEP Policy: *Soil protection and contaminated sites rehabilitation policy* MENV (1998).

680 000 mE
685 000 mE
690 000 mE
695 000 mE
700 000 mE

5 860 000 mN
5 855 000 mN
5 850 000 mN
5 845 000 mN

Secteur de la mine / Mine area

R-13
R-7
R-1
R-5S
R-4
R-8
R-2
R-3
R-9

Lac Lagopède

4

167

Secteur de la piste d'atterrissage / Airstrip area

Bancs d'emprunts potentiels / Potential borrow pits

LEET

14

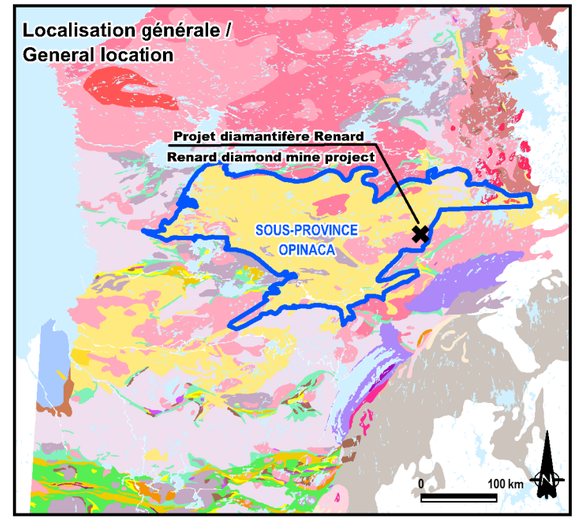
0 2.0 4.0 km

Échelle / Scale 1 : 75 000

UTM, zone 18 (NAD83)

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Localisation générale / General location



Emprise du projet / Project footprint (26/10/2011)

R-X — Autres ressources minérales / Other mineral resources

Fosse d'extraction à ciel ouvert / Open pit

Aire d'étude / Study area

Formations géologiques
Geological setting

PROVINCE DU SUPÉRIEUR / SUPERIOR PROVINCE

Granitoïdes / Granitoids

14 — Roches granitiques syn- à tarditectoniques : granite, granodiorite, monzonite et syénite; quantité mineure de diatexite / Syn- to late-tectonic granitic rocks: granite, granodiorite, monzonite and syenite; minor diatexite

Roches sédimentaires / Secimentary rocks

4 — Roches métasédimentaires : paragneiss et schiste à biotite, grenat, orthopyroxène, sillimanite, andalousite, cordiérite, staurotide et/ou disthène; formation de fer, marbre et granite blanc d'anatexie associé aux roches métasédimentaires; présence commune de roches intrusives et volcaniques / Metasedimentary rocks: paragneiss and schist with biotite, garnet, orthopyroxene, sillimanite, andalusite, cordierite, staurolite and/or kyanite; iron formation, marble and white anatectic granite associated with the metasedimentary rocks; common presence of intrusive and volcanic rocks

Sous-province géologique Opinaca / Opinaca geological subprovince

Roche kimberlitique à l'intérieur de l'aire d'étude / Kimberlitic rock within the study area

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Géologie de l'aire d'étude / Geological setting of the study area

ROCHE

Adaptée de / Data from : MRNF, Québec, 2002
Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33AI6-33A09, RNCan, 2010
Fichier / File : 61470_EIES_Geologie_111220.wor

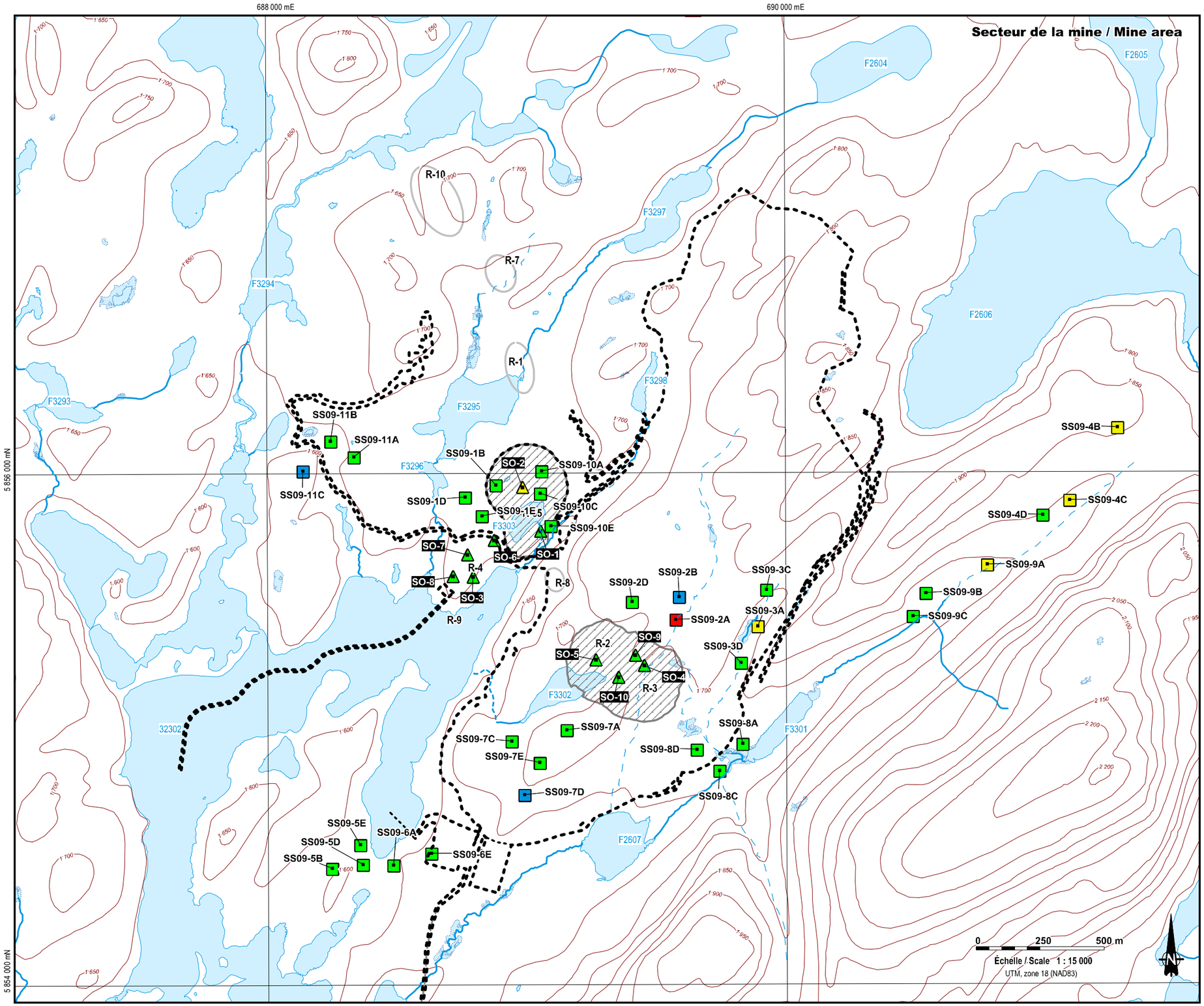
Décembre 2011 / December 2011

Carte / Map 6.5.1

Projet diamantifère Renard / Renard diamond mine project

les diamants stornoway (canada) inc.

Étude d'impact environnemental et social /
Environmental and Social Impact Assessment



Emprise du projet / Project footprint (26/10/2011)

Fosse d'extraction à ciel ouvert / Open pit

R-x — Autres ressources minérales / Other mineral resources

F3293 — Numéro d'identifiant de lac de CEHQ / CEHQ lake ID number

R-x — Identification du gisement / Deposit identification

Courbe topographique(intervalle de 50 pieds) /
Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain /
Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Station d'échantillonnage de sols / Soil sampling station

SS09-2B — Stantec, 2009

SO-5 — Roche, 2003

Niveau de contamination / Contamination level

Stantec	Roche	
■	▲	> critère C de la politique* / Crtieria C of the Policy*
■	▲	Plage B-C de la Politique* / Range B-C of the Policy*
■	▲	Plage A-B de la Politique* / Range A-B of the Policy*
■	▲	< critère A de la Politique* / Criteria A of the Policy*

** Politique de protection des sols et de réhabilitation des terrains contaminés / Soil Protection and Contaminated Sites Rehabilitation Policy*

Localisation des stations d'échantillonnage des sols / Soil sampling stations location

ROCHE

Carte de base / Base Map : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_StationSol_111221.WOR
Décembre 2011 / December 2011

Carte / Map 6.5.3

Table 6.5.1 Natural Background Levels Calculated for Soil

Element	Sample Number	Criterion A of the MDDEP Policy for the Superior Province[1]	Background Level (98th percentile)
	n	mg/kg	mg/kg
Silver	6	0.5	< 0.01
Aluminium	6	-	2,560
Arsenic	48	5	3
Barium	6	-	15.9
Beryllium	6	-	0.06
Bismuth	6	-	< 0.09
Calcium	6	-	435
Cadmium	48	0.9	0.3
Chromium	48	85	**210**
Copper	48	50	10.12
Tin	6	5	< 0.5
Iron	6	-	1,690
Lithium	6	-	< 2
Manganese	6	1,000	21.5
Magnesium	48	-	8,900
Mercury	6	0.3	< 0.1
Molybdenum	6	6	0.455
Nickel	48	50	40.96
Lead	48	40	19.2
Potassium	6	-	613
Phosphorous	42	-	474
Selenium	6	3	< 0.7
Sulphur	42	400	**1,800**
Strontium	6	-	5.58
Titanium	6	-	21
Uranium	6	-	0.0782
Zinc	48	120	21

1: *Soil Protection and Contaminated Sites Rehabilitation Policy*

6.5.2 Impacts during the Construction Phase

6.5.2.1 Identification of Sources of Impact and Description of Impacts

The project components likely to affect the soil during the construction phase are the following:

- Site preparation and development - Activities associated with site preparation, development, and construction are likely to cause disturbance of natural soil;
- Quarry and borrow pit operation;

- Traffic and the use and maintenance of machinery and generator sets - The use of vehicles and machinery on the site could result in accidental spills or leakage during construction activities;
- Storage and management of fuel and hazardous materials - The use and maintenance of machinery, generator sets, fuel and hazardous material storage increases the probability of surface soil contamination due to accidental leakage of hydrocarbons or other contaminants.

➢ *Site Preparation and Development (Clearing, Drilling, Blasting, Cutting, Filling, Drainage, Bulk Material Confinement and Storage Areas) for All Facilities*

The preparation and development of the lands that will contain the various mine infrastructures (processing plant, stockpile, pits, etc.) will have impacts on the soil. Activities related to clearing, stripping, backfilling, mucking, drainage, etc. will cause the removal, burial, or disturbance of natural soils, which could increase erosion. The passage of machinery could cause some soil compaction and lifting of fine particles, which increases the risk of erosion.

➢ *Quarry and Borrow Pit Operation*

For construction and development purposes, a volume of 66,000 m^3 of aggregate will be required, that is, about 40,000 m^3 of aggregate MG-112 and 26,000 m^3 of aggregate MG-20 that will be extracted from the borrow pits. Borrow pit development activities will have the potential to create impacts that could increase erosion due to the removal and disturbance of soils.

➢ *Traffic and the Use and Maintenance of Machinery and Generator Sets*

Traffic and the use of vehicles and heavy machinery required for the construction of the various infrastructures of the project could lead to hazardous material spillage that could eventually contaminate soil. The possibility of leakage or accidental spills during use will increase the risks of soil contamination by hydrocarbons or other contaminants. Therefore, several preventive and corrective measures are planned to limit the risk of accidental spills or leakage of hydrocarbons and to quickly identify leaks and spills, confine them, clean them up, and dispose of them at an authorized site as explained in detail in Section 3.12.

➢ *Storage and Management of Hazardous Materials and Fuel*

During the construction phase, use of the fuel and hazardous materials storage areas and the machine shop will constitute operations that may cause soil contamination if accidental spills or leakage of petroleum products or hazardous materials happens and is not confined and cleaned up quickly.

6.5.2.2 Mitigation Measures

The work methods described below will be used to mitigate unfavorable repercussions on soil regarding excavation and operation of heavy machinery. In addition, they will reduce the risk of soil contamination associated with the different activities described above.

- *Site Preparation and Development (Clearing, Drilling, Blasting, Filling, Excavation, Drainage) and the Confinement and Stockpile Areas for All Facilities*

  - Machinery and other mobile equipment traffic will mainly be limited to the work areas identified above;
  - Stabilization of excavated soil and fills using soil stabilization techniques that blend as much as possible with the natural surroundings. These techniques include revegetation, restoration of plant cover, gabions and riprap using geomembranes when necessary;
  - Excavated soil and fill slopes must be stabilized by using techniques that blend as much as possible with the natural surroundings and that in all locations where erosion may cause sediment transportation in streams. Whenever possible, slopes must be softened to 1.5 (H):1(V) or protected using other available techniques.
  - If an area must remain bare for a longer period, it should be protected using riprap or another strategy considered effective for the site;
  - Protection of bulk materials (cement, sand, etc.) storage areas with plastic tarps for small areas and sediment barriers for larger areas;
  - Where soil has an impervious indurated layer, the layer must remain intact and humus must be conserved, except where there is a road constructed in accordance with legal provisions.

- *Quarry and Borrow Pit Operation*

The following measures will be applied during the construction phase for development and operation of the borrow pits:

  - Complete clearing of the required areas before their use;
  - Segregation of topsoil (organic fraction) and conservation of this material for restoration activities;
  - Restoration activities for the borrow pits following the end of their operation;
  - Covering with a layer of organic matter and revegetation of the impacted areas by the borrow pits operation;
  - Revegetation of deforested surfaces following the above measures.

- *Traffic and the Use and Maintenance of Machinery and Generator Sets*

  - Traffic of machinery and other mobile equipment will be mainly limited to the access road and work areas previously identified;
  - Vehicle speed on the site will be limited to reduce dust and fine particles emissions;
  - Abrasives will be used during winter instead of salt;
  - Maintenance of vehicles and other mobile machines will be carried out at sites planned for these activities. Maintenance and refueling areas will be designed to avoid soil contamination in the case of accidental spills or leakage;
  - Work with heavy machinery will be limited, if possible, to firm soil to avoid rut formation. Use of machinery with tires or tracks.

- *Storage and Management of Fuel and Hazardous Materials*

  - The requirements of the *Petroleum Products Act* (R.S.Q., c. P-30.01) and the *Petroleum Products Regulation* (R.R.Q., c. P-30.01, r.1) will be applied for management of petroleum products and materials;

- The number of petroleum storage tanks and refueling areas for the machinery will be kept to a minimum to reduce the number of sites at risk. They will be developed according to the regulations in force;
- Petroleum product storage areas will be equipped with retention ponds with a capacity of at least 110% of the volume of the largest tank to contain accidental spills and leaks;
- Barrel storage areas will be equipped with impervious dykes or other confinement measures sufficient to contain 25% of the total capacity of all of the stored contents or 125% of the largest, whichever volume is greater;
- Underground areas designated as permanent places for routine maintenance activities, lubrication, and refueling will be covered with a concrete block designed to prevent the flow of petroleum products beyond the area or equipped with an automatic, leak-free filling system;
- Hazardous materials will be managed in accordance with the *Regulation respecting hazardous materials* (R.S.Q., c. Q-2, r. 15.2). Transportation of hazardous materials will be carried out in accordance with the *Transportation of Dangerous Substances Regulation* (R.R.Q., c. C-24.2, Section 622, Subsections 1 to 8);
- The hazardous materials storage area will be located at a distance of at least 30 m or 60 m from drainage ditches, sedimentation ponds, and any other sensitive area;
- Accidental spillage and leakage risk prevention procedures will be implemented, as well as an emergency response plan (e.g. confinement, treatment of runoff in fuel storage and handling areas, etc.);
- An emergency kit for petroleum and hazardous materials recovery that is complete, permanent, and easily accessible at all times will be available at each refueling area on the site. Absorbents will be used to retain used oil. Soiled absorbents will be disposed of securely;
- Any accidental spill or leak will be reported immediately to the person in charge of the mine's emergency plan. The spill response plan will be implemented quickly and rigorously;
- An area affected by a spill will immediately be contained and cleaned without delay. Contaminated soil will be removed and transported to a contaminated soil storage area in accordance with the *Regulation respecting contaminated soil storage and contaminated soil transfer stations*, and a characterization will be carried out according to the standards and good practices in force;
- Contaminated soil, oil residue, and other residual hazardous materials will be disposed of in accordance with the acts and regulations in force;
- There will be clearly identified waterproof containers available on site to contain waste soiled by petroleum products.

6.5.2.3 Residual Impacts

During the construction phase, industrial operations will be limited to construction sites in operation for infrastructure development, so the risk of major spills will largely be limited to these areas. The risk of accidental spills will be minimized by the implementation of mitigation measures. These measures are focused on prevention through regular equipment inspection and the implementation of an emergency response plan that will allow for rapid intervention in the case of an accident. The risk of a major spill will therefore be limited. The intensity of impacts on soil is considered low. The spatial extent is considered site specific given that contamination will occur in a restricted area and evaluation of its duration is short because it will be possible to intervene immediately and to decontaminate the site in the case of a spill. Globally, the impacts are deemed low.

6.5.3 Impacts during the Operation Phase

6.5.3.1 Identification of Sources of Impact and Description of Impacts

- Pit development - The development of these sites will require the displacement of large volumes of material, which will have to be managed adequately to limit erosion;
- Management of material from mining operations (overburden, waste rock, and processed kimberlite) - Management of material from mining operations has the potential to entrain, through leaching, various chemical elements naturally present in the materials;
- Traffic and the use and maintenance of machinery;
- Storage and management of fuel and hazardous materials - Accidental spillage or leakage of contaminants on the sites can cause changes in groundwater quality;
- Progressive rehabilitation of the site - Restoration activities will be undertaken at sites that are not required during the operation phase to re-establish the plant cover and thereby limit soil erosion.

During the operation phase, several sources may have impacts on soil and their quality, similar to those identified in the construction phase. These impacts mainly concern site development activities, traffic, refuelling and maintenance of machinery, management of materials from mining operations, storage and management of fuel and hazardous materials. Anticipated impacts as a result of these activities are described below.

➢ *PIT DEVELOPMENT*

Pit development activities will have the potential to generate impacts on soil throughout the removal and handling of soil, which will increase the likelihood of erosion. The passage of machinery could also cause soil settlement and lifting of particles, increasing the likelihood of erosion.

➢ *MANAGEMENT OF MATERIAL FROM MINING OPERATIONS*

The extraction, handling, and management of waste rock, overburden, and processed kimberlite have the potential to modify soil quality. The area that will be used for the storage areas will occupy approximately 115 hectares. The water percolating through or under these storage areas could dissolve certain minerals in these materials and transport these contaminants into the underlying soil. Indeed, runoff from waste rock and overburden stockpiles and the processed kimberlite confinement area could leach metals into the soil. Clay materials in the till may retain a portion of these metals. Metal concentrations in soil could therefore increase locally on the surface and be exposed following removal of the waste rock stockpile. However, the results of leaching tests completed on waste rock, overburden, and processed kimberlite samples show that these materials are not leachable according to the kinetic tests, nor are they acid generators according to the criteria of Guideline 019 (Golder, 2011c). Therefore, the impacts associated with the metal leaching from the stockpiles and confinement areas are considered negligible.

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

As will be the case during the construction phase, traffic, the use of vehicles and heavy machinery could lead to spillage of hazardous materials that have a potential to contaminate soil with hydrocarbons or other contaminants. The preventive and corrective measures planned for the construction phase will therefore also be applied during the operation phase to limit the risk of accidental hydrocarbon spills or leaks and quickly identify, confine, and remove leaks and spills and dispose of them at an authorized site.

➢ *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

As for the construction phase, the fuel and hazardous materials storage areas and the machine shop will be potential surface soil contamination sites during the operation phase, whether by petroleum products or other hazardous materials. Depending on the nature of the underlying soil, if the contaminated soil is not removed quickly, contaminants could potentially reach the groundwater table and then, make resurgence in surface waters.

➢ *PROGRESSIVE REHABILITATION OF THE SITE*

Restoration work will be undertaken progressively during the operation phase. As soon as construction activities have ended, deforested areas that will no longer be required for the operation phase will undergo revegetation. The slopes of the borrow pits will be softened, covered with a layer of organic matter, and revegetated. In addition, the berms of the processed kimberlite confinement area will also undergo progressive revegetation. Progressive restoration activities serve to gradually re-establish forest cover and therefore limit soil erosion. This constitutes a positive impact.

6.5.3.2 Mitigation Measures

➢ *PIT DEVELOPMENT*

The following measures will be applied during the operation phase for pit development:

- Complete clearing of required areas before use;
- Segregation of topsoil (organic fraction) and conservation of this material for restoration activities.

➢ *MANAGEMENT OF MATERIAL FROM MINING OPERATIONS*

The mitigation measures that were mentioned in the construction phase will also apply during the operation phase. The following additional measures will also apply:

- Storage areas will be clearly delineated in order to facilitate confinement. Ore losses at transshipment sites will be recovered during operation. Ore losses at conveyor and transfer sites will be minimized during operation by the use of wind erosion protection (covering of conveyors and transfer towers);

- Ore, processed kimberlite, waste rock, and overburden storage areas will be delineated, and a drainage system will ensure collection of runoff;
- The processed kimberlite confinement area will be progressively restored in an effort to reduce, through stabilization, the transportation of suspended particles. This approach should minimize the leaching of metals and their infiltration through runoff into soil;
- Overburden will be reused as much as possible for berm construction.

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

The mitigation measures used during the construction phase for impacts related to traffic and the use and maintenance of machinery will also be applied during the operation phase.

➢ *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

The mitigation measures used during the construction phase for impacts related to the storage and management of fuel and hazardous materials will also be applied during the operation phase.

➢ *PROGRESSIVE REHABILITATION OF THE SITE*

Impacts related to progressive rehabilitation of the site will have a positive effect on the soil. Therefore, no mitigation measures are proposed for this component of the project during the operation phase.

6.5.3.3 Residual Impacts

Considering the mitigation measures and the fact that a portion of the sites will already be restored at the end of the operation phase, the project's impacts on soil and their quality can be considered to have moderate intensity. The spatial extent of the impacts on soil is considered site specific because the impacts will be confined within the project site. The duration of impacts is considered moderate, that is the duration of the operation phase. The significance of impacts on soil during the operation phase is therefore considered moderate.

6.5.4 Impacts during the Closure Phase

6.5.4.1 Identification of Sources of Impact and Description of Impacts

The main components of the project likely to affect soil quality during the closure phase are associated with the rehabilitation and revegetation of the site. The sources of impact on soil will therefore mainly be related to activities undertaken in order to return the site to its original state.

- Traffic and the use and maintenance of machinery: the use of vehicles and machinery on the site could accidentally cause limited spills or leaks during closure;
- Final rehabilitation and revegetation of the site: At closure, restoration activities will be completed at the sites to re-establish plant cover and limit soil erosion.

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

Site dismantling and rehabilitation activities will require the use of specialized equipment and machinery. The use, maintenance, and traffic of vehicles and machinery during closure activities will

emit certain substances into the environment. The sources of impact on soil during the closure phase are related to the use and maintenance of machinery and storage and maintenance of fuel and hazardous materials associated with said machinery. The possibility of accidental spillage or leakage during use will increase the risk of soil contamination by hydrocarbons or other contaminants.

- *FINAL SITE REHABILITATION AND REVEGETATION*

As soon as production activities cease, revegetation of the majority (75%) of the impacted areas will be initiated in order to gradually restore vegetation cover, with the exception of the slopes of the processed kimberlite confinement area, the overburden stockpile, and the water-filled pit, which will not be revegetated once the mine closes and which will cover 76.8 ha (25% of the impacted area). It should be noted, however, that the flat surfaces of the processed kimberlite confinement area and overburden stockpile will be revegetated. In addition, in the long term, the species that will be established on the flat surfaces will be able to propagate naturally and cover the sloped areas so that vegetation will be present throughout the mine site once it is closed. The pit to be backfilled at mine closure represents the only long-term loss of vegetation and consists of 7% of the impacted surface area.

Revegetation will be carried out in two stages: During the first stage, hydroseeding will be carried out. The species chosen will be adapted to northern conditions and will not be invasive. A seed mix such as the Mountain Northern Mix will be used. This mix is composed solely of grass. During the second stage, black spruce seeds will be planted at a density of 2,000 plants per hectare.

If, as mentioned in section 3.13 of the restoration plan (Roche, 2011), the soil characterization study that will be carried out following the final cessation of mining activities indicates soil contamination, restoration of contaminated soil will be carried out following closure.

The goal of the final restoration activities will be to re-establish forest cover, limit soil erosion and, if necessary, rehabilitate contaminated areas in accordance with applicable regulations, which will constitute positive impacts.

6.5.4.2 Mitigation Measures

- *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

Mitigation measures and work methods used during site closure activities will allow the prevention of soil contamination risks. Measures implemented for traffic and the use and maintenance of machinery during closure operations will be the same as those described for the construction and operation phases.

➢ *FINAL REHABILITATION AND REVEGETATION OF THE SITE*

Additional mitigation measures have been developed to address issues that could remain in the soil following the cessation of operations:

- The surfaces of the PKC area and overburden stockpile will be restored by the establishment, following the specifications of the site restoration plan, of non-invasive plant species adapted to northern conditions and requiring little maintenance;
- The flat surfaces of the PKC area, which represent 32.7% of the confinement area, will be revegetated. The flat surfaces will be covered with a layer of overburden followed by a layer of topsoil, then revegetated;
- The flat surfaces of the overburden stockpile, representing 40.5% of the area of the stockpile, will be revegetated, and the slopes will be covered with waste rock to ensure stability;
- The pre-production ore stockpile area will be covered with a layer of overburden of about 0.5 m thick and a layer of topsoil from 0.3 m to 0.5 m thick, then revegetated;
- Grading and levelling activities will be carried out, whenever possible, immediately before revegetation activities are undertaken;
- Whenever possible, slopes will be softened to 1.5(H):1(V) or using other available techniques;
- Slopes of cut and fill must be stabilized using techniques that blends as much as possible with the natural surroundings at any place where erosion is likely to lead to sediment transport in a stream. If an area must remain bare for a longer period, it will be protected using riprap or any other strategy considered appropriate for the site;
- The area to be revegetated will be free of debris, waste, unusable materials, piece of machinery, or other elements that were not located on the site before work began;
- Slopes will be softened and stabilized;
- Previously stored organic matter will be spread over the site;
- An environmental characterization study of soil will be completed within six months following the final cessation of mining activity in accordance with Section 31.51 of the *Environment Quality Act*;
- If necessary, soil contaminated above the applicable criteria will be removed and taken away from the site for treatment and final disposal at an authorized location.

6.5.4.3 Residual Impacts

Following application of the mitigation measures, the impacts of the project on the soil during the closure phase may be considered as low intensity and positive overall. The impacts will be site specific and will be felt for a long duration. Thus the importance of the impact on soil is therefore deemed low.

6.6 Hydrogeology and Groundwater

6.6.1 Current Conditions

The Renard Project Environmental Baseline Study (Roche, 2011), on which the description of the hydrogeological conditions is based, deals with the following:

- Various components of the hydrogeological systems (hydrostratigraphy, hydraulic properties, hydraulic head, recharge areas, etc.) at the location of the future Renard Project facilities;
- Potential use of water resources;
- Connections to surface water and wetlands.

Information gathered in several previous studies was used to define the hydrogeological context of the site, establish a portrait of water quality, and identify issues related to groundwater. To complete existing information and gather the necessary data for the project's impact assessment study, a hydrogeological study program was prepared. This program takes into account the mine planned development and the information already available. The results are discussed in this section.

6.6.1.1 Hydrogeological Context

The various geological formations observed in the Renard Project study area were the subject of several studies, largely for the purposes of mineral exploration. The lithological and stratigraphical data gathered during these studies were consulted in the Stornoway exploration drilling database and other previous studies and government reports and maps. The regional geological context is presented in Section 6.5 of this report.

Available information shows that the region of the project is located in an area dominated by Archean rocks covered with deposits of glacial origin. The various lithologies associated with the rock formations present highly variable hydrogeological characteristics, but typical for their nature and can be grouped into two systems.

- *Bedrock Hydrogeological Systems*

The bedrock of the Renard Project study area is associated with two geological provinces part of the Canadian Shield, that is, the Superior Province dating from the Archean era (4 to 2.5 Ga) and the Grenville Province Front dating from the Proterozoic period (1.2 to 0.950 Ga). The Otish and Mistassini basins from the Paleoproterozoic era (2.5 Ga to 1.6 Ga) lie in discordance on the Superior Province bedrock. The project site is entirely in the Superior Province. Map 6.5.1 presents the regional geological setting.

The types of rock formations found in the study area, mostly granite and metasedimentary formations, generally have poor hydrogeological properties. These rocks have low primary porosity related to the matrix, which limits their capacity for water flow and storage. The hydrogeological characteristics are linked to a secondary porosity related to fracturation. The density and connectivity of the network of fractures allow for the accumulation of significant quantities of water in places. At the project site, fault zones were identified during certain drilling activities.

- *Hydrogeological Systems in Geological Surface Material*

In the study area, surficial deposits were put in place during the most recent glaciation and throughout deglaciation. The area is mainly covered by glacial and glaciofluvial deposits, and there are also some small, more recent deposits near streams and water bodies (alluvions) or formed as organic deposits (bogs). Map 6.5.2 (in folder) from the previous section presents the spatial distribution of the surficial deposits in the study area of the project.

The predominant unit in the area (see Map 6.5.2 in folder), overlying the rock, is composed of a compact basal till. The till can include various facies (basal, ablation, and undifferentiated till). In the study area, the till observed on the surface is essentially composed of a loose, sandy to silty matrix from brownish beige to grey, with some gravel. The surface of the soil is often punctuated by metre-sized boulders. Available data indicates that the thickness of deposits in the area is highly variable, that is, between 0 m and 24 m. The characteristics of the various surficial formations found in the study area are described in detail in Section 6.1.

The hydrogeological context associated with the surface deposits suggests a low hydraulic potential. The study area is covered by a layer of till overlying the bedrock, whose extend is confirmed by the cartography of the surficial deposits. The basal till contains a significant portion of silt, which indicates low natural permeability in the deposits. The presence of a cover of till deposit with low permeability overlying the bedrock on the majority of the area studied suggests a confined or semi-confined hydrogeological system in the bedrock.

Among the surficial deposists, only the coarser granular deposits (sand and gravel) such as eskers and outwash, presents favorable hydrogeological properties. The typically higher primary porosity of this type of deposit allows for the storage of large water quantities potentially available for supply, provided that the deposits are large enough. In the project study area, however, their extent is rather limited, and they are concentrated only in specific areas (see Map 6.5.2 in folder).

6.6.1.2 Hydraulic Properties

The hydraulic properties of the various geological units in the area were examined in previous studies. Hydraulic tests were carried out in several monitoring wells installed at the site in suficial deposits, and in existing wells and drill holes. The operations carried out include, among others, pumping tests, downhole permeability tests, slug tests, and packer tests. The results allowed for the estimation of the main hydraulic properties of the surface deposits and bedrock, that is, hydraulic conductivity,[11] transmissivity,[12] and the storage coefficient.[13] Table 6.6.1 presents a summary of the results that were obtained.

[11] The hydraulic conductivity of a material represents its ability to allow water to pass through it. Hydraulic conductivity corresponds to the coefficient of permeability, K, of Darcy's law. Its dimensions are those of velocity (L/T). (Banton and Bangoy, 1997).

[12] Transmissivity of an aquifer is the product of the hydraulic conductivity of the aquifer material and its thickness. Its dimensions are those of surface per unit of time (L^2/T). (Banton and Bangoy, 1997).

[13] The storage coefficient of an aquifer is the product of the specific storage coefficient of the aquifer material and its thickness. This coefficient is dimensionless (Banton and Bangoy, 1997).

Table 6.6.1 Hydrogeological Parameters Measured during Previous Studies

Hydrogeological Parameter	Range	Geometric Mean	Source
Surficial Deposits (Till)			
Hydraulic Conductivity (m/s)	1.6×10^{-7} to 3.3×10^{-6} 2.5×10^{-6}	1.1×10^{-6} -	Genivar, 2006 Golder, 2011h Golder, 2011i
Transmissivity (m^2/s)	2.0×10^{-6} to 4.5×10^{-5}	1.3×10^{-5}	Genivar, 2006
Surficial Deposits (Till)/Bedrock			
Hydraulic Conductivity (m/s)	1.5×10^{-8} to 7.9×10^{-7}	1.0×10^{-7}	Golder, 2011h Golder, 2011i
Bedrock			
Hydraulic Conductivity (m/s)	2.4×10^{-8} to 7.2×10^{-8} 3.1×10^{-9} to 3.1×10^{-7} 1.7×10^{-9}	3.8×10^{-8} 4.5×10^{-8} -	Genivar, 2006 Roche, 2011 Golder, 2011h Golder, 2011i
Transmissivity (m^2/s)	8.2×10^{-6} to 9.7×10^{-6}	9.0×10^{-6}	Genivar, 2006
Storage Coefficient (-)	1.9×10^{-4} to 4.8×10^{-3}	$9{,}6 \times 10^{-4}$	Genivar, 2006

The results generally confirm the low hydraulic potential of the bedrock and till formations. The hydraulic conductivity of the bedrock is, in general, 10 to 100 times lower than the conductivity measured in surficial deposits. Estimated values for surficial deposits are on the order of 10^{-7} m/s to 10^{-6} m/s, while for the bedrock, the values are on the order of 10^{-9} m/s to 10^{-7} m/s. These values are comparable to those generally reported in the literature for these units (Freeze and Cherry, 1979).

The transmissivity values measured during the tests are also very low. The average estimated value for the bedrock is 9.0×10^{-6} m^2/s (0.78 m^2/day), while the value for surficial deposits is 1.3×10^{5} m^2/s (1.12 m^2/day). These transmissivity values are considered very low and indicate that the deposits can only support development of very local supply sources for limited consumption (Krásný, 1993).

Estimated values for the storage coefficient for bedrock formations vary from 1.9×10^{-4} to 4.8×10^{-3} for an average of 9.6×10^{-4}. These values confirm the presence of a confined or semi-confined hydrogeological system in the bedrock.

Spatial variation of hydraulic properties in surficial deposits has also been reported (Genivar, 2006). Hydraulic conductivity decreases considerably with depth. Additionally for the horizon in contact with the bedrock; hydraulic conductivity also decreases laterally by almost one order of magnitude toward the north and northeast going away from Lake Lagopede.

The hydrogeological system in the bedrock presents highly variable hydraulic characteristics. Properties measured are generally representative of local hydrogeological conditions associated with faults and fracture zones encountered during drilling.

6.6.1.3 Groundwater Flow

Hydrogeological studies carried out on the project site served to define the groundwater flow patterns. Several wells and drill holes performed at the project site have allowed for the measurement of the

depth of the groundwater surface in order to determine the elevation of water levels and the flow directions. The understanding of the different components of the groundwater flow pattern on the project site must allow for assessment of the hydraulic connections between surface water and groundwater and the risk of potential migration of contaminants toward the various receiving environments.

The piezometric surface in the study area was determined by numerical modelling (Itasca, 2011). The hydraulic –head values were calibrated with values measured in the area during a groundwater level survey carried out for the Environmental Baseline Study (Roche, 2011) to ensure the validity of the model. The piezometric map obtained as a result of this modeling represents the spatial distribution of the hydraulic heads (Map 6.6.1).

The data indicate that the hydraulic head is generally at elevations of between 481.4 m and 510.6 m, that is, at a depth of between 0 m and 8.0 m below the surface of the land. Since 2010, monitoring has been regularly carried out in the observation wells developed on the project site in order to document seasonal variations in groundwater level.

The piezometric map (Map 6.6.1) shows that groundwater flow occurs in the direction of the various surface water bodies. Streamlines running perpendicular to the equipotential lines show flow direction to the south and the northwest from the R-3 area and to the southwest and the northwest in the R-65 area. These conditions suggest groundwater seepage in the various lakes, with recharge of the system from topographical highs (outcrops). These observations agree with the groundwater flow directions observed during the Genivar (2006) study and the results of hydrogeological modelling (Itasca, 2011).

Water flow in surficial deposits was partially examined in the Genivar study. Flow was oriented toward the south in the Renard 2 area, that is, toward Lake Lagopede. The groundwater depth reported in the surficial deposits varies from 0.6 m to 5.0 m. These observations also agree with groundwater flow directions modelled by Itasca (2011). Considering the flow pattern and the depth of the groundwater table, it is probable that groundwater in the deposits is in hydraulic contact with surface water.

The pumping test carried out by Genivar in 2006 in a well drilled in the bedrock also demonstrated a response to the groundwater level in wells drilled in deposits. These results suggest that a portion of the groundwater that will eventually be pumped for open pit dewatering will come from the more permeable horizons of surface deposits.

6.6.1.4 Classification of Hydrogeological Formations

Groundwater resources status and its relative value vary depending on certain hydrogeological criteria and potential use. The MDDEP Groundwater Classification System is a tool for balancing land use and groundwater resources. In this system, hydrogeological formations are placed into the following classes (MENV, 1999):

I. Hydrogeological formation that constitutes an irreplaceable source of water supply (the only water supply or water reserve source for a community);

II. Hydrogeological formation that constitutes a current or potential source of water supply due to its acceptable quality (potable with standard treatment) and sufficient quantity (transmissivity of over 1 m²/day);

III. Hydrogeological formation that, although saturated with water, cannot constitute a source of water supply (mediocre quality, insufficient quantity, or extraction not economically viable).

The rather limited potential of the bedrock aquifers beneath the mine site suggests that they could not be considered Class I aquifers. In addition, Mistissini, the closest municipality that could require the use of a groundwater supply, is located approximately 285 km from the project site.

The transmissivity values established by Genivar (2006) indicate an average transmissivity of 0.8 m²/day in the bedrock. According to this value, the bedrock aquifer could not be considered a Class II aquifer and would therefore implicitly be considered a Class III, even though the water could be usable for consumption after primary treatment.

The superficial deposits do not have significant aquifers. The site is predominantly covered by till deposits with low permeability. The few more granular deposits on or near the site (eskers, outwash) have limited extent and depth, which makes them less viable as water reserve sources.

6.6.1.5 Groundwater Quality

A preliminary portrait of groundwater quality was established for the Environmental Baseline Study (Roche, 2011). The results obtained are reported in this section. Values for groundwater present in the rock formations are presented in Table 6.6.2, and values for groundwater in surficial deposits are presented in Table 6.6.3.

Water quality criteria for situations where groundwater seepage occurs in surface water were used for comparison in the tables. Threshold values from the criteria set out in *Résurgence dans les eaux de surface ou infiltration dans les égouts* (Seepage into surface water or infiltration into sewer systems) (MDDEP 2006) for silver, barium, cadmium, copper, nickel, lead, and zinc were adjusted for a hardness of 10 mg/L of $CaCO_3$ (Sylvie Cloutier, Direction du suivi de l'état de l'environnement, MDDEP, personal communication).

- *GROUNDWATER QUALITY IN THE BEDROCK*

During the 2010 survey carried out by Roche, groundwater samples taken from six existing exploration drill holes (G04-271A-1, RC-R2-03, RC-R3-02, R-4-21, RC-65-01, and R65-27) allowed for measurement of the background levels in the water present in the bedrock at the mine site. In 2003, the results of analyses obtained by Roche in the same fashion were also compiled for drill holes R5-04, R6-07, R4-06, R3-08, and R2-11.

The results of chemical analysis of various inorganic parameters obtained from groundwater samples are presented in Table 6.6.2. Some of the analyzed parameters show concentrations above the criteria set out in *Résurgence dans les eaux de surface ou infiltration dans les égouts* (MENV, 1999),

hereinafter referred to as "seepage criteria." More specifically, barium concentrations in drill holes R4-21 and R65-27 and copper concentrations in drill holes RC-R3-02 and DUP1 (R4-21) exceed the seepage criteria.

Relatively high levels of certain parameters, especially copper, manganese, molybdenum, nickel, sulphurs, and barium suggest naturally high levels in the water contained in the rock formations rather than contamination due to anthropogenic activities.

- *GROUNDWATER QUALITY IN SURFICIAL DEPOSITS*

Groundwater quality in the suficial deposits was the subject of sampling in 2010 in three observation wells installed by Genivar in 2006 in the Renard 2 area (OW-R2-03, OW-R2-04, and OW-R2-05). For a more complete understanding of water quality in the surface aquifer, wells OW-R-2-01 to OW-R-2-05 and 12 additional wells installed by Golder in 2010 and 2011 were sampled during a subsequent campaign carried out in the summer of 2011. The results for the analyzed parameters are presented in Table 6.6.3.

Some of the results from groundwater samples taken in the surficial deposits exceed the "seepage criteria" for surface water. These exceeding occurrences are observed sporadically for total phosphorous, sulphurs, aluminium, zinc, and copper. A network of observation wells will be established on the project site before the construction phase to allow for consolidation of the database and more precise measurements of the variability of natural background levels in surface water.

Table 6.6.2 Results of Analyses of Groundwater Sampled in Bedrock

Sampling date					L32215	L32236	L32238	L32240	L32240	L32241	L32242	L32235
					2010-08-06	2010-08-06	2010-08-06	2010-08-06	2010-08-06	2010-08-06	2010-08-06	2010-08-06
Slip Number					E-807321	E-807321	E-807321	E-807321	E-807321	E-807321	E-807321	E-807321
Sample Number	**Units**	**Criteria for Consumption[1]**	**Surface Water Seepage and Sewer Infiltration Criteria[1]**	**Reported Detection Limit (RDL)**	**G04-271A-1**	**RC-R3-02**	**RC-R2-03**	**R-65-27**	**R-65-27 Dup. de Lab.**	**RC-65-01**	**R4-21**	**DUP1 (R4-21)**
Physicochemical Parameters												
pH	-	-	-	-	6.03	10.2	8.92	8.6	-	8.65	7.71	8.26
Conductivity	mS/cm	-	-	-	0.024	2.8	0.073	0.20	N/A	0.075	0.11	0.11
Major Ions and Nutrients												
Total Phosphorous	mg/L	-	3	0.02	0.51	0.12	0.05	0.21	N/A	ND	0.06	0.04
Sulphides (H2S)	mg/L	0.05	0.2	0.02	0.13	0.04	0.04	0.14	N/A	0.04	0.04	0.03
Nitrate(N) and Nitrite(N)	mg/L	10	-	0.02	ND	ND	0.05	ND	ND	0.02	0.04	0.10
Metals												
Mercury (Hg)	mg/L	0.05	-	0.0001	ND	ND	ND	ND	ND	ND	ND	ND
Aluminium (Al)	mg/L	-	0.75	0.03	ND	0.52	ND	ND	ND	ND	ND	ND
Antimony (Sb)	mg/L	0.006	-	0.006	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	mg/L	0.1	0.0001 [2]	0.0003	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	mg/L	0.025	0.34	0.002	ND	ND	ND	ND	ND	ND	ND	ND
Barium (Ba)	mg/L	1	0.44 [2]	0.030	ND	ND	ND	0.52	0.50	ND	4.3	4.6
Cadmium (Cd)	mg/L	0.005	0.0005 [2]	0.001	ND	0.002	ND	ND	ND	ND	ND	ND
Chromium (Cr)	mg/L	0.05	-	0.03	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	mg/L	-	0.5	0.03	ND	ND	ND	ND	ND	ND	ND	ND
Copper (Cu)	mg/L	1 [3]	0.0022 [2]	0.003	ND	0.004	ND	ND	ND	ND	ND	0.003
Manganese (Mn)	mg/L	0.05 [3]	-	0.003	0.099	ND	0.14	ND	ND	0.038	0.77	0.89
Molybdenum (Mo)	mg/L	0.07	2	0.03	ND	1.0	ND	ND	ND	ND	ND	ND
Nickel (Ni)	mg/L	0.02	0.09 [2]	0.01	ND	0.03	ND	ND	ND	ND	ND	ND
Selenium (Se)	mg/L	0.01	0.02	0.001	ND	ND	ND	ND	ND	ND	ND	ND
Lead (Pb)	mg/L	0.01	0.0067 2	0.001	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (Zn)	mg/L	5 [3]	0.023 [2]	0.005	ND	ND	ND	0.004	ND	ND	ND	ND

1 Provincial criterion applicable to cases of groundwater contamination. Soil Protection and Contaminated Sites Rehabilitation Policy, Updated 2005.
Ministère du Développement durable, de l'Environnement et des Parcs

2 Criterion adjusted for a hardness of 10 mg/L of CaCO3, as specified in the MDDEP Critères de qualité de l'eau de surface au Québec [Quebec surface water quality criteria]

3 Esthetic Criterion

0,1 Concentration above or equal to the MDDEP goundwater consumption criteria[1]

0,1 Concentration above or equal to MDDEP surface water seepage and sewer infiltration criteria[1]

ND	Not Detected
N/A	Not Applicable
LOD	Limit of Detection
RDL	Reported Detection Limit
Lab-Dup	Laboratory Duplicate
QC Lot	Quality Control Lot
-	Nonexistent data or standard

688 000 mE

690 000 mE

5 856 000 mN

5 854 000 mN

Secteur de la mine / Mine area

32300

32304-2

32302

F2602

F2603

F2604

F2605

F2606

F2607

F2608

F3292

F3293

F3294

F3295

F3296

F3297

F3298

F3299

F3300

F3301

F3302

F3303

F3304

F3305

F3306

F3307

F3308

F3309

F3311

F3312

F3313

F3314

F3315

F3316

R-1

R-2

R-3

R-4

R-7

R-8

R-9

R-10

R-65

0 500 1000 m

Échelle / Scale : 1 : 30 000

UTM, zone 18 (NAD83)

Projet diamantifère Renard / Renard diamond mine project

les diamants stornoway (canada) inc.

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

- Emprise du projet / Project footprint (26/10/2011)
- Fosse d'extraction à ciel ouvert / Open pit
- R-x — Autres ressources minérales / Other mineral resources
- F3293 — Numéro d'identifiant de lac de CEHQ / CEHQ lake ID number
- R-x — Identification du gisement / Deposit identification
- Courbe topographique(intervalle de 50 pieds) / Contour line (50 feet interval)
- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
- Écoulement souterrain / Underground flow
- 500 — Contours piézométriques estimés (m) / Simulated piezometric contours (m), Itasca, 2011

Piézométrie de l'aire d'étude et distribution spatiale des charges hydrauliques / Piezometric levels and distribution of hydraulic lead

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_Piezo_111221.WOR
Décembre 2011 / December 2011

Carte / Map 6.6.1

Table 6.6.3 Results of Analyses of Groundwater Sampled in Surficial Deposits

Sampling date					L32237	L34761	L32239	N83659	N83663	N83664	N83665	N83666	N83667
					2010-08-06	2010-08-10	2010-08-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06
Slip Number					E-807321	E-802681	E-807321	44526-02	44526-02	44526-02	44526-02	44526-02	44526-02
Sample Number	**Units**	**Criteria for Consumption[1]**	**Surface Water Seepage and Sewer Infiltration Criteria[1]**	**Reported Detection Limit (RDL)**	**OW-R2-03**	**OW-R2-04**	**OW-R2-05**	**OW-R2-01**	**OW-R2-02**	**OW-R2-03**	**OW-R2-03 DUP**	**OW-R2-04**	**OW-R2-05**
Physicochemical Parameters													
pH	-	-	-	-	8.92	8.12	7.44	-	-	-	-	-	-
Conductivity	mS/cm	-	-	0.001	0.042	0.044	0.052	0.43	0.093	0.10	0.11	0.11	0.089
Major Ions and Nutrients					-	-	-						
Ammoniacal Nitrogen (N-NH3)	mg/L	-	-	0.05	-	-	-	-	-	-	-	-	-
Total Cyanides	mg/L	0.2	-	0.01	-	-	-	-	-	-	-	-	-
Fluoride (F)	mg/L	1.5	**4**	0.1	-	-	-	ND	ND	0.2	0.3	ND	ND
Total Phosphorous	mg/L	-	3	0.02	0.02	ND	ND	0.72	0.14	0.07	0.04	0.13	0.87
Chlorides (Cl)	mg/L	250	860	0.05	-	-	-	-	-	-	-	-	-
Sulfides (S2-)	mg/L	0.05	0.2	0.02	ND	0.02	ND	ND	ND	0.28	0.17	ND	ND
Sulfates (SO4)	mg/L	-	-	0.5	-	-	-	-	-	-	-	-	-
Nitrate(N) and Nitrite(N)	mg/L	10	-	**0.02**	0.14	0.81	1.7	44	2.0	ND	ND	2.0	2.7
Metals													
Mercury (Hg)	mg/L	0.05	-	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aluminium (Al)	mg/L	-	0.75	0.03	ND	ND	ND	ND	ND	ND	ND	ND	0.09
Antimony (Sb)	mg/L	0.006	-	0.006	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	mg/L	0.1	0.0001 [2]	0.0003	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	mg/L	0.025	0.34	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium (Ba)	mg/L	1	0.44 [2]	0.030	ND	ND	ND	ND	ND	ND	ND	ND	0.03
Cadmium (Cd)	mg/L	0.005	0.0005 [2]	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium (Cr)	mg/L	0.05	-	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	mg/L	-	0.5	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper (Cu)	mg/L	1 [3]	0.0022 [2]	0.003	ND	ND	ND	0.008	ND	ND	ND	0.014	ND
Lead (Pb)	mg/L	0.05 [3]	-	0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese (Mn)	mg/L	0.07	2	0.03	0.003	0.006	0.22	ND	ND	0.22	0.23	0.030	0.49
Molybdenum (Mo)	mg/L	0.02	0.09 [2]	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	mg/L	0.01	0.02	0.001	ND	ND	ND	ND	ND	ND	ND	0.01	ND
Selenium (Se)	mg/L	0.01	0.0067 [2]	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium (Na)	mg/L	200 [3]		0.200	-	-	-	7.0	2.9	3.4	3.5	2.8	5.7
Zinc (Zn)	mg/L	5 [3]	**0.023** [2]	0.005	0.038	0.008	0.004	0.010	0.006	ND	0.010	0.057	0.014
Boron (B)	mg/L	-	-	0.05	-	-	-	ND	ND	ND	ND	ND	ND
Iron (Fe)	mg/L	-	-	0.1	-	-	-	ND	ND	4.2	5.1	ND	ND
Magnesium (Mg)	mg/L	-	-	0.2	-	-	-	7.8	2.2	4	4.1	2.7	1.8
Beryllium (Be)	mg/L	-	-	0.002	-	-	-	ND	ND	ND	ND	ND	ND

1 Provincial criterion applicable to cases of groundwater contamination. Soil Protection and Contaminated Sites Rehabilitation Policy, Updated 2005. Ministère du Développement durable, de l'Environnement et des Parcs

2 Criterion adjusted for a hardness of 10 mg/L of CaCO3, as specified in the MDDEP Critères de qualité de l'eau de surface au Québec [Quebec surface water quality criteria]

3 Esthetic Criterion

0,1 Concentration above or equal to the MDDEP goundwater consumption criteria[1]

0,1 Concentration above or equal to MDDEP surface water seepage and sewer infiltration criteria[1]

ND	Not Detected
N/A	Not Applicable
LOD	Limit of Detection
RL	Reported Detection Limit
Lab-Dup	Laboratory Duplicate
QC Lot	Quality Control Lot
-	Nonexistent data or standard

Table 6.6.3 Results of Analyses of Groundwater Sampled in Surficial Deposits - Continued

Sampling date					N83617	N83629	N83630	N83631	N83632	N83633	N83643	N83644	N83645	N83654	N83655	N83656	N83657
					2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06	2011-06-06
Slip Number					44526-03	44526-03	44526-03	44526-03	44526-03	44526-03	44526-03	44526-03	44526-03	44526-03	44526-02	44526-02	44526-02
Sample Number	**Units**	**Criteria for Consumption[1]**	**Surface Water Seepage and Sewer Infiltration Criteria[1]**	**Reported Detection Limit (RDL)**	**BH-01**	**BH-01A**	**BH-02**	**BH-03**	**BH-04**	**BH-10-05**	**BH-06**	**BH-10-07**	**BH-10-50**	**BH-10-50 DUP**	**BH-10-51**	**BH-10-52**	**BH-10-53**
Physicochemical Parameters																	
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity	mS/cm	-	-	0.001	0.028	0.020	0.018	0.13	0.17	0.21	0.14	0.12	0.046	0.052	0.007	0.24	0.053
Major Ions and Nutrients																	
Ammoniacal Nitrogen (N-NH3)	mg/L	-	-	0.05	-	-	-	-	-	-	-	-	0.12	0.13	0.07	0.15	0.09
Total Cyanides	mg/L	0.2	-	0.01	-	-	-	-	-	-	-	-	ND	ND	ND	ND	ND
Fluoride (F)	mg/L	1.5	**4**	0.1	ND	ND	0.1	0.1	0.3	0.4	0.6	0.4	ND	ND	ND	0.8	ND
Total Phosphorous	mg/L	-	3	0.02	4.9	5.4	0.30	0.41	23	0.67	1.2	0.43	0.30	0.21	0.38	1.0	0.89
Chlorides (Cl)	mg/L	250	860	0.05	-	-	-	-	-	-	-	-	0.13	0.13	0.06	1.7	0.10
Sulfides (S2-)	mg/L	0.05	0.2	0.02	0.02	0.03	0.09	ND	0.20	ND	0.02	0.02	0.04	ND	ND	0.07	ND
Sulfates (SO4)	mg/L	-	-	0.5	-	-	-	-	-	-	-	-	1.1	1.1	0.6	22	3.2
Nitrate(N) and Nitrite(N)	mg/L	10	-	**0.02**	ND	ND	0.11	ND	0.09	0.26	0.02	ND	ND	ND	ND	ND	ND
Metals																	
Mercury (Hg)	mg/L	0.05	-	0.0001	ND	ND	ND	ND	0.0003	0.0002	0.0006	0.0025	ND	ND	ND	0.0017	ND
Aluminium (Al)	mg/L	-	0.75	0.03	0.16	0.10	0.06	0.06	0.30	0.15	0.39	2.1	0.46	0.46	ND	0.23	ND
Antimony (Sb)	mg/L	0.006	-	0.006	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	mg/L	0.1	0.0001 [2]	0.0003	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	mg/L	0.025	0.34	0.002	ND	ND	ND	ND	ND	0.003	0.007	0.003	ND	ND	ND	0.003	ND
Barium (Ba)	mg/L	1	0.44 [2]	0.030	ND	ND	ND	ND	ND	ND	ND	0.04	0.09	0.09	ND	ND	ND
Cadmium (Cd)	mg/L	0.005	0.0005 [2]	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium (Cr)	mg/L	0.05	-	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	mg/L	-	0.5	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper (Cu)	mg/L	1 [3]	0.0022 [2]	0.003	0.004	0.006	ND	0.008	0.006	0.007	0.015	0.061	ND	ND	0.030	0.004	ND
Lead (Pb)	mg/L	0.05 [3]	-	0.003	ND	ND	ND	ND	0.003	0.001	ND	0.004	ND	ND	ND	ND	ND
Manganese (Mn)	mg/L	0.07	2	0.03	0.062	0.050	0.10	0.027	0.012	0.008	0.010	0.030	0.075	0.080	0.014	0.046	0.086
Molybdenum (Mo)	mg/L	0.02	0.09 [2]	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	mg/L	0.01	0.02	0.001	ND	ND	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND
Selenium (Se)	mg/L	0.01	0.0067 [2]	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002	ND
Sodium (Na)	mg/L	200 [3]		0.200	1.8	1.3	2.4	14	52	36	27	16	1.2	1.9	0.8	51	3.4
Zinc (Zn)	mg/L	5 [3]	**0.023** [2]	0.005	0.010	0.019	0.006	0.006	0.012	0.022	0.009	0.051	0.011	0.014	0.014	0.016	0.007
Boron (B)	mg/L	-	-	0.05	ND	ND	ND	ND	ND	0.12	ND	ND	ND	ND	ND	ND	ND
Iron (Fe)	mg/L	-	-	0.1	0.3	0.2	4.2	0.2	1.1	0.3	0.3	2.5	8.6	8.6	0.1	0.6	0.3
Magnesium (Mg)	mg/L	-	-	0.2	0.6	0.4	ND	1.1	ND	1.2	0.6	1.6	0.6	0.6	ND	0.9	1.8
Beryllium (Be)	mg/L	-	-	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

1 Provincial criterion applicable to cases of groundwater contamination. Soil Protection and Contaminated Sites Rehabilitation Policy, Updated 2005. Ministère du Développement durable, de l'Environnement et des Parcs

2 Criterion adjusted for a hardness of 10 mg/L of CaCO3, as specified in the MDDEP Critères de qualité de l'eau de surface au Québec [Quebec surface water quality criteria]

3 Esthetic Criterion

0,1 Concentration above or equal to the MDDEP goundwater consumption criteria[1]

0,1 Concentration above or equal to MDDEP surface water seepage and sewer infiltration criteria[1]

ND	Not Detected
N/A	Not Applicable
LOD	Limit of Detection
RDL	Reported Detection Limit
Lab-Dup	Laboratory Duplicate
QC Lot	Quality Control Lot
-	Nonexistent data or standard

6.6.1.6 Groundwater vulnerability

The assessment of groundwater vulnerability to potential contamination from human activities allows for the implementation of measures to protect resources in the most sensitive areas, if necessary. One of the methods suggested by the MDDEP to assess groundwater aquifer vulnerability is the DRASTIC method (Aller *et al.,* 1987).

Assessment of vulnerability using the DRASTIC method is carried out in two steps. The first step consists of defining the hydrogeological units based on characteristics that influence groundwater flow from the surface to the aquifer formation (Table 6.6.4) and within the aquifer. Then, the DRASTIC index of each unit is calculated using the sum, weighted by a value of 1-5 (weight), of ratings attributed to seven parameters that characterize the aquifer environment. The calculation results in minimum and maximum values of 23 and 226, respectively (often reported as a percentage). The DRASTIC vulnerability index corresponds to a number whose value increases based on the risk of aquifer contamination.

Table 6.6.4 DRASTIC Vulnerability Index Assessment

	Description	Rating	Weight
D	**D**epth to Water Table	1 to 10	5
R	Net **R**echarge	1 to 10	4
A	**A**quifer Media	1 to 10	3
S	**S**oil Media	1 to 10	2
T	**T**opography	1 to 10	1
I	**I**mpact Vadose Zone	1 to 10	5
C	Hydraulic **C**onductivity	1 to 10	3

Roche (2011) assessed the DRASTIC index for the surface aquifer considering the spatial distribution of the deposits in the area (Map 6.5.2 in folder). Values of 95-140 were estimated for the areas with till deposits, 140-180 for the sand and gravel deposits, and 111-135 for the rocky outcrop areas. The DRASTIC indices obtained indicate vulnerability considered low to medium for till on rock and basal till units and vulnerability considered high to very high for sand and gravel deposits and wetlands.

Potential contamination sources related to the construction and operation of the mine initially seem likely to contaminate groundwater. However, the risk of contamination seems limited because the vast majority of the area is covered with till deposits resting on the bedrock aquifer that typically have low permeability. The hydrogeological conditions observed on the project site therefore suggest that the groundwater contamination potential from the surface is low where till deposits are present on the surface.

6.6.1.7 Resource Users

According to the MDDEP, approximately 12% of the population of the administrative region of James Bay, that is, close to 4,600 people, is supplied by groundwater, over 25% of which comes from individual wells. This population is essentially located south of the 55th parallel.

Close to 120 wells have been the subject of drilling reports and are registered in the MDDEP Hydrogeological Information System (S.I.H.) in the James Bay area. All of these wells are located in the municipality of James Bay, just north of the Abitibi-Ouest RCM, in a 20 km by 20 km quadrilateral. Hundreds of surface wells and wells for which drilling reports were not filed or for which the reports are not yet numerized must be added to this number. It is estimated that there are about 290 wells dispersed throughout the region.

For the project's requirements, drinkable water supply will be ensured by a surface water intake located in Lake Lagopede. There are no groundwater users near the site or in the area of influence of the mining activities.

6.6.2 Impacts during the Construction Phase

6.6.2.1 Identification of Sources of Impact and Description of Impacts

The following project components are likely to have some effect on groundwater during the construction phase:

- Site preparation and development - Activities associated with site preparation, development, and construction are likely to influence groundwater quality and modify surface water recharge patterns in granular media;
- Quarry and borrow pit operation;
- Water and sediment management and dewatering of lakes and streams;
- Storage and management of fuel and hazardous materials - The use and maintenance of machinery and generator sets and fuel and hazardous material storage will increase the probability of contamination of surface water due to accidental spills or leakage of hydrocarbons or other contaminants;
- Traffic and the use and maintenance of machinery and generator sets - The use of vehicles and machinery on the site could accidentally lead to limited spills or leakage during operations.

➢ *SITE PREPARATION AND DEVELOPMENT*

The construction of the mining site will lead to surface sealing of different areas of the soil (building footprints and contractor facility, soil compaction due to the passage of trucks, etc.). This situation will increase the runoff coefficient on the site and, as a result, will lead to a local decrease in groundwater recharge rates from surface infiltration water. However, the area of these surfaces is not very large compared to the site as a whole. The area where vertical groundwater recharge will decrease will nevertheless continue to receive water through the lateral inflow of the water table.

Certain areas will also be able to act as recharge areas (e.g. permeable floor of new ditches channelling runoff). The stripping and handling of soils by machinery is also likely to modify the infiltration pattern of water in the soil toward groundwater.

Therefore, during the construction phase, impacts associated with the modification of groundwater recharge patterns can be considered minimal. The impacts will be located within the project site, over a rather limited area, and for a short duration, that is, the construction phase.

- *Quarry and Borrow Pit Operation*

Operation of the borrow pits will be limited to the portion located above the water table, as much as possible. That way, no pumping will be necessary to keep the borrow pits dry. No significant impact on groundwater resulting from operation of the borrow pits is expected.

- *Lake and Stream Dewatering and Management of Water and Sediments*

Before mining can begin in pits R-2/R-3 and R-65, lakes F3302 and F3303 must be dewatered. Dewatering of these small lakes could have an impact on the surface water table because they are local groundwater recharge and discharge areas. However, the impacts are also considered minimal because these lakes only drain from small subwatersheds, and a portion of the surface water that normally flows to them will be redirected through the drainage network developed on the site.

- *Storage and Management of Fuel and Hazardous Material*

During the construction phase, the operation of the fuel and hazardous materials storage areas and the machine shop will be sources of potential groundwater body contamination if accidental spillage or leakage of petroleum products or hazardous materials were to occur without being confined and quickly recovered. Contaminated groundwater could reappear on the surface and affect Lake Lagopede. The project site impinges almost exclusively upon an aquifer with a vulnerability considered low to medium, according to the DRASTIC index calculated in Section 6.6.1.5, since this aquifer is composed of till on rock, basal till, and bedrock, which reduces the potential for groundwater contamination.

- *Traffic and the Use and Maintenance of Machinery*

Traffic and the use and maintenance of vehicles, heavy machinery, and generator sets could lead to the spillage of hazardous materials that could potentially reach groundwater. The possibility of accidental spills or leaks during use will increase the risk of groundwater contamination by hydrocarbons or other contaminants.

6.6.2.2 Mitigation Measures

The mitigation measures and work methods implemented will limit changes to groundwater recharge patterns. It will also allow for mitigation of negative repercussions on groundwater quality so as to

prevent the risk of water contamination due to accidental spillage or leakage of hydrocarbons or other possible sources of contamination.

- *Site Preparation and Development*

The global development plan for the mine site has been progressively optimized to limit, as much as possible, the disturbance of the hydrological network and the hydrogeological systems of the surficial deposits caused by site preparation and development activities.

Mitigation measures will be adopted during the construction phase to reduce runoff and water flow to a minimum beyond the site from areas that are potential contamination sources.

- *Traffic and the Use and Maintenance of Machinery and Generator Sets*

Machinery and other mobile equipment traffic will mainly be limited to the area of access roads and work areas that will have been identified ahead of time.

- *Storage and Management of Fuel and Hazardous Materials*

Mitigation measures for the protection of groundwater resources that will be implemented for the storage and management of fuel and hazardous materials are essentially the same as those listed in Section 6.8 on water quality:

- Hazardous materials will be managed in accordance with the *Regulation respecting Hazardous Materials* (R.R.Q., c. Q-2, r. 32), the *Transportation of Dangerous Goods Regulations* (L.R.Q., c. C-24.2, Section 622), and the *Regulation respecting Biomedical Waste* (R.R.Q., c. Q-2, r. 12, Paragraphs 1-8). Petroleum products will be managed in accordance with the *Petroleum Products Act* (R.S.Q., c. P-30.01) and the *Petroleum Products Regulation* (R.R.Q., c. P-30.01, r.1) for management of petroleum products and materials;
- Petroleum product storage areas will be equipped with retention ponds with a capacity of at least 110% of the volume of the largest tank to contain accidental spills and leaks;
- Barrel storage areas will be equipped with impervious dykes or other confinement measures sufficient to contain 25% or the total capacity of all of the stored contents or 125% of the largest, whichever volume is greater;
- Leakage and spillage risk prevention and intervention procedures will be implemented (e.g. confinement structures, treatment of runoff water in fuel storage and handling areas, etc.), as well as an emergency response plan in case of spillage (intervention procedures and methods);
- Any accidental spill will be reported immediately to the person in charge of the mine's emergency plan;
- Underground areas designated as permanent spaces for routine maintenance activities, lubrication, and refuelling will be covered with a concrete floor designed to prevent the flow of petroleum products beyond the area or equipped with an automatic, leak-free filling system;
- An emergency kit for petroleum and hazardous materials recovery that is complete, permanent, and easily accessible at all times will be available at each relevant area on the site. Absorbents will be used to retain used oil;
- There will be clearly identified waterproof containers available on site to contain waste soiled by petroleum products;
- Absorbents soiled with petroleum products will be disposed of safely.

6.6.2.3 Residual Impacts

During the construction phase, considering all of the environmental design and mitigation measures that will be implemented, the intensity of the negative impact of the project on groundwater quality can be considered low. The impacts will be felt at a limited number of locations, but for a duration that may exceed the closure phase. However, with the implementation of the proposed mitigation measures, the probability that spills or leaks will alter groundwater quality will be reduced to a minimum. Modifications of groundwater recharge patterns will be limited. The significance of the impacts on groundwater during the construction phase is therefore considered low.

6.6.3 Impacts during the Operation Phase

6.6.3.1 Identification of Sources of Impact and Description of Impacts

The project components likely to affect groundwater during the operation phase are the following:

- Water management - Pumping necessary for the mine dewatering will result in changes of groundwater flow patterns, changes to the recharge patterns of Lake Lagopede (32302), recharge and discharge of lakes F3295 and F3301;
- Management of materials from mining activities (overburden, waste rock, and processed kimberlite) - Management of materials from mining activities has the potential to leach different chemical elements in the materials;
- Pit development - The presence of these sites could modify the surface water and groundwater flow in the surficial deposits;
- Traffic and the use and maintenance of machinery and generator sets;
- Waste storage, management system and trench landfill site (TLFS) - Burial of waste in the trench landfill site (TLFS) could potentially lead to the leaching of contaminants into groundwater;
- Storage and management of fuel and hazardous materials - Accidental spills or leaks of contaminants on these sites could result in changes of groundwater quality.

➢ *WATER MANAGEMENT*

One important issue of the project concerns the effects of mine pit dewatering on groundwater during operation of the mine. Indeed, the piezometric surface of the groundwater must be gradually lowered in the pit areas to allow operation of dry pits. The groundwater level in the pits will therefore be maintained by pumping under the bottom of the pits during mine operation, that is, to a final depth of 113 m below the natural surface of the soil for pit R-2/R-3 and 61 m for pit R-65.

The influence of dewatering activities on the groundwater flow regime will be controlled by hydrogeological characteristics, that is, the hydraulic properties of the geological formations and the relation between them and the hydrological network. These characteristics are complex in hydrogeological systems in fractured-rock environments, particularly in the presence of many surface waterbodies. For this reason, a numerical model was used for the needs of the project to represent the hydrogeological system and evaluate the potential impacts of dewatering.

The hydrogeological model of the Renard Project site was designed by Itasca (2011). The details of the model are presented in Appendix 6.6.1. The primary goal of the model is to assess the importance of the anticipated inflow rates during dewatering. Inflows remain relatively stable for most of the operating period assessed and are between 3,000 m^3/day and 4,000 m^3/day for all the pits, with a maximum of 4,200 m^3/day for the base case scenario. Figure 6.6.1 presents the total flow during dewatering simulated for the duration of the project based on various hypotheses on the hydrogeological context (Itasca, 2011).

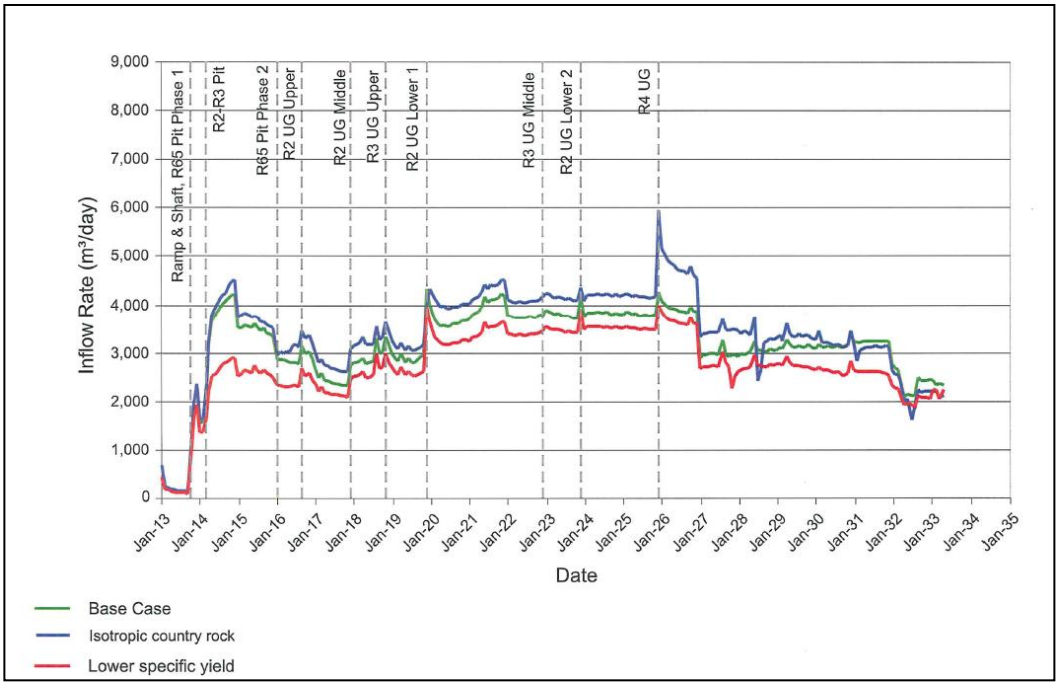


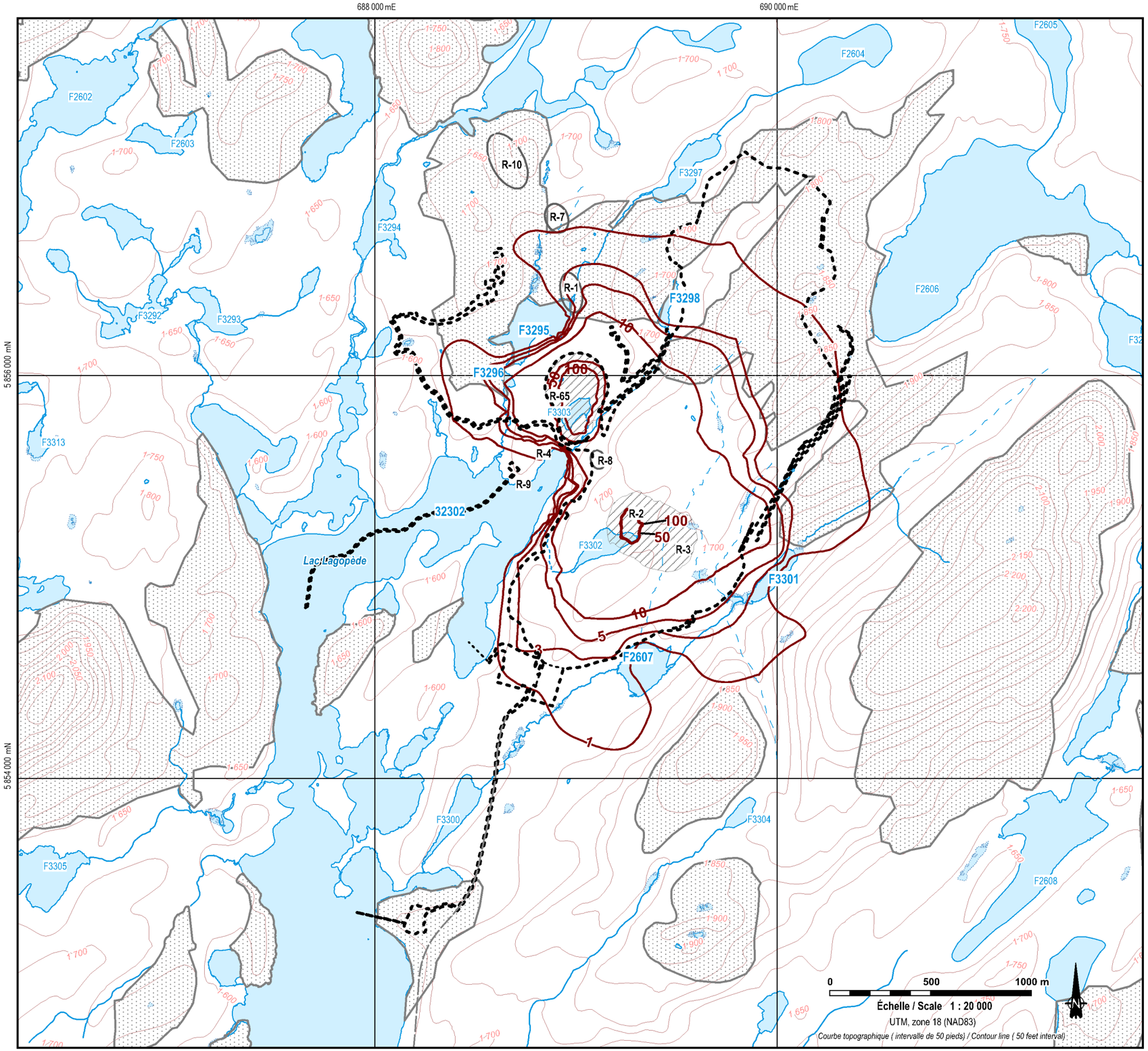
Figure 6.6.1 Total Inflow during Pit Dewatering Simulated for the Duration of Mine Operations

The model was also calibrated to examine water table drawdown caused by dewatering activities. The results of numerical simulations carried out by Itasca allowed for a spatial representation of the influence of pit dewatering on the piezometric surface at the closure of the mine. Map 6.6.2 presents the maximum drawdown induced at the closure of the mine considering the base case (expected conditions).

Map 6.6.2 illustrates that the expected groundwater levels drawdown will be at a maximum near the pits and will decrease gradually with distance from the pits. According to the simulation results, groundwater level drawdown could be on the order of ten metres deep up to a maximum distance of approximately 500 m from the pit walls. Drawdown of one metre is mainly limited to the mine site, that is, about 1 km from the pits.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment



Emprise du projet / Project footprint (26/10/2011)

Fosse d'extraction à ciel ouvert / Open pit

R-x — Autres ressources minérales / Other mineral resources

F3293 — Numéro d'identifiant de lac de CEHQ / CEHQ lake ID number

R-x — Identification du gisement / Deposit identification

Courbe topographique(intervalle de 50 pieds) / Contour line (50 feet interval)

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Affleurements rocheux / Bedrock outcrop

500 — Contours de rabattements (m) / Drawdown contours (m)

0 500 1000 m

Échelle / Scale 1 : 20 000

UTM, zone 18 (NAD83)

Courbe topographique (intervalle de 50 pieds) / Contour line (50 feet interval)

Rabattement maximal simulé des niveaux de l'eau souterraine à la fin des opérations minières / Drawdown maximal contours under steady-state conditions post pit reflooding

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_RSNES_111221.WOR

Décembre 2011 / December 2011

Carte / Map 6.6.2

The extent of the drawdown implies that groundwater levels could be lowered in some waterbodies located near the pits, which suggests that there could be surface water flow into groundwater, thus reducing a portion of the base flow of affected streams and groundwater discharge in the lakes. The magnitude of the drainage will depend on the hydraulic connection between surface water and groundwater, which in turn depends on the hydraulic properties of the bedrock and surficial formations in these areas.

Thus, six lakes were identified in the area that could potentially be affected by groundwater drawdown (Map 6.6.2). They are Lake Lagopede (32302), two lakes located at the northwest of pit R-65 (F3295 and F3296), one lake to the northeast of the same pit (F3289), one lake to the southeast (F3301), and one last lake located completely at the south of the site (F2607). These lakes were integrated to the hydrogeological model, with the exception of Lake F3296, which was deemed too small. The simulation results indicate a negligible decrease in discharge in the case of lakes F3295 and F3298, whereas for lake F3301 there would be a reduction of about 40 m^3/day of base flow , and about 60 m^3/day for lake F2607 (Itasca, 2011).

Table 6.6.5 compares the groundwater base flow reductions and the anticipated average daily inflow of surface water in Lake Lagopede for the periods before and after mine operation. The estimated reductions correspond to less than 1% of the average daily inflow to Lake Lagopede from the smaller lakes. The effect is negligible on the whole Lake Lagopede watershed.

On the basis of Itasca (2011) baseline report, Golder suggests that the low permeability of the bedrock would not favour infiltration of water from surficial deposits to the bedrock. A significant portion of the surface water will therefore mainly come from groundwater seepage from the surface deposits. As shown on Table 6.6.5, although surface water inflow to Lake Lagopede would be slightly affected by pit development (see Section 6.8.3), when compared to the overall inflow from all of the subwatersheds that drain into Lake Lagopede.

Table 6.6.5 Variations of Surface Water and Groundwater Inflow Rates in Lakes Located in the Area of Influence of Drawdown resulting from Pit Dewatering

Lake	Initial Watershed Area (ha)	Watershed Area After Mining Operation (ha)	Percentage of the Reduction of Watershed Area (%)	Average Daily Inflow to Lake Lagopede Before Operation (m^3/day)	Average Daily Inflow to Lake Lagopede After Operation (m^3/day)	Baseflow Reduction de After Operation (m^3/day)
F3301	166.0	166.0	0.0	4,246	4,246	40
F2607	358.4	263.4	26.5	9,167	6,737	60
F3295	218.5	200.6	8.2	5,589	5,131	0
F3296	224.8	207.3	7.8	5,750	5,302	No Simulation
F3298	22.6	6.8	69.6	578	174	3
F32302	15,681.2	15,435.8	1.6	401,086	394,809	0

Using a hydrogeological model remains a simplified representation of the natural hydrogeological environment. It is therefore dependent on basic hypotheses on the geometry and hydraulic properties of the various hydrogeological units used for the design of the model as well as the number and quality of data available for integration into the model. Pumping activities in similar geological environments (fractured rock aquifer environments) generally show typical drawdown of limited extent, which agrees with the results presented here (Itasca, 2011). Nevertheless, a complementary fieldwork program is planned to gather additional information in the most problematic areas to exercise tight water management during dewatering activities. In addition, a groundwater monitoring program will be implemented throughout the different phases of the project in order to measure the real impact and adapt water management accordingly.

- *MANAGEMENT OF MATERIALS FROM MINING OPERATIONS*

Extraction and management of processed kimberlite, waste rock, and overburden will have a potential to change groundwater quality, mainly in the surficial deposits. The total area occupied by the processed kimberlite confinement (PKC) area, waste rock and overburden stockpiles will be close to 115 hectares. The water that travels through these large areas could generate significant quantities of leachate water with the potential to contain some contaminants from the chemical composition of different minerals of the materials. In response to this issue, Golder (2011) carried out a study to assess exfiltration rate and the evolution of potential contaminant concentrations over time in the groundwater situated downstream of the confinement areas.

According to Golder (2011f), a layer of overburden consisting of till would be the preferred way for contaminant transportation from the confinement areas because it is more permeable than the underlying rock. Given the contrasting permeability of the two environments, there will be little infiltration into the bedrock. According to the different simulation scenarios undertaken, the report concludes the following:

- **For the PKC Area**, the exfiltration rate would be about 0.65 L/day/m^2 and 1.0 L/day/m^2. For comparison, Guideline 019 (MDDEP, 2005) states that a storage area must be designed so that the exfiltration rate is less than 3.3 L/day/m^2. Modelling using particle tracking shows that the discharge points from the PKC area will be the pit R-65 and lakes F3297 and F3298. The concentrations that could seep into pit R-65 (C/C_0) would be between 27% and 31% of the expected source concentration in the PKC leachate (C_0). The other potential receptors, that is, lakes F3297 and F3298, have not been the subject of detailed simulations because expected concentrations should also be very low given that they are located at similar distances.
- Kinetic leaching tests on processed kimberlite (Golder, 2011c) allow estimation of expected concentrations at source corresponding to the concentrations projected directly at the outlet of the PKC area. The results have shown no levels exceeding the groundwater protection criteria in the *Politique de protection des sols et de réhabilitation des terrains contaminés*. The addition of these source concentrations of background levels shows no further instances where resurgence criteria are exceeded at the location of pit R-65, with the exception of silver. However, it should be noted that the criterion for silver, adjusted according to a hardness of 10 mg/L (as suggested by the MDDEP), is below the limit of quantitation (LoQ) of the analysis method. The LoQ value of 0.0003 mg/L for silver will therefore be considered as applicable

criteria, which will not cause the limits for this parameter to be exceeded. Only copper and zinc naturally exceed the resurgence criteria, and it was shown following modelling that there will not be additional contribution for these parameters from the PKC area.

- During operation of the site, the mine pits will act as hydraulic traps for the capture of potential contaminants from the PKC area. In addition, a portion of the exfiltration water from the PKC area flowing to pit R-65, lakes F3297 and F3298 will discharge into the ditches surrounding the site. The water from the ditches will be held in sedimentation pond R-65 and treated at the treatment station before being released into Lake Lagopede.
- **For the waste rock stockpile**, exfiltration water will migrate mainly to pits R-65 and R-2/R-3, and partly to Lake Lagopede. Exfiltration rate will be ranging between 0.72 L/day/m^2 and 1.12 L/day/m^2, which is below the maximum stated in Guideline 019 (MDDEP, 2005). The concentrations that could discharge into Lake Lagopede and the peripheral ditches will be, respectively, on the order of 0.51 and 0.56 times below the expected concentrations directly at the outlet of waste rock stockpile, and these concentrations will, in turn, be all below the groundwater protection criteria of the Policy according to kinetic leaching tests. The groundwater presents levels that naturally exceed some resurgence criteria of the Policy, including copper and zinc. However, the addition of source concentrations to natural concentrations shows no significant changes to groundwater quality at the discharge points considered, that is, Lake Lagopede and the peripheral ditches.
- **For the overburden stockpile**, exfiltration water will migrate almost entirely to pits R-2/R-3. Exfiltration rate will be in order of 0.47 L/day/m^2 and 0.73 L/day/m^2 compared to the maximum value of 3.3 L/day/m^2 stated in Guideline 019 (MDDEP, 2005). The concentrations that could discharge into pit R-2/R-3 and the peripheral ditches will be 0.35 and 0.44 times lower than concentrations at the water output point of the overburden stockpile. Concentrations at the outletthe stockpile were all below the groundwater protection criteria during static leaching tests. The addition of these source concentrations with natural background levels shows no significant changes to groundwater quality at the considered discharge points, that is, pit R-2/R-3 and the peripheral ditches.

According to the different leachate tests and modellings that have been completed, most of the groundwater protection criteria of the Policy are respected both directly at the outlet of the confinement areas and at groundwater resurgence points in the respective receiving environments (Lake Lagopede, lakes F3297 and F3298, peripheral ditches, and pits R-2/R-3 and R-65). Only the criteria for phosphorous, sulphurs, copper, and zinc are exceeded because their background levels are naturally above the applicable criteria.

Negative impacts on groundwater quality should be minimal, especially since the different modellings undertaken by Golder are conservatives and neglect adsorption, precipitation, and degradation phenomena. In addition, the scenarios used during modelling can be considered conservative because they use groundwater flow conditions after pit flooding. It is therefore reasonable to believe that pumping effects during operation will decrease the total contaminant load because the mine water will be treated before being released into the receiving environment. It should be mentioned that some parameters are already present in the groundwater at the site in natural concentrations that are above the criteria.

- *PIT DEVELOPMENT*

The pit development will modify the ground surface, which will consequently influence groundwater recharge and flow patterns in the surficial deposits. However, the activities will be carried out progressively throughout the duration of the project. The resulting changes will therefore be limited, considering the timing of the activities.

- *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS*

As for the construction phase, traffic and the use of vehicles and machinery during site operation will emit some substances into the environment. The possibility of accidental spills or leaks during use will also increase the risk of groundwater contamination by hydrocarbons or other contaminants. However, with the implementation of the proposed mitigation measures, the probability that spills will alter ground water quality will be minimized.

- *WASTE STORAGE AND MANAGEMENT SYSTEM AND THE TRENCH LANDFILL SITE (TLFS)*

A trench landfill site (TLFS) will be developed for the disposal of solid wastes on the Renard Project site. Infiltration of precipitation from the waste into the groundwater located under the trench landfill site presents a potential for the transportation of different contaminants, as presented in Table 6.8.6. These contaminants could potentially make resurgence into the neighbouring lakes and thus affect the aquatic environment. To limit the impacts related to the leaching of some contaminants into the groundwater under the trench landfill site, the design of the landfill will take into account the design criteria established in Section 3 of the *Regulation respecting the landfilling and incineration of residual materials* (RRLIRM, R.R.Q. c. Q-2, r. 19). The soil at the location of the trench landfill site will also be raised and levelled to allow the burial in unsaturated area. The design of the trench landfill site (TLFS) is discussed in detail in Section 3.12.3 of the present document.

- *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

As for the construction phase, the fuel and hazardous materials storage areas and the machine shop will be potential sites of surface contamination of groundwater during the operation phase if accidental spillage or leakage of petroleum products or hazardous materials occurs without being confined and recovered quickly. Contaminated groundwater could discharge into surface water, which would mainly affect Lake Lagopede.

6.6.3.2 Mitigation Measures

A set of environmental design and mitigation measures are planned to prevent and minimize the impact of the Renard Project on groundwater flow and quality.

➢ *WATER MANAGEMENT*

Runoff from confinement areas will be managed according to the Guideline 019. In general, the approach to water management will consider the following:

- Environmental design measures have been adopted to minimize runoff in areas with potential sources of contamination (e.g. by limiting the impervious surfaces) and reducing the outfall flow (e.g. channelling water to the retention ponds during peak flows);
- All the measures implemented to collect and control water that has been in contact with the processed kimberlite, including water from the ore processing plant, pit dewatering, the waste rock and overburden stockpiles, and the processed kimberlite confinement area;
- A percolating water collection network, including drainage ditches around the waste rock stockpiles, will be installed to channel collected water to the appropriate treatment facilities;
- A monitoring programm of groundwater quality will be implemented, as requested by Guideline 019.

The results of field studies and hydrogeological modelling have allowed for identification of areas likely to present particular issues following pit dewatering activities. The following specific mitigation measures have therefore been designed to address these issues:

- Development of additional observation wells in the areas where the groundwater drawdown influence could be most significant;
- Monitoring of water levels in the observation wells during construction to validate the modelling results;
- Monitoring of flow in some streams to verify potential flow variations following dewatering activities;
- Design of a contingency plan following the acquisition of new data.

Monitoring of water levels will allow the implementation of the contingency plan, if necessary.

➢ *MANAGEMENT OF MATERIALS FROM MINING OPERATIONS*

The environmental measures design and mitigation measures proposed for the management of material from mining operations are the following:

- Only the processed kimberlite will be accepted in the processed kimberlite confinement areas;
- If anthropogenic contamination of overburden occurs or is suspected, the characterization and establishment of a management regime for this material will be made according to the rules of the most recent version of the *Politique de protection des sols et de réhabilitation des terrains contaminés* published by the MDDEP (2005).

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

Machinery and other mobile equipment traffic will mainly be limited to the area of access roads and work areas that will have been previously identified.

➢ *WASTE STORAGE AND MANAGEMENT SYSTEM AND TRENCH LANDFILL SITE (TLFS)*

The environmental design and mitigation measures proposed for the management of waste in the trench landfill site (TLFS) are as follows:

- Disposal of solid waste according to the regulations in force (Regulation respecting the application of the *Environment Quality Act* (Q-2, r.3), *Regulation respecting biomedical waste* (c. Q-2, r. 12), *Regulation respecting the landfill and incineration of residual materials* (Q-2, r.19), *Regulation respecting the environmental and social impact assessment and review procedure applicable to the Territory of James Bay and Northern Quebec* (Q-2, r.25), *Regulation respecting hazardous materials* (c. Q-2, r. 32), *Regulation respecting used tire storage* (c. Q-2, r.6.1), and *Regulation respecting the quality of the atmosphere* (c. Q-2, r. 38));
- Implementation of a groundwater quality monitoring programm as stipulated by the *Regulation respecting the landfilling and incineration of solid waste* (Q-2, r.19).

➢ *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

The mitigation measures for the protection of groundwater resources that will be implemented for the storage and management of fuel and hazardous materials are essentially the same as those to be applied during the construction phase:

- Hazardous materials will be managed in accordance with the *Regulation respecting hazardous materials* (R.R.Q., c. Q-2, r. 15.2), the *Transportation of dangerous goods regulations* (L.R.Q., c. C-24.2, section 622), and the *Regulation respecting biomedical waste* (c. Q-2, r.12), par. 1-8). Petroleum products will be managed in accordance with the *Petroleum Products Act* (R.S.Q., chapter P-30.01) and the *Petroleum Products Regulation* (R.R.Q. c. P-30.01, r.1) for management of petroleum material and products;
- Minimize the use and use alternatives to hazardous materials;
- Petroleum product storage areas will be equipped with retention basins with a capacity of at least 110% of the volume of the largest tank in order to contain accidental spills and leaks;
- Barrel storage areas will be equipped with impervious dykes or other confinement measures sufficient to contain 25% of the total capacity of all the store contents or 125% of the largest, whichever volume is greater;
- Accidental spills and leaks risk prevention procedures will be implemented (e.g. confinement structures, runoff treatment in fuel storage and handling areas, etc.), as well as an emergency response plan for spills (procedures and intervention methods);
- Any accidental spill will be reported immediately to the person in charge of the mine's emergency response plan;
- Underground areas designated as permanent places for routine maintenance activities, lubrication, and refueling will be covered with a concrete block designed to prevent the flow of petroleum products beyond the area or equipped with an automatic, leak-free filling system;
- An emergency kit for petroleum and hazardous materials recovery that is complete, permanent, and easily accessible at any times will be available at target locations on the site;
- There will be clearly identified, waterproof containers available on site to contain waste soiled by petroleum products;
- Absorbents soiled with hydrocarbons and all other solid hazardous materials will be disposed of securely in an authorized site;
- A network of groundwater monitoring wells will be implemented around developments in risk for contamination to monitor changes in groundwater quality.

6.6.3.3 Residual Impacts

Considering all of the planned environmental design and mitigation measures, the negative impact of the Renard Project on the groundwater flow regime during the operation phase can be considered moderate. Pit drainage activities during mine operation will cause drawdown of groundwater levels,

which could influence surface flow. However, it is expected that the spatial extent of the drawdown will be rather limited and mainly located near the boundaries of the pits.

The expected negative impacts on groundwater quality during the operation phase can be considered low. The different leaching tests performed in laboratory, the natural geochemical background levels measured on the site, as well as the different modellings performed indicate that the change in groundwater quality will be negligible and that at stockpile water output point at the time of resurgence in the respective receiving environments.

With the implementation of the mitigation measures, the impacts of the project on groundwater can be considered as low intensity. The impacts will be limited to the Renard Project footprint area for a moderate duration, that is, mainly the duration of the operation phase.

6.6.4 Impacts during the Closure Phase

6.6.4.1 Identification of Sources of Impact and Description of Impacts

The project components likely to affect groundwater during the closure phase are the following:

- Water management - The end of pit dewatering activities will lead to the return of groundwater levels to their initial conditions. However, the presence of new lakes, created by the flooding of the pit, could lead to changes in groundwater flow components. In addition, materials from mining operations left in place after site operation have the potential to result in different chemical elements naturally present in the material by leaching. Management of leachate water in contact with processed kimberlite and overburden in the confinement areas will be secured after site closure;
- Traffic and the use and maintenance of machinery;
- Dismantling and rehabilitation of mining facilities sites;
- Presence of site remains.

➢ *WATER MANAGEMENT*

Once mine operations have finished, the cessation of dewatering activities will result in the formation of lakes in the pits and the return of groundwater to its initial levels. The lakes will be connected to the surface water network which flows into Lake Lagopede. The final groundwater level will depend on the hydraulic characteristics of the lakes, that is, effluent and tributary flows and their steady-state conditions.

The hydrogeological model prepared by Itasca (2011) allowed for examination of groundwater upwelling in the hydrogeological system of the bedrock. Unlike the water network that is mainly fed by groundwater from the surficial deposits, the deep lakes that will be created by pit flooding will also be fed by groundwater from the bedrock. The model results suggest that the piezometric surface will not return completely to its initial conditions, but rather will be slightly lower due to the presence of the lakes (Map 6.6.3). The return to steady-state conditions would, however be quite fast, that is, in about six years (Itasca, 2011).

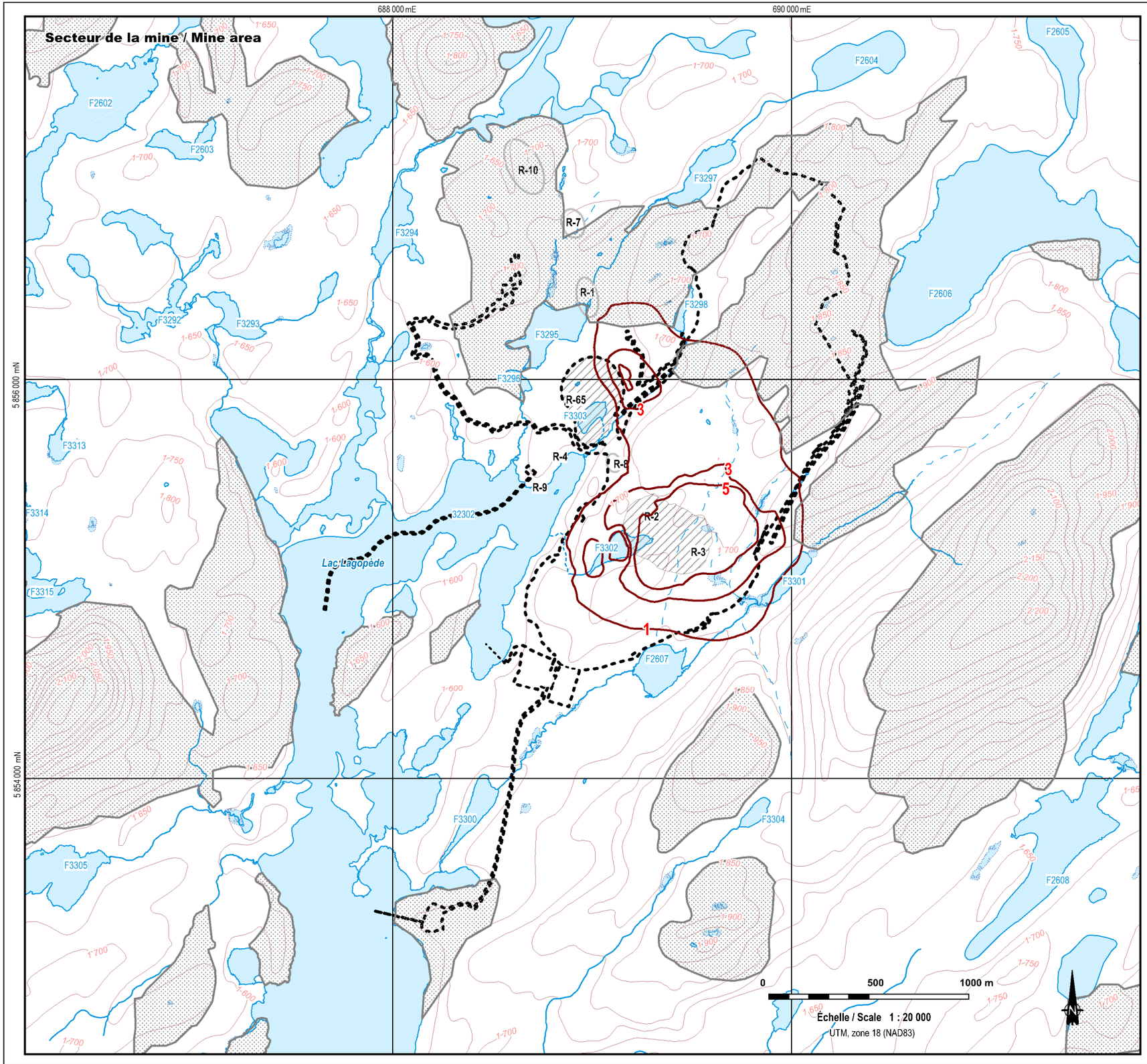
- *PRESENCE OF SITE REMAINS*

Some materials from mining operations will remain in place after site closure. This is the case for materials stored in the PKC area and the overburden stockpile, but not those of the waste rock stockpile. Design measures are planned to minimize water infiltration, control runoff, and confine water that will be in contact with the processed kimberlite. The presence of the stockpile should not significantly modify the groundwater flow regime in the areas that should return to their initial piezometric conditions. Map 6.6.3 presents the drawdown modelled once after the pits were flooded (Itasca, 2011).

Following the operation period, changes in the groundwater geochemistry near the overburden stockpile and processed kimberlite confinement areas are also possible. As previously discussed in the section on impacts during the operation phase, the concentrations that could be encountered in aquatic environments were modelled according to various scenarios deemed conservative (Golder, 2011f). During PKC area modelling, source concentrations (C_0) were maintained for the entire duration of the simulations performed with the model because the confinement area will be left in place after operation.

In general, for the PKC area, maximum normalized concentrations (ration of source concentration (C_0) divided by downstream concentration results (C) simulated at the location of the artificial lake that will be created in pit R-65 will stabilize between 0.27 and 0.31 times the source concentration expected in the PKC leachate water. The addition of source concentrations to natural concentrations shows no significant change to groundwater quality at the considered discharge points, that is, Lake Lagopede and the peripheral ditches. It was also shown by particle tracking that Lake Lagopede will not be a discharge point for groundwater from the PKC area, as illustrated in Map 6.6.4.

For the waste rock stockpile, source concentrations (C_0) were removed after the 19th year of simulation because at the end of operation this stockpile will no longer exist. The normalized concentrations (C_0/C) fall to zero after about ten years following removal of the waste rock stockpile due to removal of the source concentration (C_0).



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- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
- Écoulement souterrain / Underground flow
- Affleurements rocheux / Bedrock outcrop
- Contours de rabattements (m) / Drawdown contours (m)

Rabattement résiduel simulé des niveaux de l'eau souterraine suivant l'ennoiement des fosses / Drawdown contours at the end of mining

Carte de base / Base Map : Stornoway, 2010.
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_RSNES_risiduel_111215.WOR

Décembre 2011 / December 2011

Carte / Map 6.6.3

For the overburden stockpile, normalized concentrations (C_0/C) will stabilize after about 20 years, according to the modeling scenario. The maximum normalized concentrations (C_0/C) will be from 0.35 to 0.44 times the expected source concentration in the leachate water from the overburden stockpile. Addition of these concentrations and the natural background levels does not show significant change in groundwater quality at the considered discharge points, that is, pit R-2/R-3 and the peripheral ditch. These results seem to demonstrate that only low concentrations of contaminants in the water flowing through the materials confinement areas from mining activities will be encountered at discharge points. The results of modelling and geochemical testing suggest concentrations on the order of the natural background levels.

- *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

As for the construction and operation phases, traffic and the use of vehicles and machinery during site closure could cause the emission of some substances into the environment. The possibility of accidental spills or leaks during use will also increase the risks of groundwater contamination by hydrocarbons or other contaminants. However, with the implementation of the proposed mitigation measures, the probability that some spills will affect groundwater quality will be minimized.

- *DISMANTLING AND REHABILITATION OF FACILITY SITES*

Site dismantling activities will require specialized equipment and machinery. The use, maintenance, and traffic of vehicles and machinery during site closure will cause the emission of some substances into the environment. Sources of impact on groundwater during the closure phase are also related to traffic and the use and maintenance of machinery and generator sets, as well as the storage and management of the fuel and hazardous materials associated with them. The possibility of accidental spills or leaks during use increases the probability for contamination of groundwater by hydrocarbons or other contaminants. The implementation of the proposed mitigation measures will minimize the probability of spills that could affect groundwater quality.

6.6.4.2 Mitigation Measures

A set of environmental design and mitigation measures are planned to minimize the impacts of the Renard Project on groundwater following the closure phase.

- *WATER MANAGEMENT*

The following mitigation measures were developed to address issues that might remain on the groundwater flow regime following the closure of the site:

- Monitoring of water levels in the observation wells after site closure to validate the predictions until levels reach a steady-state conditions;
- Monitoring of flow in some streams to verify the potential flow increases following cessation of dewatering activities.

Monitoring water levels will allow for the implementation, if necessary, of elements of the contingency plan designed for the operation phase.

- *PRESENCE OF SITE REMAINS*

As specified in Section 6.6.3.2, many environmental design measures will be applied during the construction of the PKC area and the overburden stockpile to minimize the impacts related to leachate exfiltration into groundwater following the closure phase. If contaminants are observed in groundwater at the end of operations, post-restoration monitoring of groundwater quality at the downstream of the PKC area and/or the overburden stockpile will be performed over a 5-year period as recommended by Guideline 019. Monitoring will help for validation of the numerical model predictions and prevention of the loss of use of groundwater after the end of mining activities.

- *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

To minimize vehicle and machinery use, maintenance, and traffic during the site's closure phase, machinery and other mobile equipment traffic will mainly be limited to the access road area and the work areas that will have been identified previously in the site's restoration plan.

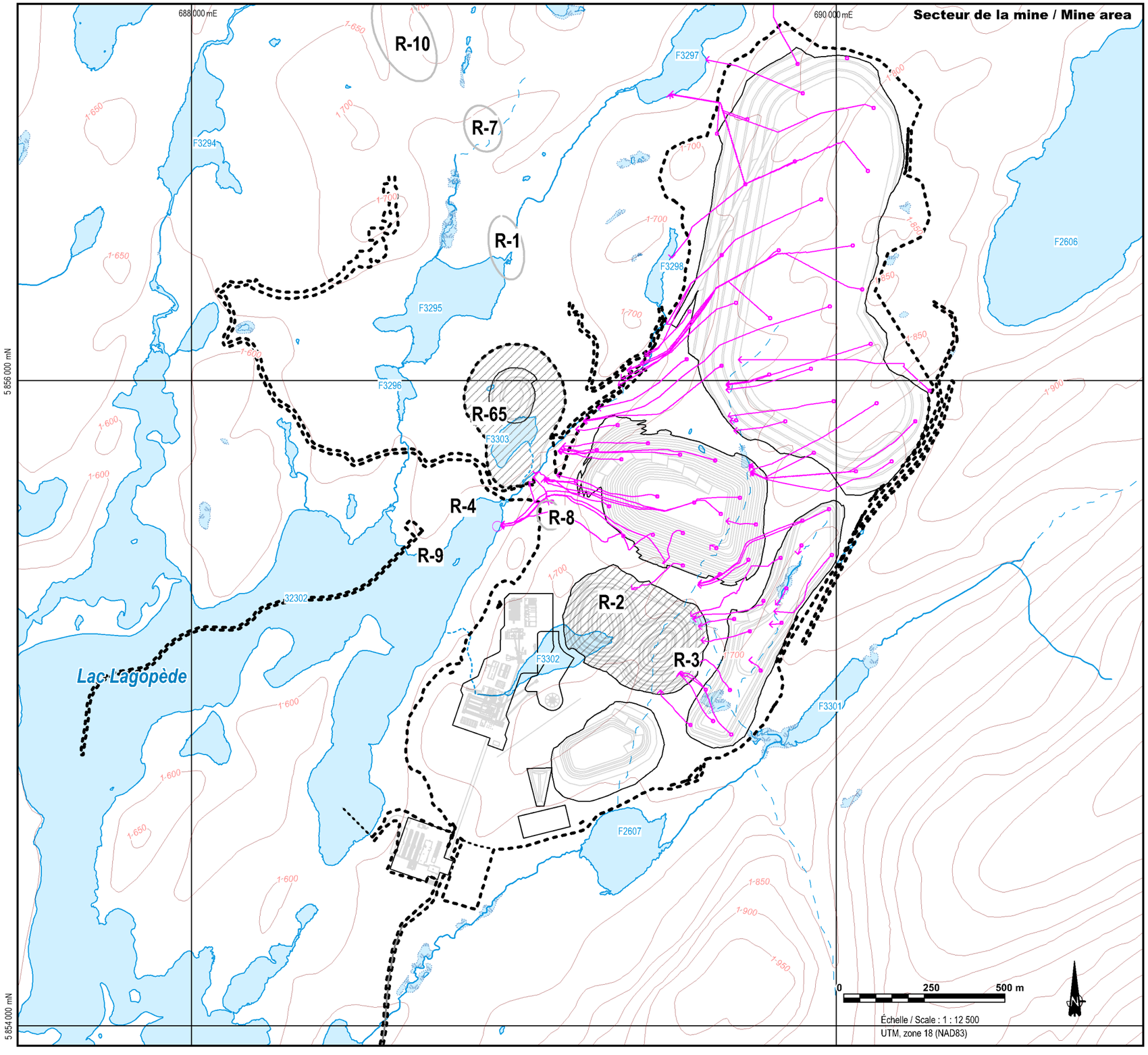
- *DISMANTLING AND RESTORATION OF MINING FACILITY SITES*

As mentioned previously, the traffic of machinery and other mobile equipment used for facilities dismantling will be limited to the area of the access roads and the work areas that will be identified in the site's restoration plan.

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- Écoulement souterrain / Underground flow
- Traçage de particules (le point indique l'origine) / Particle track (dot indicates point of origin)

Simulation du transport des contaminants par traçage de particules / Simulated contaminant transport by particle tracking

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Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_Particle track_111221.WOR

Décembre 2011 / December 2011

Carte / Map 6.6.4

6.6.4.3 Residual Impacts

Considering the environmental design and mitigation measures planned, the negative impact of the Renard Project on the groundwater flow regime at the end of the project can be considered low. The cessation of dewatering activities after mine operation will result in the return of groundwater levels to their initial conditions. The waste rock stockpile will also be removed, which will eliminate a potential source of contamination.

With the implementation of all the mitigation measures, the impacts of the project on groundwater resources during the closure phase can be considered as low intensity. The spatial extent of the impacts will be site specific to the study area of the project and have a long duration. Therefore, the importance of the impacts on groundwater is considered low.

6.7 Hydrological Regime

The Renard Project will be carried out over a period of about twenty years from 2012 to about 2033. The sequence of mining activities over time will influence the nature and significance of the impacts on the site's hydrological regime. The timeframe for activities is presented in Table 6.7.1.

Table 6.7.1 Mine Project Timeframe

Year	Site Development Sequence
2012 or 2013	Construction begins Dewatering of lake F3302 (pit R-2) Operation of first water treatment unit for treatment of water from pit R-65 begins
2013	Ramp development Shaft sinking begins Waste rock extraction from underground mine R-2 begins Delineation of projected pit R-2/R-3 Development of waste rock and overburden stockpiles Dewatering of lake F3303 (pit R-65) Construction of pit R-65 sedimentation pond Ore extraction begins
2014	Operation of open pit mines and underground mines R-2/R-3 begins Operation of second unit for treatment of water from pit R-65 begins
2015	Operation of ore process plant begins Development of the processed kimberlite confinement area
2017	Connection of pits R-2/R-3 to the underground mine
2021	Waste rock extraction from underground mine R-4 begins
2022	Ore extraction from R-65 resumes
2023	Ore extraction begins in underground mine R-4
2033	Likely end of ore extraction activities Likely end of ore process plant operations

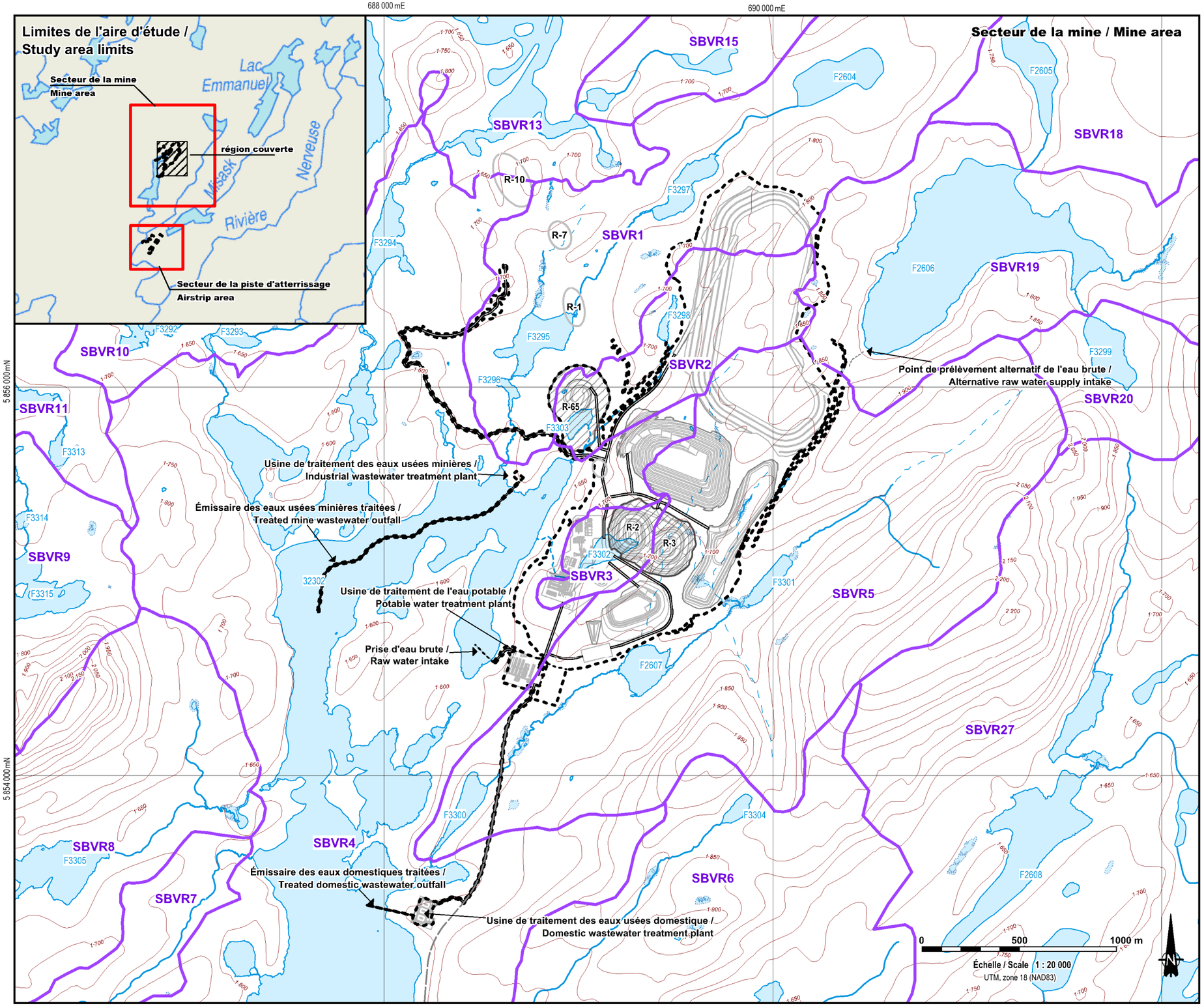
This section provides a summary of the main results of the hydrological site characterization conducted for the Environmental Baseline Study (EBS) (Roche, 2011). Then, the impacts of the various project components on the site's hydrological regime are presented for the construction, operation, and closure phases of the mine.

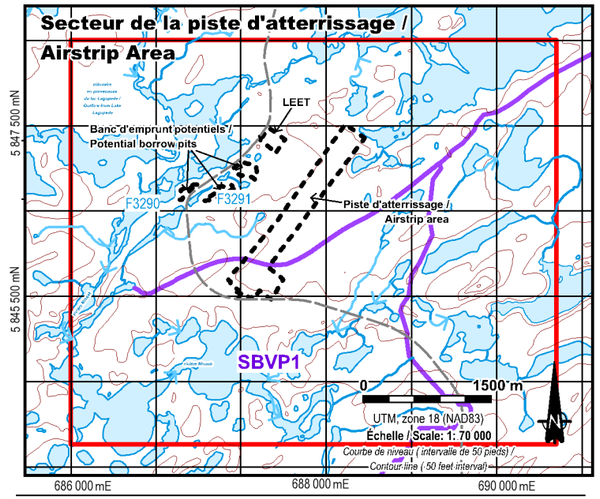
6.7.1 Current Conditions

The hydrological processes that could influence the water balance are described in detail in the EBS (Roche, 2011). The current section presents the main results and findings.

6.7.1.1 Description of the Hydrographical Network

Map 6.7.1 outlines the general location of the property within the large regional watersheds. The Renard Project is located in the Misask River watershed (1,515 km²). The Misask River flows into the Eastmain River (with a 32,893 km² watershed), where 90% of whose water is diverted to the La Grande River watershed, which has an extent of 97,400 km². The entire Eastmain watershed located upstream of the diversion point is therefore now part of the La Grande River watershed.





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- Écoulement souterrain / Underground flow
- Sous-bassins versants / Subwatersheds

Plan d'aménagement général du site et sous-bassins versants / General site layout plan and subwatersheds

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_InfraSousbassin_111221.WOR
Décembre 2011 / December 2011

Carte / Map 6.7.1

The main subwatersheds in the study area drain into Lake Lagopede. The Lake Lagopede watershed drains into the Misask River, located south of the lake. The main tributary of Lake Lagopede is a large stream located downstream of lake F3294 (Photo 6.7.1).

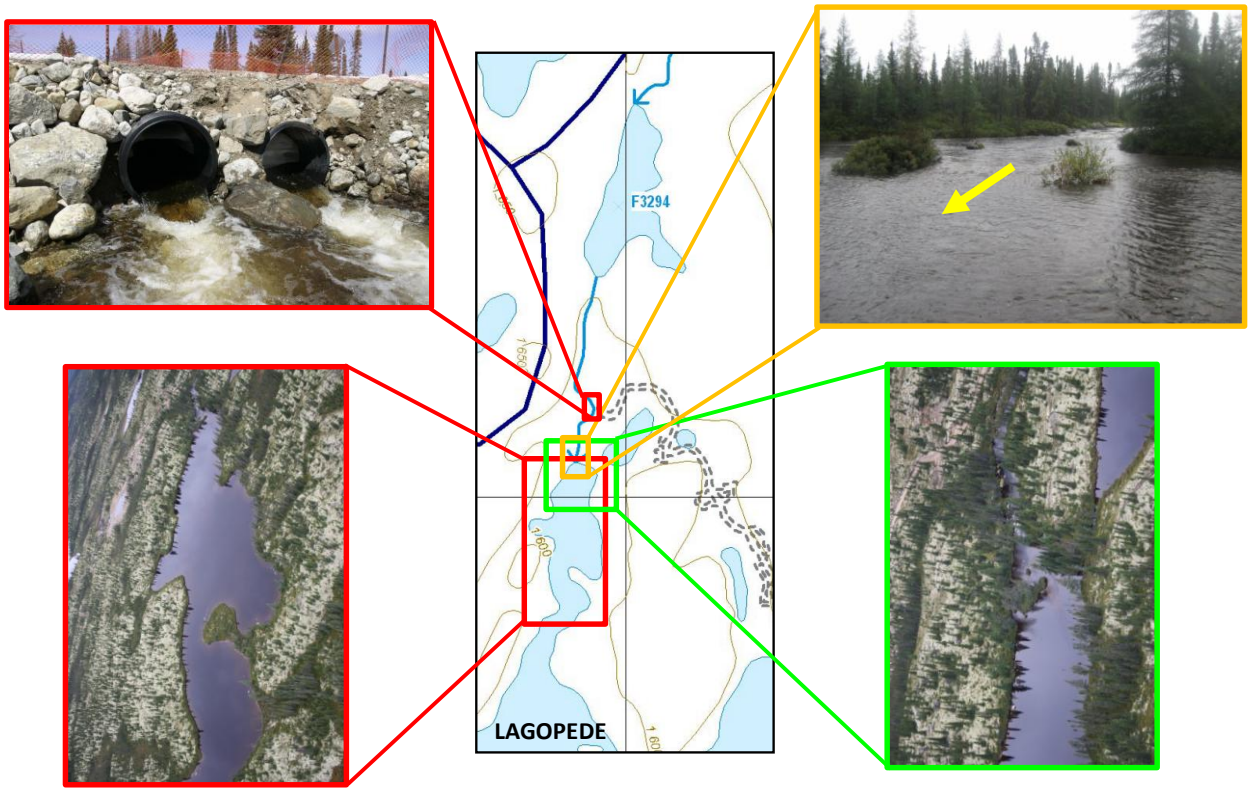


Photo 6.7.1 Photos of the Northern Bay of Lake Lagopede Showing the Lake's Main Tributary

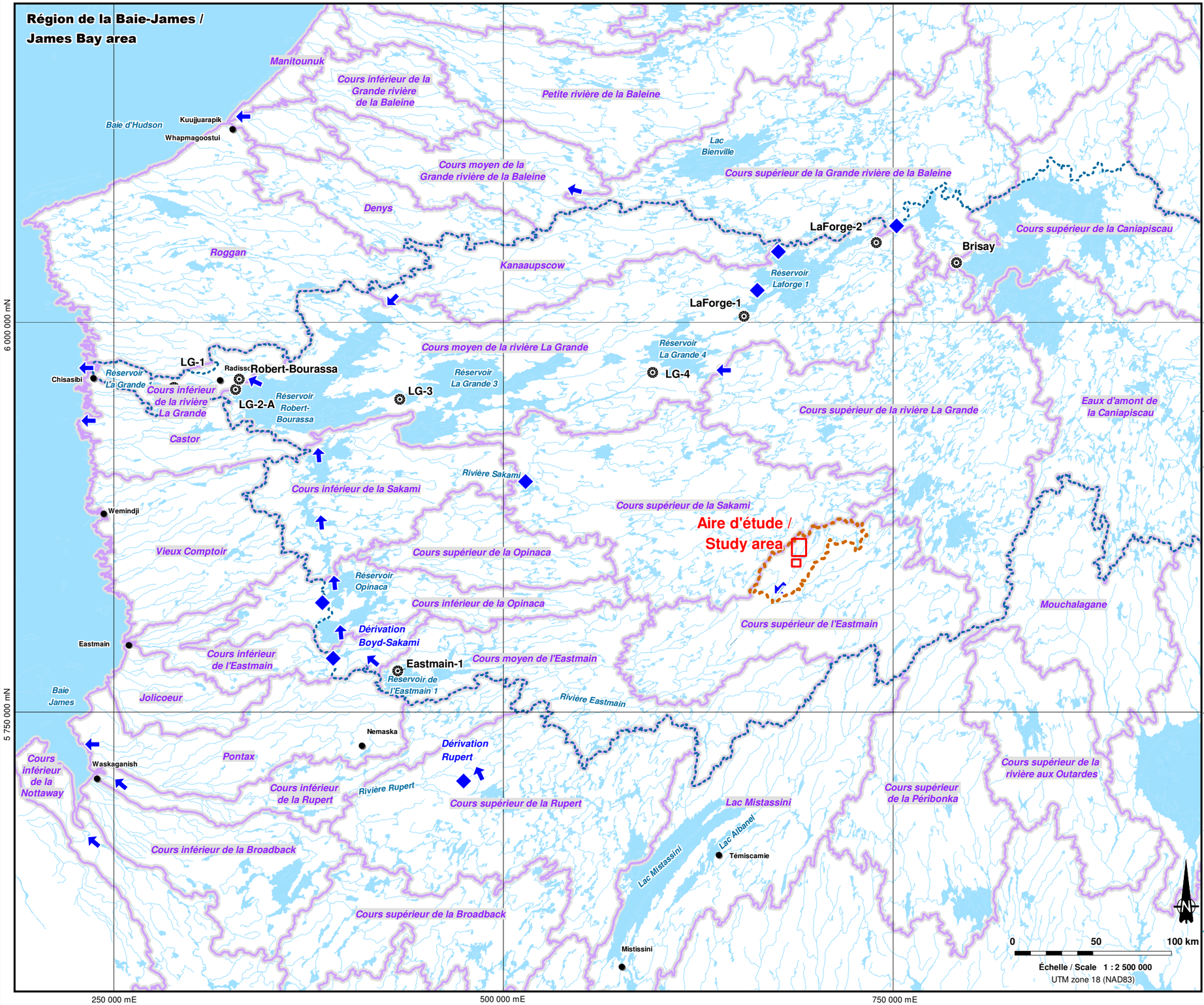
The subwatersheds located within the study area were delineated on topographical maps at a scale of 1:50,000 (Map 6.7.2). Table 6.7.2 presents the area of the subwatersheds and the area occupied by lakes within these subwatersheds. Much of the areas of certain subwatersheds are occupied by lakes. The presence of these lakes leads to flood routing[14] of water flow from the subwatersheds.

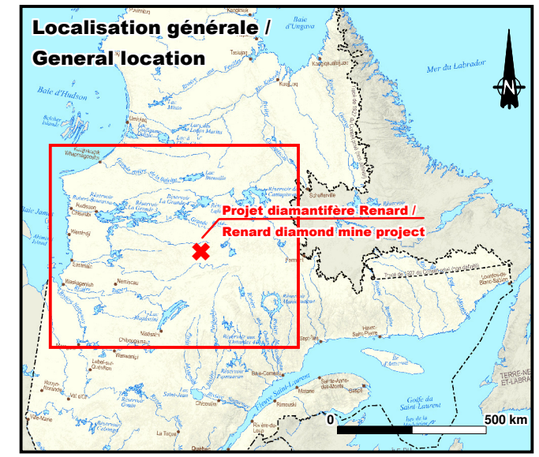
Initial field reconnaissance activities resulted in the observation that streams in the study area have very low flow and that they generally run through wetlands or boulder fields where their flow is diffuse. During surveys in summer and fall 2010, the depth of the streams measured generally varied from 0.10 m to 0.60 m. In spring 2011, during the spring flood, the depth of the streams measured was over 0.90 m. The site surveys allow to define the site's hydrological network, even where flow is diffuse. This network is illustrated by the arrows on Map 6.7.3 (list of Maps in Volume 3).

[14] Flood routing is the phenomenon of flood wave transformation causing a decrease in the flood peak (critical discharge) by spreading out the flood volume over time. This is possible because of the temporary storage of a portion of the flood volume in a stream or lake's floodplain (natural flood routing) or in the reservoir of a dam (artificial flood routing).

Table 6.7.2 Area of Subwatersheds in the Study Area

Subwatershed	Subwatershed Area (ha)	Total Area of Lakes and Waterbodies (ha)	Total Area of Lakes and Waterbodies (%)
SBVR1	233.5	18.7	8.0
SBVR2	74.8	2.2	3.0
SBVR3	21.7	2.4	10.9
SBVR4	1,576.3	520.9	33.0
SBVR5	416.8	9.8	2.4
SBVR6	835.3	107.0	12.8
SBVR7	100.8	0.0	0.0
SBVR8	220.3	12.9	5.9
SBVR9	166.5	18.6	11.2
SBVR10	139.6	13.8	9.9
SBVR11	1,586.7	393.6	24.8
SBVR12	36.8	1.9	5.1
SBVR13	700.6	237.7	33.9
SBVR14	103.7	9.3	9.0
SBVR15	56.6	3.4	6.1
SBVR16	155.5	34.9	22.4
SBVR17	148.3	0.5	0.4
SBVR18	1,006.7	95.9	9.5
SBVR19	216.9	55.8	25.7
SBVR20	63.5	5.5	8.6
SBVR23	2,700.3	444.6	16.5
SBVR24	185.6	0.0	0.0
SBVR25	1,001.9	60.1	6.0
SBVR26	338.3	24.0	7.1
SBVR27	3,594.2	422.6	11.8





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and social Impact Assessment

- Barrages (positionnés seulement lorsque le cours d'eau est partiellement ou fortement dévié de son cours naturel) - Dams are only shown where water flow is partially or largery diverted from its natural course
- Sens d'écoulement / Flow direction
- Bassin versant / Watershed
- Bassin versant la rivière La Grande / La Grande river watershed
- Bassin versant de la rivière Misask / Misask river watershed

Source:

** Bassin versant : RNC, Données-cadres nationales de l'atlas du Canada, Hydrologie - Aire de drainage, 2008 / Watershed : NRC, the atlas of Canada national framework data, Hydrology - Drainage areas, 2008*
** Bassin versant La Grande / La Grande watershed : Centre d'expertise hydrique du Québec, 2011*
** Bassin versant de la rivière Misask: RNC, Données-cadres nationales de l'atlas du Canada, Hydrologie - Aire de drainage, 2008 / Misask river watershed : NRC, the atlas of Canada national framework data, Hydrology - Drainage areas, 2008*
** Sens de l'écoulement et barrage : L'atlas des bassins versants du Canada, 2006 / Flow direction and dam : The Atlas of Canada Watershed Framework 2006*

Positionnement de l'aire d'étude au sein des grands bassins versants de la Baie-James / Location of the study area within the main watersheds of James Bay

ROCHE

Carte de base / Base Map : BNDT, 50K, 33A16-33A09
Fichier / File : 61470_EIES_BassinBJ_111219.WOR
Décembre 2011 / December 2011

Carte / Map 6.7.2

A detailed bathymetry was carried out for lakes likely to be affected by the Renard Project. The resulting bathymetric maps are presented in the EBS report (Roche, 2011). Table 6.7.3 shows the main characteristics of the lakes observed.

Table 6.7.3 Area and Volume of Lakes and Bays for which Bathymetry was Carried out in the Context of the Renard Project

Waterbody	Maximum Depth (m)	Area of the Waterbody (m^2)	Reservoir Volume (m^3)
F2607	0.98	44,230	8,575
F3295	7.06	66,910	131,600
F3296	2.27	8,278	7,720
F3300	2.88	30,050	18,910
F3302	3.26	23,240	28,360
F3301	0.98	24,630	11,530
F3303	3.83	12,560	12,780
F3290	5.24	72,660	106,900
F3312	2.44	26,290	30,790
F3316	3.63	59,830	110,080
32302	21.00	1,286,180	5,941,570
F2606	17.00	537,100	4,206,670
F32302 Lake Lagopede or Lake Kaakus Kaanipaahaapisk	25.18	4,820,084	21,076,045

6.7.1.2 Characterization of Winter Conditions

Wintertime hydrological processes that influence the project site's water balance include snowmelt, snow storage, and the ice regime. The characterization of winter conditions for the Renard Project study area was carried out based on data from the following sources:

- The Canadian Ice Service Archive (CISA[15]);
- Canadian Snow Data CD-ROM;
- Measurements taken on the site by Roche in spring 2011.

Figure 6.7.1 presents the spatial distribution of the measurement points located around the Renard Project site. The measurement stations are located between 49° and 56° latitude north and between 62° and 79° longitude west. The data analysis from these stations was used to determine the following:

- Average ice thickness (Table 6.7.4);
- Average monthly snow thickness (Table 6.7.5);
- Snow water equivalent (Table 6.7.6);
- Average monthly snow density (Table 6.7.7).

[15] http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=0A70E5EB-1

The average ice thickness value on the Renard Project site obtained by spatial interpolation from historical data is 61.42 cm. On the project site, the average annual snowfall accumulation is 3,170 mm, which is equivalent to 815 mm of water, that is, an average annual snow density of 0.26. The measurements of ice and snow taken by Environnement Illimité at the Renard Project site during the March 2011 complementary survey campaign confirm these results.

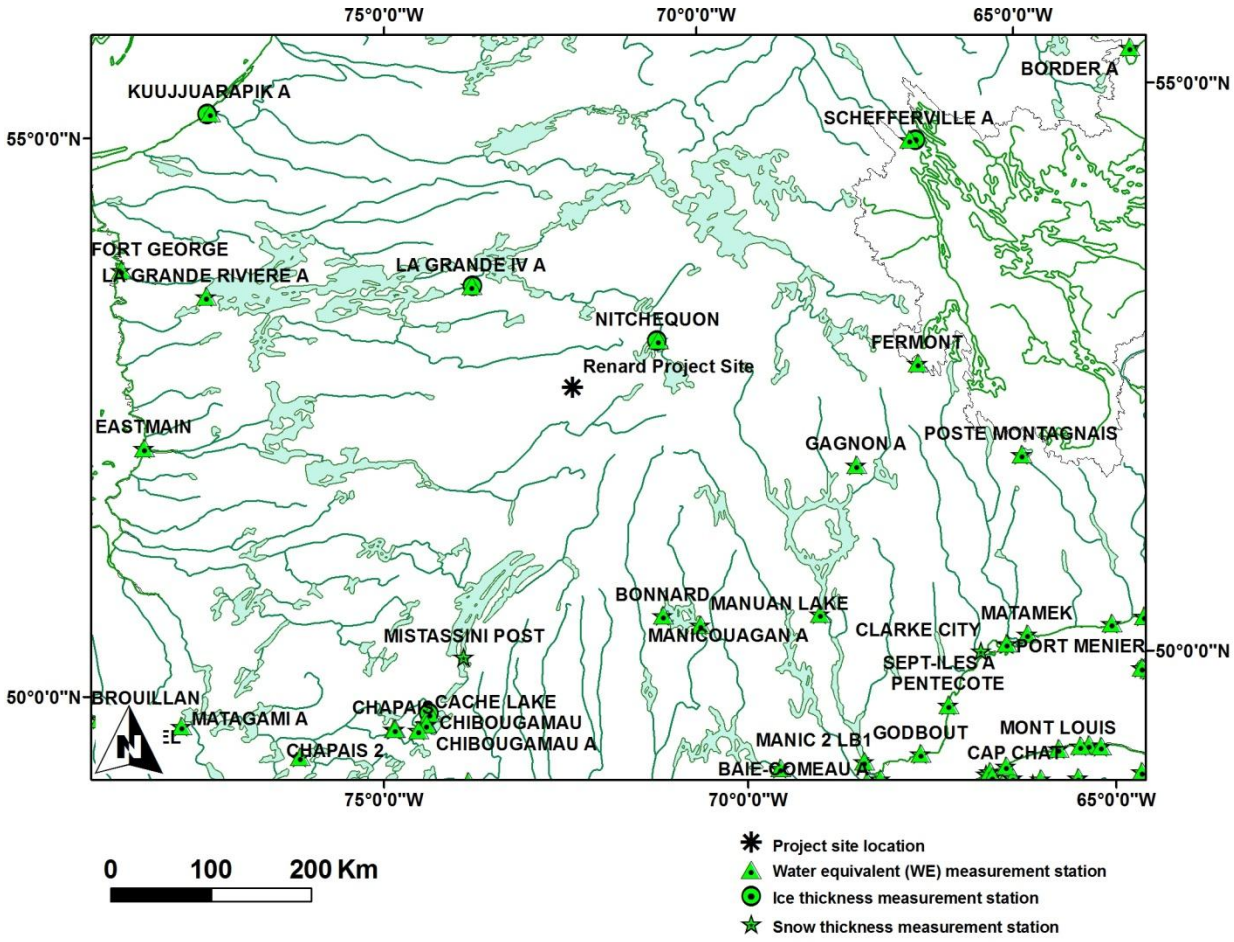


Figure 6.7.1 Location of Ice and Snow Measurement Stations and Hydrological Stations around the Renard Project Site

Table 6.7.4 Average Ice Thickness at Stations around the Renard Project Site

Station	Station ID	Distance from Site (km)	Average Thickness (cm)	Standard Deviation (cm)
Kuujjuarapik	YGW	456	102	35
La Grande IV A	YAH	143	64	23
Matagami	YMT	355	49	17
Nitchequon	YNI	96	67	27
Shefferville	YKL	424	83	33

6.7.1.3 Surface Flow Characterization

Regional and local surface flow characterization for the project site was conducted based on data from the following sources:

- Hydrological surveys from Environment Canada and the Centre d'Expertise Hydrique du Québec (CEHQ);
- CEHQ study (CEHQ, 2004) on the determination of low flow rate at hydrological stations in the Province of Quebec;
- Measurements carried out on the site by Roche and Environnement Illimité between fall 2010 and spring 2011.

Tables 6.7.8 and 6.7.9, respectively, present the specific discharge[16] for peak flow and low flow rates at the stations around the project site.

As flow in the majority of the streams located on the project site is diffuse and has little depth, the characterization of surface flow of the site's subwatersheds was carried out indirectly through the establishment of "stage-discharge" relations for lakes F3296, F3300, and F3294. These relationships are presented in Figures 6.7.2, 6.7.3, and 6.7.4. There is a strong correlation between water levels and discharge flow in the lakes gauged. The correlation coefficients are 0.9805, 0.9864, and 0.9964, respectively, for lakes F3296, F3300, and F3294. The maximum water level variations observed between fall 2010 and spring 2011 were 29.3 cm, 22.6 cm, and 57.1 cm, respectively, for lakes F3296, F3300, and F3294. Although the observation period only covers one spring flood, one can note that the rating curves of lakes F3296 et F3294 are well developed compared to that of lake F3300, whose curve remains rather high around the maximum flows measured.

[16] Specific discharge refers to flow per watershed surface unit

Table 6.7.5 Average Monthly Snow Thickness (mm) at Stations around the Renard Project Site

Station Name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Gagnon A	570	745	890	903	227	0	0	0	1	23	125	342	**3,825**
Fermont	596	754	840	691	100	0	0	0	0	21	145	417	**3,565**
Bonnard	539	681	766	667	117	0	0	0	0	11	115	334	**3,230**
Eastmain	525	709	699	412	0	0	0	0	0	9	86	357	**2,797**
La Grande Rivière A	417	478	453	281	32	0	0	0	1	23	153	316	**2,155**
La Grande IV A	531	561	546	341	33	0	0	0	1	37	164	389	**2,603**
Nitchequon	602	764	874	772	225	9	0	0	1	36	180	392	**3,854**
Renard Project Site	531	638	720	596	135	0	0	0	0	32	158	360	**3,170**

Table 6.7.6 Average Monthly Snow Water Equivalent Thickness (mm) at Stations around the Renard Project Site

Station Name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Gagnon A	146	230	256	332	110	0	0	0	0	0	15	76	**1165**
Fermont	145	182	217	205	77	0	0	0	0	0	20	92	**938**
Bonnard	138	171	202	227	89	0	0	0	0	0	20	79	**927**
Eastmain	120	164	188	135		0	0	0	0	0	19	67	**693**
La Grande Rivière A	99	130	116	95	15	0	0	0	0	1	31	66	**553**
La Grande IV A	120	135	156	116	22	0	0	0	0	0	32	82	**664**
Nitchequon	125	182	218	238	116	2	0	0	0	0	26	70	**976**
Renard Project Site	120	155	187	180	72	0	0	0	0	0	27	74	**815**

Table 6.7.7 Average Monthly Snow Density (kg/m³) at Stations Around the Renard Project Site

Station Name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
Gagnon A	0.26	0.31	0.29	0.37	-	-	-	-	-	-	0.12	0.22	**0.26**
Fermont	0.24	0.24	0.26	0.30	-	-	-	-	-	-	0.14	0.22	**0.23**
Bonnard	0.26	0.25	0.26	0.34	-	-	-	-	-	-	0.17	0.24	**0.25**
Eastmain	0.23	0.23	0.27	0.33	-	-	-	-	-	-	0.22	0.19	**0.24**
La Grande Rivière A	0.24	0.27	0.26	0.34	-	-	-	-	-	-	0.20	0.21	**0.25**
La Grande IV A	0.23	0.24	0.29	0.34	-	-	-	-	-	-	0.20	0.21	**0.25**
Nitchequon	0.21	0.24	0.25	0.31	-	-	-	-	-	-	0.14	0.18	**0.22**
Renard Project Site	0.23	0.24	0.26	0.30	-	-	-	-	-	-	0.17	0.21	**0.23**

Table 6.7.8 Flood Flow at Hydrometric Stations in the Area around the Renard Project Site

Station Number	River	Latitude	Longitude	Watershed Area (km²)	Distance from the Site (km)	Flow Regime	Number of Years of Operation	Q_2 (l/s/ha)	Q_{10} (l/s/ha)	Q_{25} (l/s/ha)	Q_{50} (l/s/ha)	Q_{100} (l/s/ha)	Q_{1000} (l/s/ha)
090610	Eastmain	52.02	73.36	11,600	120	Natural	17	1.52	1.91	2.08	2.19	2.30	2.64
092709	Sakami	53.44	76.19	1,860	277	Natural	13	1.29	1.70	1.90	2.04	2.20	2.70
090605	à l'Eau Claire	52.21	75.88	1,870	260	Natural	19	0.55	0.74	0.81	0.85	0.89	1.01
090609	Opinaca	52.72	75.99	3,700	258	Natural	16	0.66	0.86	0.94	0.99	1.05	1.20
092715	De Pontois	53.17	74.47	13,200	158	Natural	33	0.66	0.86	0.94	0.99	1.05	1.20

Q: Specific flow
l/s/ha: Litres per second per hectare

Table 6.7.9 Low Flow at Hydrometric Stations in the Area around the Renard Project Site

Station Number	River	Latitude	Longitude	Watershed Area (km²)	Distance from the Site (km)	Flow Regime	Number of Years of Operation	$Q_{2,7}$ (l/s/ha)	$Q_{10,7}$ (l/s/ha)	$Q_{5,30}$ (l/s/ha)
090610	Eastmain	52.02	73.36	11,600	120	Natural	17	0.0424	0.03	0.0344
092709	Sakami	53.44	76.19	1,860	277	Natural	13	0.0155	0.0131	0.0134
090605	à l'Eau Claire	52.21	75.88	1,870	260	Natural	19	0.0551	0.0427	0.048
090609	Opinaca	52.72	75.99	3,700	258	Natural	16	0.028	0.0208	0.0235
092715	De Pontois	53.17	74.47	13,200	158	Natural	33	0.0428	0.0335	0.0374

Q: Specific flow
l/s/ha: Litres per second per hectare

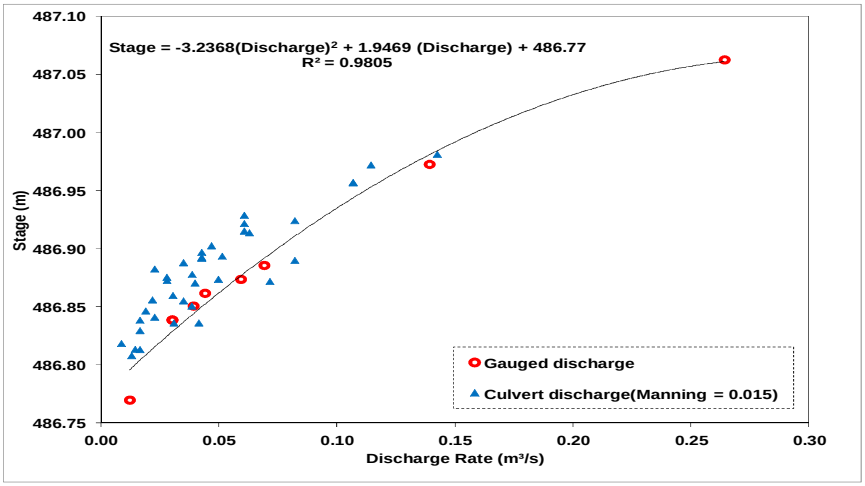


Figure 6.7.2 Rating Curve for Lake F3296

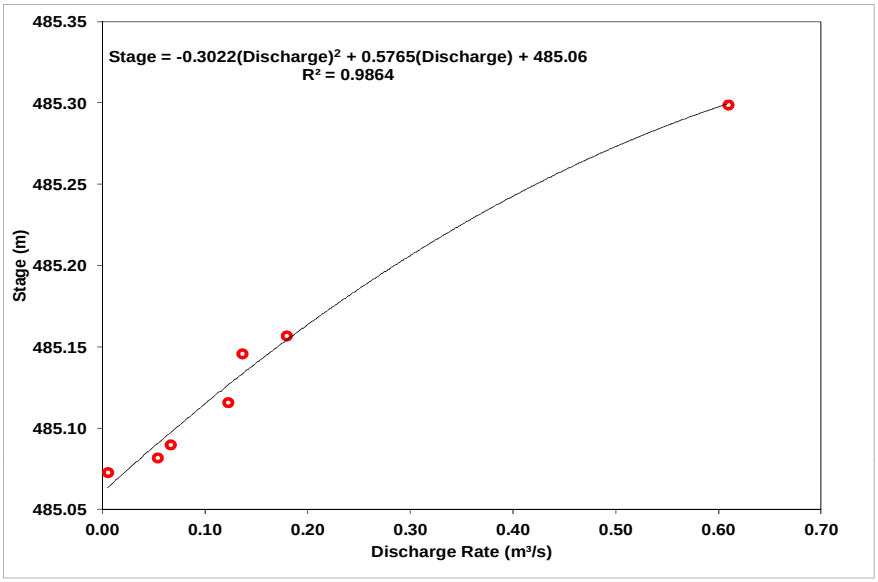


Figure 6.7.3 Rating Curve for Lake F3300

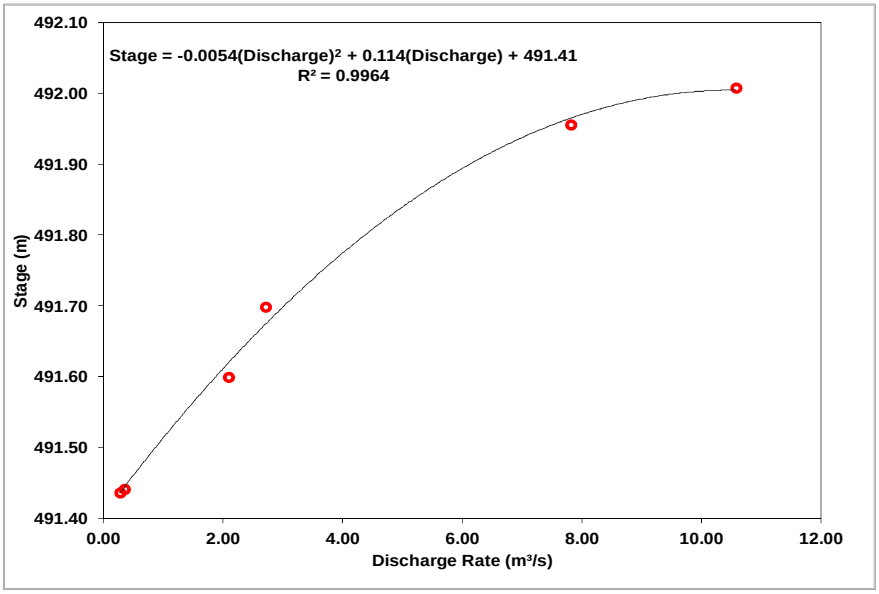


Figure 6.7.4 Rating Curve for Lake F3294

6.7.1.4 Lacustrine Evapotranspiration

An assessment of lacustrine evapotranspiration, based on evaporation estimates carried out by Environment Canada at the Nitchequon (7095480), La Grande IV A (7093GJ3), and Bonnard (7060825) stations is presented in the complementary study of the Renard Project climate and hydrology (Golder, 2011g). Table 6.7.10 presents the average monthly evaporation statistics at these stations. According to these estimates, no evaporation was observed in May and October at the Nitchequon and La Grande IV A stations, unlike the Bonnard station. According to the information obtained from the Canadian Ice Database, the average dates of ice formation, onset of snow melting, and complete thawing are October 28, May 16, and June 10, respectively, at the Nitchequon station. Some years, ice forms as early as October 4. Since the lakes in the region are partially or totally covered with ice during the months of May and October, it is reasonable to consider that evaporation is negligible during these months. If evaporation during the months of May and October is considered negligible, the annual total evaporation at this station is reduced to 319 mm (421 mm – 71 mm – 31 mm = 319 mm), that is, a value that is close to those from the other two stations. In the regional context, therefore, lacustrine evaporation is not highly variable.

Table 6.7.10 Low Flow Rate at Hydrological stations around the Renard Project Site

Month	Bonnard (1964-1994) (mm)	Nitchequon (1966-1985) (mm)	La Grande IV A (1987-1995) (mm)
May	71	0	0
June	100	92	96
July	89	98	94
August	75	79	77
September	55	49	52
October	31	0	0
Annual (mm)	421 [17]	318	319

6.7.1.5 Lake Lagopede Turnover Time

The hydrological data collected from Lake Lagopede and its watershed allowed for a more accurate assessment of the effects of anthropogenic changes to the land as a result of the project. The lake's turnover time influences its water quality and its aging process. Turnover time is a function of flow at the lake's outlet (expressed as annual volume) and the volume of the lake. Volume at the outlet corresponds to total water inflow minus loss from the lake. Loss from the lake is essentially attributed to evapotranspiration. Annual loss by evapotranspiration is estimated at 319 mm, that is, an annual volume of 5,669,761 m³. The lake's average annual inflow is estimated at 4.6 m³/s, that is, an annual volume of 146,556,852 m³. The bathymetric surveys conducted on Lake Lagopede allowed for

[17] If the evaporation values for the months of May and October at the Bonnard station are not taken into account, total annual evaporation at this station becomes 319 mm.

determination of its volume, which reaches 21,076,045 m³ (or 21 Mm^3). The turnover time of the lake corresponds to the ratio of the volume of net inflow (total inflow minus loss) and the lake's volume, that is, 0.13 years (or 53 days) or an annual turnover rate of 705%.

6.7.1.6 Runoff Coefficient

Runoff potential depends on total precipitation quantity and the characteristics of the watershed such as slope, the nature of the soil, and the proportion of lakes and waterbodies, which influences evapotranspiration and infiltration. The runoff potential of the subwatersheds is measured by the average runoff coefficient, which is the ratio between net precipitation (which represents the basin yield) and total precipitation. Net precipitation is obtained using total precipitation and deducting loss due to evapotranspiration, infiltration, and sublimation. Total annual precipitation, estimated from the Nitchequon meteorological station, is 827 mm (that is, 518 mm of rain and 309 mm in snow water equivalent). Loss from sublimation, evapotranspiration, and infiltration in the Renard Project area were estimated by Roche and Golder (2011g). Total estimated loss is 331 mm, that is, 62 mm from sublimation and 269 mm from evapotranspiration and infiltration. The subwatersheds on the Renard Project site are small, and the majority of the streams into which they drain are also small. For these types of subwatersheds, wintertime runoff is negligible. The average annual runoff coefficient in the project site area is estimated at 0.39.

6.7.2 Impacts during the Construction Phase

6.7.2.1 Description of Impacts

The following project components are likely to affect the hydrological flow regime during the construction phase:

- Dewatering of lakes and sediment and water management - Dewatering of lakes is likely to modify the water levels in neighbouring lakes and could also lead to diversion of certain streams;
- Site preparation and development (clearing, drilling, blasting, filling, cutting, drainage, materials confinement and storage areas, borrow pits, and secondary roads) for all facilities - Site preparation and development is likely to change land uses in affected areas. This may change the natural water cycle (interceptions by leaves on trees, volumes of water infiltration and runoff);
- Water management on the construction site (runoff, drinking water, process water, wastewater, etc.) - The water management plan during the construction phase is likely to temporarily modify the hydrological flow regime in certain subwatersheds.
- Water supply - Due to the large volume of water available in Lake Lagopede and the low withdrawal rate during the construction phase, water withdrawal from Lake Lagopede is not likely to modify the hydrological flow regime of the subwatersheds on the site;
- Quarry and borrow pit operation - Materials extracted from the borrow pits will only be necessary for the construction of the airstrip. Material for the construction of other sites will come mainly from the crushing of waste rock from pit R-65 and overburden. The quantities extracted will be limited and as a result will not have a significant effect on the hydrological flow regime;

- Construction of mining facilities (ore process plant, accommodation complex, airstrip, power generating sets, and ancillary facilities).

➢ *DEWATERING OF LAKES AND SEDIMENT AND WATER MANAGEMENT*

In order to securely mine pits R-2/R-3 and R-65, it will be necessary to dewater two small lakes (F3302 and F3303). A total of 41,140 m³ of water (28,360 m³ and 12,780 m³ from lakes F3302 and F3303, respectively) will be pumped to mobile treatment units capable of treating up to 2,000 PPM of total suspended solids. When necessary, pumped water will be temporarily stored in a sedimentation pond before being released into Lake Lagopede following treatment. The volume of pumped water represents 0.2% of the volume of Lake Lagopede, with a maximum estimated water level increase of 8.5 mm. Dewatering of lakes F3302 and F3303 will begin in year -2 of the mine, and pumping will be carried out using pumps with capacities of 30 L/s (476 U.S. gallons/min) and 189 L/s (3,000 U.S. gallons/min), respectively, for lakes F3302 and F3303 (Golder, 2011e). The amounts of time necessary to dewater lakes F3302 and F3303, assuming that pumping is carried out continuously, are 10.9 days and 0.8 days, respectively.

➢ *SITE PREPARATION AND DEVELOPMENT*

Site preparation and development activities, such as clearing, excavation, earthworks, secondary road construction, and the development of material storage areas and borrow pits will lead to modifications to the limits of the subwatersheds and surface runoff coefficients. Subwatersheds SBVR1, SBVR2, SBVR3, and SBVR5 will be affected by preparation and development activities. Table 6.7.11 presents the percentage of the affected area of each subwatershed. The combination of clearing and surface sealing will increase peak flows at outlets in the affected watersheds. The total area affected by site preparation and development activities is 201 ha, that is, 2.5% of the overall area of the subwatersheds that drain into Lake Lagopede.

Table 6.7.11 Area of Subwatersheds Affected by the Preparation and Development of Mine Sites

Subwatershed	Initial Area (ha)	Affected Area (ha)	Percentage of Total Area
SBVR1	233.5	11.3	4.9
SBVR2	74.8	58.8	78.6
SBVR3	21.7	21.7	100.0
SBVR5	416.8	102.0	24.5

➢ *WATER MANAGEMENT ON THE CONSTRUCTION SITE*

Open pit R-65 will be developed at the current outlet of subwatershed SBVR2 and will cover an area of 21.5 ha. The water in this subwatershed located upstream of pit R-65 will be diverted during mine construction to avoid the filling of pit R-65 during operations.

The water management plan presented by Golder (2011e) calls for the development of a 690 m ditch to divert the water of subwatershed SBVR2 upstream of pit R-65 toward lake F3295 of subwatershed SBVR1. During the construction phase, 59% of the area of subwatershed SBVR2 (that is, 44.5 ha) will be diverted toward lake F3395. Water inflow in subwatershed SBVR1 will consequently increase by about 19%. This increase is temporary because after the development of the processed kimberlite confinement area, this additional area will be reduced to 7.2 ha, or a 7% increase of the area of subwatershed SBVR1.

6.7.2.2 Mitigation Measures

- Sediments from dewatered lakes will be excavated at the start of winter to minimize the sediment transport;
- Water at the bottom of lakes with high total suspended solids content will be treated using EnviroBags before being released into Lake Lagopede;
- The water management plan presented by Golder (2011e) calls for a network of ditches and culverts to collect runoff and a water treatment station allowing for water quality control before water is released into Lake Lagopede.

6.7.2.3 Residual Impacts

During the construction phase, following implementation of the mitigation measures, impact intensity is considered high, with a site specific spatial extent and a long duration because the impacts will continue beyond the life of the mine. As a result, the significance of the residual impacts is considered medium.

6.7.3 Impacts during the Operation Phase

6.7.3.1 Description of impacts

The following project components are likely to affect the hydrological flow regime during the operation phase:

- Pit development (clearing, drilling, blasting, cutting, filling, and drainage) - Pit development is likely to modify the topography and the surface of the terrain on which runoff flows in the site's subwatersheds;
- Management of materials from mining operations (overburden, waste rock, and kimberlite). Management of these materials is likely to modify the quantity of runoff water;
- Water management (runoff water, mine water, drinking water, process water, waste water, etc.) - Water management on the site during the operation phase is likely to modify the site's natural drainage network. Peak flows and arrival times of peaks could be affected by water management;
- Water supply - Due to the large volume of water available and the low rate of removal during the operation phase, withdrawal of water from Lake Lagopede is not likely to modify the site's water regime.

- *Pit Development (Clearing, Drilling, Blasting, Cutting, Filling, and Drainage)*

The footprint areas of pits R-2/R-3 and R-65 are 16.2 ha and 21.5 ha, respectively. These areas only represent 0.2% of the overall area that drains into Lagopede Lake. As a result, clearing of these areas should not have more than a minimal impact on the site's hydrology.

- *Management of Materials from Mining Operations (Overburden, Waste Rock, and Processed Kimberlite)*

Materials from mining operations, such as overburden, waste rock, and processed kimberlite will be stored in stockpiles and confinement areas. This will lead to the reconfiguration of subwatersheds SBVR1, SBVR2, SBVR3, and SBVR5. Table 6.7.12 presents the average annual flow runoff under natural conditions for the sites where the storage areas will be developed. After the development of the storage areas, exfiltration of water in contact with stored tailings (waste rock, overburden, processed kimberlite) will occur. The volume of the exfiltrated water will vary according to the hydraulic conductivity of the materials that make up the various storage areas. Exfiltration flows have been determined through numerical modelling by Golder (2011f) and are presented in Table 6.7.12. The water management plan calls for the development of ditches around the storage areas to collect exfiltration water as well as its treatment before being discharged into Lake Lagopede.

Table 6.7.12 Exfiltrated Flows of Tailings for the Renard Project

Storage Area	Exfiltrated Flow of Mine Tailings (*) (L/s)	Natural Flow Before Storage (L/s)
Overburden	0.71 – 1.1	3.85
Waste Rock	1.71 – 2.66	6.07
Processed kimberlite	5.12 – 7.87	20.13

(*) Flows based on the Golder (2011f) model results

The development of the processed kimberlite confinement area and of the overburden, waste rock, and ore stockpiles will lead to a reduction of the areas draining into lakes F2607, F3295, F3296, F3298, and F32302. As a result, there will be a local reduction of the water table recharge. Table 6.7.13 presents the impacts of the development of the stockpiles and confinement areas on inflow to the lakes near the site.

Table 6.7.13 Changes to Inflow in Lakes Located around the Renard Project

Lake	Initial Drainage Area (ha)	Drainage Area after Mine Construction (ha)	Percentage of Decrease in Drainage Area (%)	Average Daily Flow to Lake before Mine Construction (m^3/day)	Average Daily Flow to Lake after Mine Construction (m^3/day)
F3301	166.0	166.0	0.0	4,246	4,246
F2607	358.4	263.4	26.5	9,167	6,737
F3295	218.5	200.6	8.2	5,589	5,131
F3296	224.8	207.3	7.8	5,750	5,302
F3298	22.6	6.8	69.9	578	174
F32302	15,681.2	15,435.8	1.6	401,086	394,809

- *WATER MANAGEMENT*

During the operation phase, taking into account the development of the various stockpiles and confinement areas and the construction of the mining complex, a portion of subwatersheds SBVR1, SBVR2, SBVR3, and SBVR5 with a total area estimate at 203 ha will be diverted to a sedimentation pond developed in pit R-65, where water will be treated before being released into Lake Lagopede after quality control. Table 6.7.14 (Golder, 2011e) presents the daily water volumes diverted to the sedimentation pond of pit R-65. The average daily water flow pumped from pit R-65 to Lake Lagopede will be between 2,600 m^3/day (950,000 m^3/year in 2025) and 5,265 m^3/day (1,922,000 m^3/year in 2015). The natural flow drained from these areas into Lake Lagopede is estimated at 5,200 m^3/day. Water management should not lead to a significant change to Lake Lagopede's water inflow.

Table 6.7.14 Water Flow during the Construction and Operation Phases of the Renard Project (According to Golder, 2011e)

Flow in 1,000 m^3/year	Calendar Year / Operation Year													
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11
Ditches	61	677	719	1,132	1,159	1,187	1,187	1,187	1,187	1,187	1,187	1,187	1,187	618
Surface Runoff to R-65	0	132	132	132	133	132	132	131	133	132	131	132	132	69
Exfiltration of R-65	0	47	54	44	41	38	36	34	32	31	193	216	206	109
Pumping to Pit R-65	31	113	329	614	338	228	339	327	395	322	296	348	325	154
Water Treated in Pit R-65	92	969	1,234	1,922	1,671	1,585	1,694	1,679	1,747	1,672	1,807	1,883	1,850	950

➢ *WATER SUPPLY*

During the operation phase, water withdrawal from Lake Lagopede will be necessary for the following activities: fire protection, water supply source (dust control, cleaning, etc.), and possibly for the needs of the accommodation and services complex. The average flow withdrawn will be 160 m³/day, with a peak of 240 m³/day. Inflow to Lake Lagopede during low flow periods ($Q_{2.7}$ flow) is assessed at 21,000 m³/day. The flows withdrawn are very low compared to inflow and therefore should not lead to significant modification of the lake water level.

6.7.3.2 Mitigation Measures

To minimize the impact of the mine on the site's hydrological flow regime during the operation phase, the water management plan calls for the pumping of the water collected in the sedimentation pond of pit R-65 for reuse at the ore processing plant. Thus, recirculation of the site's water in a closed loop will minimize withdrawal of water from and release into the waterbodies around the site.

The impacts of the waste rock stockpile on the configuration of the site's natural subwatersheds will be limited by the fact that throughout the mine life, material from the waste rock stockpile will be returned to the pits.

6.7.3.3 Residual Impacts

During the operation phase, following the implementation of the mitigation measures, the intensity of the impacts is considered moderate, with a site specific extent and a moderate duration because the impacts will be felt during the mine's operation phase. As a result, the significance of the residual impacts is considered medium.

6.7.4 Impacts during the Closure Phase

6.7.4.1 Description of Impacts

The following project components are likely to affect the hydrological flow regime during the closure phase:

- Water management - Water management includes flooding of pits R-65, R-2, and R-3, restoration of the affected hydrographical network, the water management plan, and the operation of domestic and mine wastewater treatment stations until they are no longer necessary. These activities will modify the natural drainage network of the site. Peak flows and arrival times of peaks could be affected by water management.
- Final site rehabilitation and revegetation - This includes all activities aimed at stabilizing disturbed soil surfaces, restoring soil and overburden cover, and revegetating surfaces using indigenous plant species. These activities will modify the topography and the drainage surface in the site's subwatersheds.

- *WATER MANAGEMENT*

At the end of mining, it is planned for open pits R-2/R-3 (4,938,000 m³) and R-65 (8,550,000 m³) to be filled with water. The water sources required for the flooding are net precipitation (net precipitation takes into account loss by evapotranspiration and sublimation), underground flow from the water table, and water from other waterbodies, such as Lake Lagopede (R-65). Average annual net precipitation on the project site is estimated at 496 mm (Roche, 2011), that is, annual inflow of 80,352 m³ and 106,640 m³ in pits R-2/R-3 and R-65, respectively. Inflow from groundwater flow has been determined using a three-dimensional hydrogeological model developed by Itasca (Itasca, 2011). Average groundwater flows during the filling of pits R-2/R-3 and R-65 will be 1.62 L/s (51,100 m³/year) and 1.19 L/s (37,500 m³/year). Surface flow within pit R-2/R-3 is estimated at 1,068,480 m³/year. It is planned that pit R-2/R-3 will be filled by net precipitation, surface runoff and groundwater inflow. The time necessary for pit R-2/R-3 to be filled with water is estimated at seven years (Itasca, 2011).

It is planned to control the filling of pit R-65 such that it will take the same amount of time as the filling of pit R-2/R-3. To accomplish this task, the development of an open ditch linking Lake Lagopede to pit R-65 is planned to allow additional inflow. Flow through this ditch will be controlled to allow the filling of pit R-65 to occur simultaneously with that of pit R-2/R-3. The annual additional flow required to contribute to the filling of pit R-65 is 516,000 m³ (or 2.8 L/s). This withdrawn flow represents 1.16% of the low flow rate of 240 L/s entering Lake Lagopede (Roche, 2011). Withdrawal should not, therefore, influence the water level in Lake Lagopede.

The filling of pits R-2/R-3 and R-65 at the end of mining activities will considerably mitigate the effects of the dewatering of lakes F3302 and F3303. Considering that the lakes resulting from pit flooding will have a larger volume than those that will have been dewatered, filling will have a positive impact on the site.

- *FINAL SITE REHABILITATION AND REVEGETATION*

At the mine closure, the overburden and processed kimberlite stockpiles will be left in place and will be permanent hills. Their presence will lead to the local reconfiguration of subwatersheds SBVR1, SBVR2, and SBVR3. The revegetation of these stockpiles will modify the runoff coefficient by slowing down surface runoff. Revegetation will also contribute to protecting the slopes of the stockpiles from erosion.

6.7.4.2 Mitigation Measures

At the mine closure, the hydrographical network on the site will be restored as much as possible. Pits R-2/R-3 and R-65 will be flooded and become new lakes with volumes 174 and 699 times greater than lakes F3302 and F3303, respectively. All of the material from the waste rock stockpile will be returned to underground sites and pits. The overburden stockpile and processed kimberlite confinement area will be revegetated to give them a more natural aspect. All of the facilities of the mining complex will be dismantled and the spaces they will have occupied will be revegetated.

6.7.4.3 Residual Impacts

During the closure phase, the overburden stockpile and processed kimberlite confinement area will be left in place as permanent hills. Their presence will lead to the local reconfiguration of subwatersheds SBVR1, SBVR2, and SBVR3. This impact will be permanent and strictly limited to the area of the affected subwatersheds.

For the closure phase, following the implementation of the mitigation measures, the impact is considered positive with a high intensity, site specific extent, and long duration. As a result, the significance of the residual impacts is considered moderate.

6.8 Surface Water

6.8.1 Current Conditions

Water is essential to maintain natural ecosystems and support traditional human activities and needs (subsistence hunting and fishing, drinking water) in the study area. Good water quality is especially necessary for the survival of aquatic organisms such as fish harvested through traditional fishing activities. Water in the study area is also important as a source of drinking water for the few Cree camps that are scattered throughout the area as well as for the current and future users of the mine site.

The characterization of surface water quality in the Renard Project study area was carried out using data from several surface water sampling campaigns conducted between 2002 and 2010 and whose detailed results are presented in the sectoral report on the physical environment for the Renard Project Environmental Baseline Study (Roche, 2011). Between 2002 and 2004, surface water samples were taken within a 15 km radius around the mine property (Amyot, 2002; Roche 2003, 2005; Appendix 6.8.3). The most recent campaigns were carried out in 2010 during a low flow period (July 2010) and a period of abundant rainfall (September-October 2010) (Roche, 2011).

The sampling stations were positioned in order to obtain a representative spatial coverage of the lakes and streams likely to be influenced by the project, and control stations were positioned upstream of the projected facilities sites.

Tables 6.8.1 and 6.8.2 summarize the 2010 water quality results from the 26 stations where samples were collected. The location of the stations, the boundaries of the subwatersheds, and the location and flow directions of lakes and streams are illustrated in Map 6.8.1. Appendices 6.8.1 and 6.8.2 present the results of quality control carried out during sampling. For each of the parameters measured, the natural variability of water quality is presented in Table 6.8.3.

Results obtained as part of the impact assessments of Route 167 North extention project (Roche-SNC Lavalin Consortium, 2010) and the Matoush Project (Strateco Resources, 2009) are used to draw a regional profile of water quality and to put the results obtained in the Renard Project study area into perspective.

In order to protect water uses, water quality results were compared to the Canadian water quality guidelines for the protection of aquatic life (CCME, 2007) and the Quebec water quality criteria for the protection of aquatic life and the contamination of aquatic organisms prevention criteria (with water intake) (MDDEP, 2009).

The criteria for the protection of aquatic life have been established to protect aquatic life in all its forms and in all aspects of their aquatic life cycles, while MDDEP criteria for protection from contamination aim to protecthuman who consume organisms from aquatic environment.

Two water quality criteria for the protection of aquatic life are set out by the MDDEP (2009) - one criterion for the protection of aquatic life from acute effects and one criterion for the protection of aquatic life from chronic effects:

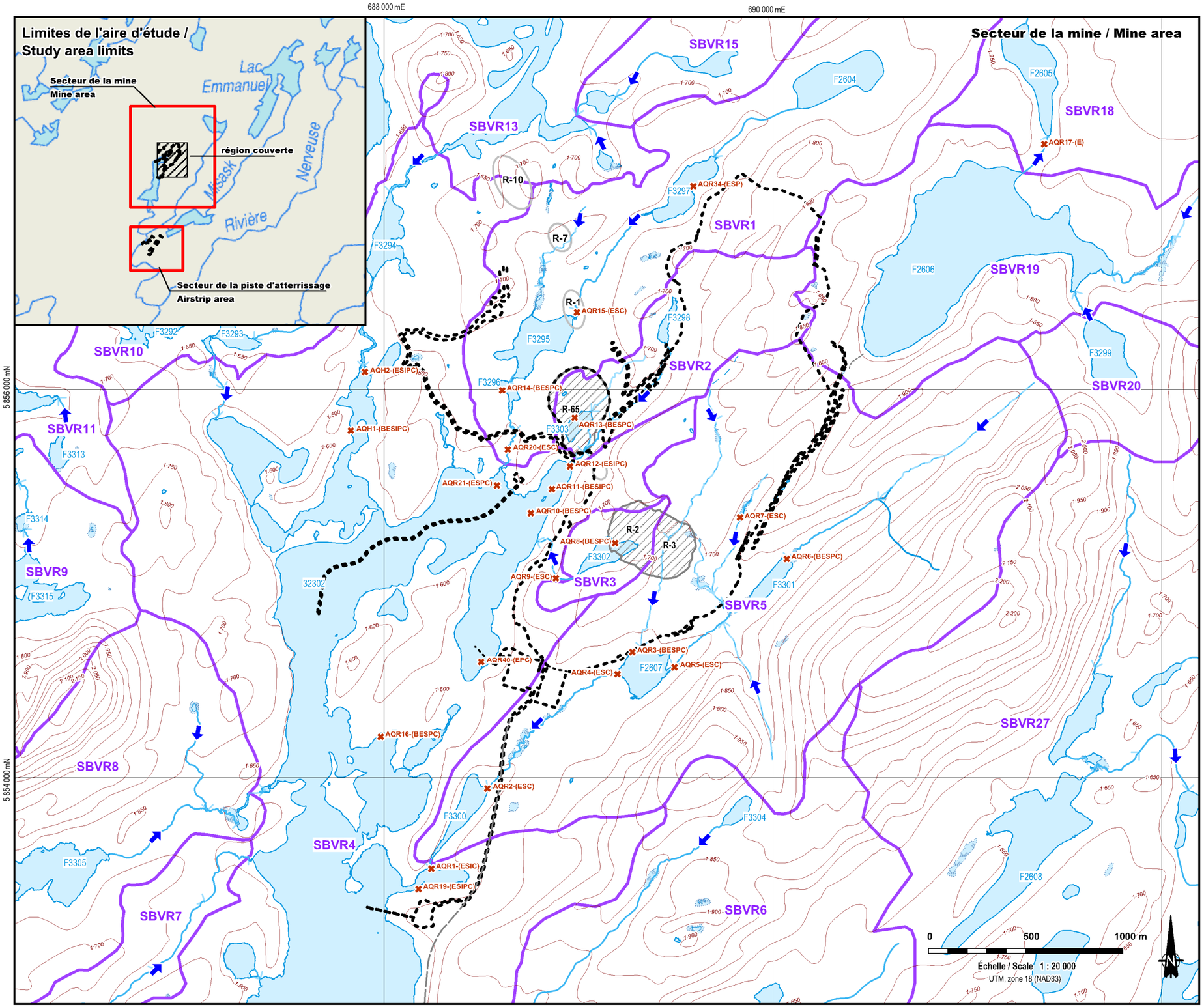
- The **chronic aquatic life toxicity criterion (CVAC, *critère de vie aquatic chronique*)** is the highest concentration of a substance that will produce no harmful effects on aquatic organisms (and their progeniture) when they are exposed to it daily for their entire lifespan;
- The **acute aquatic life toxicity criterion (CVAA, *critère de vie aquatique aïgu*)** is the maximum concentration of a substance to which aquatic organisms can be exposed for a short period of time without being seriously affected.

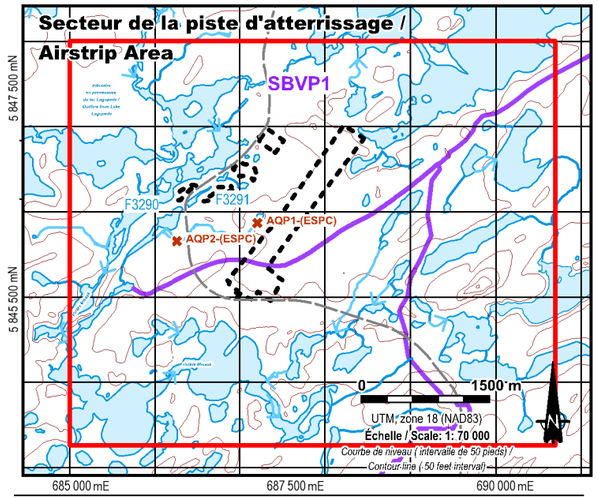
The following section first describes surface water quality at the regional level. Then, a more detailed description of the results obtained for the Renard Project study area is presented.

6.8.1.1 Regional Environmental Context

The Renard Project study area is located in the upper watershed of the Eastmain River and, more specifically, in the Misask River watershed. North of the proposed mine site, a small portion of the study area is located in the Sakami River watershed, which flows northwest toward the La-Grande-3 reservoir.

In this region, surface water is generally of good quality (Schetagne *et al.*, 2005) and has undergone very little human influences. Some factors that influence water quality in the region are geology, the nature of surficial deposits, topography, the hydrological regime and the presence of wetlands.





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

- Station d'échantillonnage de l'eau de surface et des sédiments / Surface water en sediment sampling station
- Emprise du projet / Project footprint (26/10/2011)
- Fosse d'extraction à ciel ouvert / Open pit
- R-x — Autres ressources minérales / Other mineral resources
- F3293 — Numéro d'identifiant de lac de CEHQ / CEHQ lake ID number
- R-x — Identification du gisement / Deposit identification
- Courbe topographique(intervalle de 50 pieds) / Contour line (50 feet interval)
- Cours d'eau permanent / Permanent stream
- Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow
- Écoulement souterrain / Underground flow
- Sous-bassin versant / Sub-watershed

Localisation des stations d'échantillonnage de l'eau de surface et des sédiments / Position of surface water and sediment sampling station

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_StationEauSurface_111221.WOR
Décembre 2011 / December 2011

Carte / Map 6.8.1

Table 6.8.1 Surface Water Quality Results from 19 Samples Collected between July 7 and July 10 2010 in the Renard Project Study Area

Area								Renard											
Type of Waterbody								Streams									Lakes		
Sampling Station	Unit	Analytical Method Detection Limit (DL)	Water Quality Guidelines and Criteria[1]					AQR1	AQR2	AQR4	AQR5	AQR7	AQR9	AQR12	AQR15	AQR17	AQR3	AQR6	AQR8[2]
			Federal (CCME)	Provincial (MDDEP)															
			Guidelines for the Protection of Aquatic Life	Protection of Aquatic Life		Contamination Prevention													
				Chronic Effects	Acute Effects	With Drinking Water Intake	Without Intake												
Station Characteristics																			
Sampling Date								2010-07-08	2010-07-08	2010-07-08	2010-07-08	2010-07-09	2010-07-09	2010-07-10	2010-07-07	2010-07-09	2010-07-08	2010-07-08	2010-07-09
UTM (NAD 83, Zone 18) East								688 244	688 532	689 202	689 496	689 834	688 884	688 958	688 994	691 397	689 335	690 020	689 183
UTM (NAD 83, Zone 18) North								5 853 543	5 853 955	5 854 543	5 854 578	5 855 352	5 855 038	5 855 615	5 856 407	5 857 272	5 854 548	5 855 033	5 855 181
Lake Name or Number								-	-	-	-	-	-	-	-	-	F2607	F3301	F3302
Basic Physicochemical Parameters																			
Dissolved Oxygen	% Saturation	-	-	54 to 63[k]	-	-	-	96.2	96	86.8	82	72	90	Problem[3]	90.3	77	65.5	91	100
	ppm	-	6.5 to 9.5[a]	5 to 7[k]	-	-	-	7.73	7.96	6.61	7.06	6.51	7.26	Problem	7.65	6.34	**5.28**	7.26	8.1
Water Temperature	°C	-	-	Statement[l]	-	-	-	24.8	21.4	26	19.1	17.1	23.3	16.9	20.5	21.5	23	23.4	23.7
pH	pH Value	-	6.5 to 9.0	6.5 to 9.0[m]	5.0 to 9.0[kk]	6.5 to 8.5[yy]	-	***6.2***	***5.9***	***6.1***	***5.7***	***5.02***	***6.39***	***5.82***	***6.1***	***6***	***6***	***5.6***	7.02
Total Alkalinity	mg/L	1	-	Statement[n]	-	-	-	3	2	2	2	<1	4	3	2	<1	2	2	4
Turbidity	NTU	-	over 2 to 8 or 10%[b]	over 2 to 8 or 10%[o]	over 8[ll]	-	-	1.31	0.88	1.37	1.02	1.14	1.27	1.8	2.41	1.01	1.33	1.05	2.04
Conductivity	µS/cm	-	-	-	-	-	-	10.3	9.7	9.6	9	10.2	25.5	11	8.8	6.1	13.3	10.7	28.4
Total Suspended Solids	mg/L	2	over 5 to 25[c]	over 5 to 25[p]	over 25[mm]	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Dissolved Solids	mg/L	10	-	-	-	-	-	23	29	30	29	42	30	33	18	16	29	33	33
Oxidation-Reduction Potential	mV	-	-	-	-	-	-	150	160	165	135	100	137	175	120	130	207	120	105
Total Hardness	mg/L	1	-	-	-	-	-	<1	<1	<1	<1	<1	6	3	<1	<1	<1	<1	7
Major Ions and Nutrients																			
Total Kjeldahl Nitrogen	mg/L	0.15	-	-	-	-	-	0.66	0.61	0.65	0.63	0.69	0.62	0.6	0.55	0.51	0.65	0.62	0.66
Nitrates and Nitrites	mg/L	0.02	NO_3: 13, NO_2: 0.197	NO_3: 2.9[q]; NO_2: 0.02[r]	NO_2: 0.06[r]	10[yy, zz]	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ammoniacal Nitrogen	mg/L	0.02	0.767[s]	1.23[s]	17.9[s]	0.2[A] and 1.5[B]	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Phosphorous	mg/L	0.005	0.004-0.01[d]	0.02[t], 0.03[u], or >50%[v]	-	-	-	0.006	0.006	0.005	0.006	<0.005	0.007	0.007	0.006	<0.005	0.006	0.006	0.0075
Calcium	mg/L	0.1	-	Statement[w]	-	-	-	0.6	0.6	0.8	0.5	0.7	2.6	1.1	0.7	0.3	0.6	0.7	2.85
Magnesium	mg/L	0.02	-	-	-	-	-	0.19	0.2	0.24	0.17	0.18	0.71	0.25	0.18	0.12	0.21	0.2	0.82
Sodium	mg/L	0.03	-	-	-	200[B]	-	0.57	0.63	0.61	0.56	0.37	1.1	0.59	0.62	0.23	0.51	0.58	1.25
Potassium	mg/L	0.1	-	-	-	-	-	0.2	0.2	0.2	0.1	<0.1	0.8	0.3	0.2	0.1	0.2	0.1	1
Sulphates	mg/L	0.1	-	500[x]	500[x]	500[C]		1.1	1	0.9	0.9	0.6	6	1.2	1.6	0.9	0.9	0.9	6.75
Chlorides	mg/L	0.05	-	230[y]	860[nn]	250[B]	-	0.1	0.1	0.29	0.21	0.06	0.37	0.46	0.49	0.09	0.14	0.32	0.395
Metals and Nonmetals																			
Aluminium	mg/L	0.01	0.005 to 0.1[e]	0.087z	0.75[oo]	0.2[D]	-	**0.04**	**0.08**	**0.12**	***0.13***	***0.2***	<0.01	**0.08**	<0.01	<0.01	**0.08**	***0.2***	<0.01
Antimony	mg/L	0.006	-	0.24	1.1	0.006[E]	0.64	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Arsenic	mg/L	0.001	5.0[f]	0.15	0.34	0.003[F]	0.021[J]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	*0.0005*	0.000005[f]	0.000049[aa]	0.00021[pp]	0.005[yy]	0.13	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	mg/L	0.001	CrIII: 0.0089; CrVI: 0.001	0.013[bb]	0.27[qq]	0.05[yy]	CrVI: 9.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	0.1	0.37	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.002g	0.0013[cc]	0.0016[rr]	1 and 1.3[B]	38	<0.001	<0.001	*0.002*	***0.003***	0.001	***0.003***	*0.002*	<0.001	*0.002*	<0.001	*0.002*	*0.002*
Iron	mg/L	0.02	0.3	1.3[dd]	3.4[ss]	0.3[G]	-	0.23	0.22	0.19	0.19	0.26	0.18	0.2	0.1	0.1	0.18	0.21	0.205
Manganese	mg/L	0.001	-	0.26[ee]	0.55[tt]	0.05[G]	59	0.002	0.002	0.002	0.001	0.001	0.004	0.003	0.002	0.005	0.002	0.002	0.004
Mercury	mg/L	0.0001	0.000026[h]	9.1x10-4[ff]	0.0016[ff]	1.8x10^{-6} H	1.8x10^{-6} H	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.073	3.2	29	0.04[I]	10	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	*0.001*	0.025[j]	0.0074[gg]	0.03[uu]	0.07[I]	4.6	<0.001	<0.001	*0.001*	<0.001	*0.001*	*0.005*	<0.001	<0.001	<0.001	<0.001	<0.001	*0.004*
Lead	mg/L	*0.001*	0.001[j]	0.00017[hh]	0.0044[vv]	0.01[yy]	0.19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.001	0.001	0.005	0.062[ww]	0.01[yy]	4.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.002	0.03	0.017[ii]	0.017[ii]	5[B]	26	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Other Parameters																			
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/L	0.100	-	0.01jj	0.11[xx]	-	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

[1] Notes are presented in Appendix 6.8.4

[2] Stations AQR8 and AQR11 were sampled in duplicate, and the results correspond to the average of the two analytical results obtained. QAQC results are given in Appendix 6.8.1.

[3] Problem: These values are not available due to a problem with the calibration of the oxygen probe.

bold	**Result exceeding the Canadian water quality guidelines for the protection of aquatic life**
italics	*Result exceeding the Quebec criterion for the protection of aquatic life from chronic effects*
underlined	*Result exceeding the Quebec criterion for the protection of aquatic life from acute effects*
in red	Result exceeding the Quebec criterion for the prevention of contamination (with water intake)
in grey	Result exceeding the Quebec criterion for the prevention of contamination (without water intake)
	Result exceeding the Quebec critierion for the protection of piscivorous land animals

Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

MDDEP (Ministère du Développement Durable, de l'Environnement et des Parcs). 2009. Critères de qualité de l'eau de surface. Direction du suivi de l'état de l'environnement, Gouvernement du Québec (French only).

Table 6.8.1 Surface Water Quality Results from 19 Samples Collected between July 7 and July 10, 2010 in the Renard Project Study Area

Area								Renard					Airstrip		Descriptive Statistics					
Type of Waterbody								Lake					Lake	Stream						
Sampling Station	Unit	Analytical Method Detection Limit (DL)	Water Quality Guidelines and Criteria[1] Federal (CCME)	Provincial (MDDEP)				AQR10	AQR11[2]	AQR16	AQR13	AQR14	AQP1	AQP2	Number of Values	% <DL	Criteria Exceeded	Minimum	Median	Maximum
Station Characteristics																				
Sampling Date			Guidelines for the Protection of Aquatic Life	Protection of Aquatic Life		Contamination Prevention		2010-07-10	2010-07-10	2010-07-10	2010-07-07	2010-07-10	2010-07-10	2010-07-10						
UTM (NAD 83, Zone 18) East								688 756	689 496	687 984	688 981	688 625	687 213	686 271						
UTM (NAD 83, Zone 18) North				Chronic Effects	Acute Effects	With Drinking Water Intake	Without Intake	5 855 374	5 855 374	5 854 221	5 855 865	5 856 013	5 845 902	5 845 690						
Lake Name or Number								Lake Lagopede (32302)			F3303	F3296	F3291	-						
Basic Physicochemical Parameters																				
Dissolved Oxygen	% Saturation	-	-	54 to 63[k]	-	-	-	Problem	Problem	Problem	83.4	105	93.5	106	15	0%	0%	65.5	90.3	106
	ppm	-	6.5 to 9.5[a]	5 to 7[k]	-	-	-	Problem	Problem	Problem	6.36	8.4	7.58	11.33	15	0%	7%	**5.28**	7.26	11.33
Water Temperature	°C	-	-	Statement[l]	-	-	-	23.2	23.2	24.8	26.7	23	23.4	9.6	19	0%	-	9.6	23.2	26.7
pH	pH Value	-	6.5 to 9.0	6.5 to 9.0[m]	5.0 to 9.0[kk]	6.5 to 8.5[yy]	-	6.62	6.53	***6.48***	7.1	6.6	***4.88***	***5.16***	19	0%	74%	***4.88***	6.1	7.1
Total Alkalinity	mg/L	1	-	Statement[n]	-	-	-	2	2	2	7	3	<1	1	19	16%	0%	<1	2	7
Turbidity	NTU	-	over 2 to 8 or 10%[b]	over 2 to 8 or 10%[o]	over 8[ll]	-	-	1.18	1.11	0.78	1.08	0.9	1.46	1.85	19	0%	0%	0.78	1.18	2.41
Conductivity	µS/cm	-	-	-	-	-	-	7.7	8	7.3	17.8	12.1	6.8	11	19	0%	0%	6.1	10.2	28.4
Total Suspended Solids	mg/L	2	over 5 to 25[c]	over 5 to 25[p]	over 25[mm]	-	-	<2	<2	<2	<2	<2	<2	<2	19	100%	0%	<2	<2	<2
Total Dissolved Solids	mg/L	10	-	-	-	-	-	24	13.5	24	23	16	28	50	19	0%	0%	13.5	29	50
Oxidation-Reduction Potential	mV	-	-	-	-	-	-	160	165	180	240	140	175	205	19	0%	-	100	160	240
Total Hardness	mg/L	1	-	-	-	-	-	<1	<1	<1	5	3	<1	3	19	68%	-	<1	<1	7
Major Ions and Nutrients																				
Total Kjeldahl Nitrogen	mg/L	0.15	-	-	-	-	-	0.52	0.55	0.57	0.61	0.56	0.69	0.69	19	0%	-	0.51	0.62	0.69
Nitrates and Nitrites	mg/L	0.02	NO_3: 13, NO_2: 0.197	NO_3: 2.9[n]; NO_2: 0.02[r]	NO_2: 0.06[r]	10[yy, zz]	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	19	100%	0%	<0.02	<0.02	<0.02
Ammoniacal Nitrogen	mg/L	0.02	0.767[s]	1.23[s]	17.9[s]	0.2[A] and 1.5[B]	-	<0.02	0.04	<0.02	0.02	<0.02	<0.02	0.02	19	84%	0%	<0.02	<0.02	0.04
Total Phosphorous	mg/L	0.005	0.004-0.01[d]	0.02[t], 0.03[u] or >50 %[v]	-	-	-	<0.005	<0.005	<0.005	0.006	<0.005	0.006	0.007	19	32%	0%	<0.005	0.006	0.0075
Calcium	mg/L	0.1	-	Statement[w]	-	-	-	0.7	0.7	0.7	2	1.1	<0.1	1.1	19	5%	0%	<0.1	0.7	2.85
Magnesium	mg/L	0.02	-	-	-	-	-	0.18	0.195	0.18	0.64	0.32	<0.02	0.35	19	5%	-	<0.02	0.2	0.82
Sodium	mg/L	0.03	-	-	-	200[B]	-	0.34	0.36	0.34	0.65	0.74	<0.03	0.75	19	5%	0%	<0.03	0.58	1.25
Potassium	mg/L	0.1	-	-	-	-	-	0.2	0.2	0.2	0.8	0.3	<0.1	0.2	19	11%	-	0.1	0.2	1
Sulphates	mg/L	0.1	-	500[x]	500[x]	500[C]		1	1.1	1	1.2	1.5	0.3	0.8	19	0%	0%	0.3	1	6.75
Chlorides	mg/L	0.05	-	230[y]	860[nn]	250[B]	-	0.26	0.28	0.23	0.27	0.85	0.1	0.06	19	0%	0%	0.06	0.26	0.85
Metals and Nonmetals																				
Aluminium	mg/L	0.01	0.005 to 0.1[e]	0.087[z]	0.75[oo]	0.2[D]	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.07**	19	53%	47%	<0.01	<0.01	***0.2***
Antimony	mg/L	0.006	-	0.24	1.1	0.006[E]	0.64	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	19	100%	0%	<0.006	<0.006	<0.006
Arsenic	mg/L	0.001	5.0[f]	0.15	0.34	0.003[F]	0.021[J]	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	19	95%	0%	<0.001	<0.001	0.001
Cadmium	mg/L	*0.0005*	0.000005[f]	0.000049[aa]	0.00021[pp]	0.005[yy]	0.13	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	19	100%	0%	<0.0005	<0.0005	<0.0005
Chromium	mg/L	0.001	CrIII: 0.0089; CrVI: 0.001	0.013[bb]	0.27[qq]	0.05[yy]	CrVI: 9.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	19	100%	0%	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	0.1	0.37	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	19	100%	0%	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.002[g]	0.0013[cc]	0.0016[rr]	1 and 1.3[B]	38	<0.001	***0.0035***	0.001	***0.003***	<0.001	*0.002*	***0.003***	19	32%	58%	<0.001	*0.002*	***0.0035***
Iron	mg/L	0.02	0.3	1.3[dd]	3.4[ss]	0.3[G]	-	0.06	0.065	0.05	0.07	0.06	**0.47**	**0.55**	19	0%	11%	0.05	0.19	**0.55**
Manganese	mg/L	0.001	-	0.26[ee]	0.55[tt]	0.05[G]	59	0.003	0.003	0.003	0.001	0.001	0.002	0.003	19	0%	0%	0.001	0.002	0.005
Mercury	mg/L	0.0001	0.000026[h]	9.1x10^{-4}[ff]	0.0016[ff]	1.8x10^{-6} [H]	1.8x10^{-6} [H]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	19	100%	0%	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.073	3.2	29	0.04[I]	10	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	19	100%	0%	<0.001	<0.001	<0.001
Nickel	mg/L	*0.001*	0.025[j]	0.0074[gg]	0.03[uu]	0.07[I]	4.6	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	19	74%	0%	<0.001	<0.001	0.005
Lead	mg/L	*0.001*	0.001[j]	0.00017[hh]	0.0044[vv]	0.01[yy]	0.19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	19	100%	0%	<0.001	<0.001	<0.001
Selenium	mg/L	0.001	0.001	0.005	0.062[ww]	0.01[yy]	4.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	19	100%	0%	<0.001	<0.001	<0.001
Zinc	mg/L	0.002	0.03	0.017[ii]	0.017[jj]	5[B]	26	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	19	100%	0%	<0.002	<0.002	<0.002
Other Parameters																				
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/L	0.100	-	0.01[jj]	0.11[xx]	-	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	19	100%	0%	<0.100	<0.100	<0.100

[1] Notes are presented in Appendix 6.8.4

[2] Stations AQR8 and AQR11 were sampled in duplicate, and the results correspond to the average of the two analytical results obtained. QAQC results are given in Appendix 6.8.1.

[3] Problem: These values are not available due to a problem with the calibration of the oxygen probe.

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Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

MDDEP (Ministère du Développement Durable, de l'Environnement et des Parcs). 2009. Critères de qualité de l'eau de surface. Direction du suivi de l'état de l'environnement, Gouvernement du Québec (French only).

Table 6.8.2 Surface Water Quality Results from 26 Samples Collected between September 4 and September 6, 2010 in the Renard Project Study Area

Area								Renard										
Type of Waterbody								Stream								Lake		
Sampling Station	Unit	Analytical Method Detection Limit (DL)	Water Quality Guidelines and Criteria [1] Federal (CCME)	Provincial (MDDEP)				AQR1	AQR2	AQR4	AQR5	AQR7	AQR9 [2]	AQR12	AQR15	AQR3 [3]	AQR6 [3]	AQR8 [2,3]
Station Characteristics																		
Sampling Date			Guidelines for the Protection of Aquatic Life	Protection of Aquatic Life: Chronic Effects	Protection of Aquatic Life: Acute Effects	Contamination Prevention: With Drinking Water Intake	Contamination Prevention: Without Intake	2010-09-04	2010-09-04	2010-09-05	2010-09-05	2010-09-05	2010-09-06	2010-09-05	2010-09-05	2010-09-05	2010-09-05	2010-09-06
UTM (NAD 83, Zone 18) East								688 244	688 532	689 202	689 496	689 834	688 884	688 958	688 994	689 278	690 074	689 190
UTM (NAD 83, Zone 18) North								5 853 543	5 853 955	5 854 543	5 854 578	5 855 352	5 855 038	5 855 615	5 856 407	5 854 659	5 855 138	5 855 220
Lake Name or Number								-	-	-	-	-	-	-	-	F2607	F3301	F3302
Basic Physicochemical Parameters																		
Dissolved Oxygen	% Saturation	*In Situ*	-	54 to 63[k]	-	-	-	91.8	-	96.4	91.3	60.6	77	68.5	86	82	94.8	86.8
	ppm	*In Situ*	6.5 to 9.5[a]	5 to 7[k]	-	-	-	8.48	-	9.25	9.02	***5.84***	7.57	6.85	8.04	7.69	9.32	8.29
Water Temperature	°C	*In Situ*	-	Statement[j]	-	-	-	14.93	-	13.19	11.9	12.63	12.29	11.22	14.41	14.23	12.09	13.71
pH	pH Value	*In Situ*	6.5-9.0	6.5-9.0[m]	5.0-9.0[kk]	6.5-8.5[yy]	-	***5.56***	***5.34***	***5.03***	7.93	***4.97***	**6.08**	***5.21***	***5.6***	***4.97***	***4.73***	***5.91***
Total Alkalinity	mg/L	1	-	Statement[n]	-	-	-	<1	<1	<1	<1	<1	4	1	<1	<1	<1	5.5
Turbidity	NTU	*In Situ*	over 2 to 8 or 10%[b]	over 2 to 8 or 10%[o]	over 8[ll]	-	-	0	0	0	0	0.08	0.04	2.41	0	0	0.12	1.06
Conductivity	µS/cm	*In Situ*	-	-	-	-	-	9.8	8.3	13.2	12.8	15.5	26.9	15.7	9.6	15.3	14.6	28.1
Total Suspended Solids	mg/L	2	over 5 to 25[c]	over 5 to 25[p]	over 25[mm]	-	-	<2	<2	<2	<2	3	<2	<2	<2	<2	<2	<2
Total Dissolved Solids	mg/L	10	-	-	-	-	-	31	46	48	51	43	30	54	30	57	50	25.5
Oxidation-Reduction Potential	mV	*In Situ*	-	-	-	-	-	255.5	248.3	248.9	240.5	225.9	297.8	244	237.8	230.9	242.4	293.3
Total Hardness	mg/L	1	-	-	-	-	-	<1	<1	<1	<1	<1	6.5	4	<1	<1	<1	7
Major Ions and Nutrients																		
Total Kjeldahl Nitrogen	mg/L	0.15	-	-	-	-	-	0.28	0.33	0.37	0.42	0.42	0.335	0.44	0.43	0.44	0.45	0.35
Nitrates and Nitrites	mg/L	0.02	NO_3: 13, NO_2: 0.197	NO_3: 2.9[q]; NO_2: 0.02[r]	NO_2: 0.06[r]	10[yy, zz]	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.025
Nitrites	mg/L	0.01	0.197	0.02[r]	0.06[r]	1[yy]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammoniacal Nitrogen	mg/L	0.02	0.767[s]	1.23[s]	17.9[s]	0.2[A] and 1.5[B]	-	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	0.02
Total Phosphorous	mg/L	0.005	0.004-0.01[d]	0.02[t], 0.03[u] or >50 %[v]	-	-	-	0.007	0.005	0.005	0.007	0.01	0.008	**0.011**	0.008	0.008	**0.011**	0.0075
Calcium	mg/L	0.1	-	Statement[w]	-	-	-	0.8	0.7	0.8	0.8	0.8	2.5	1.6	0.8	0.8	0.6	2.5
Magnesium	mg/L	0.1	-	-	-	-	-	0.2	0.2	0.3	0.2	0.2	0.85	0.5	0.2	0.3	0.2	0.8
Sodium	mg/L	0.03	-	-	-	200[B]	-	0.55	0.54	0.51	0.48	0.44	1.1	0.63	0.45	0.45	0.42	1
Potassium	mg/L	0.1	-	-	-	-	-	0.1	0.1	0.1	<0.1	0.1	0.9	0.3	0.1	0.2	<0.1	0.9
Sulphates	mg/L	0.1	-	500[x]	500[x]	500[C]		0.6	0.6	0.6	0.5	0.5	5	0.7	0.7	0.5	0.5	5.3
Chlorides	mg/L	0.05	-	230[y]	860[nn]	250[B]	-	0.11	0.1	0.09	0.1	0.08	0.28	0.33	0.2	0.13	0.1	0.3
Metals and Nonmetals																		
Aluminium	mg/L	0.03	0.005 to 0.1[e]	0.087[z]	0.75[oo]	0.2[D]	-	***0.34***	***0.35***	***0.43***	***0.43***	***0.28***	**0.12**	***0.48***	***0.19***	***0.39***	***0.47***	**0.11**
Antimony	mg/L	0.006	-	0.24	1.1	0.006[E]	0.64	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Arsenic	mg/L	0.002	5.0[f]	0.15	0.34	0.003[F]	0.021[J]	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	mg/L	*0.001*	0.000005[f]	0.000049[aa]	0.00021[pp]	0.005[yy]	0.13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	mg/L	0.03	CrIII: 0.0089; CrVI: 0.001	0.013[bb]	0.27[qq]	0.05[yy]	CrVI: 9.4	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Cobalt	mg/L	0.03	-	0.1	0.37	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	mg/L	0.003	0.002[g]	0.0013[cc]	0.0016[rr]	1 and 1.3[B]	38	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Iron	mg/L	0.1	0.3	1.3[dd]	3.4[ss]	0.3[G]	-	0.3	0.3	0.3	0.2	0.3	0.2	**0.4**	0.2	**0.7**	0.2	0.25
Manganese	mg/L	0.003	-	0.26[ee]	0.55[tt]	0.05[G]	59	<0.003	<0.003	<0.003	<0.003	0.004	<0.003	0.005	<0.003	0.006	<0.003	0.006
Mercury	mg/L	*0.0001*	0.000026[h]	9.1x10^{-4}[ff]	0.0016[ff]	1.8x10^{-6} H	1.8x10^{-6} H	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.03	0.073	3.2	29	0.04[I]	10	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	mg/L	0.01	0.025[i]	0.0074[gg]	0.03[uu]	0.07[I]	4.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	mg/L	0.001	0.001[j]	0.00017[hh]	0.0044[vv]	0.01[yy]	0.19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.001	0.001	0.005	0.062[ww]	0.01[yy]	4.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.03	0.017[ii]	0.017[ii]	5[B]	26	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Other Parameters																		
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/L	0.100	-	0.01[jj]	0.11[xx]	-	-	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

[1] *Notes on the surface water quality protection criteria are given in Appendix 6.8.3.*

[2] Stations AQR8 and AQR9 were sampled in duplicate, and the results correspond to the average of the two results obtained. QAQC results are given in Appendix 6.8.2.

[3] *The positions of these stations were modified slightly between the July 2010 and September 2010 sampling campaigns in order to facilitate sample collection from lakeshore.*

bold	**Result exceeding the Canadian water quality guidelines for the protection of aquatic life**
italics	*Result exceeding the Quebec criterion for the protection of aquatic life from chronic effects*
underlined	*Result exceeding the Quebec criterion for the protection of aquatic life from acute effects*
in red	Result exceeding the Quebec criterion for the prevention of contamination (with water intake)
in grey	Result exceeding the Quebec criterion for the prevention of contamination (without water intake)
	Result exceeding the Quebec critierion for the protection of piscivorous land animals

Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

MDDEP (Ministère du Développement Durable, de l'Environnement et des Parcs). 2009. Critères de qualité de l'eau de surface. Direction du suivi de l'état de l'environnement, Gouvernement du Québec

The criteria were updated in August 2011.

Table 6.8.2 Results of Surface Water Quality from 26 Samples Collected between September 4 and September 6, 2010 in the Renard Project Study Area

Area								*Renard*									*Hibou*	
Type of Waterbody								*Lake*									*Lake*	
Sampling Station	**Unit**	**Analytical Method Detection Limit (DL)**	***Water Quality Guidelines and Criteria*** [1]					*AQR13*	*AQR14* [3]	*AQR34*	*AQR10*	*AQR11*	*AQR16*	*AQR19*	*AQR20*	*AQR21*	*AQH1*	*AQH2*
Station Characteristics			***Federal (CCME)***	***Provincial (MDDEP)***														
			Guidelines for the Protection of Aquatic Life	***Protection of Aquatic Life***		***Contamination Prevention***												
				Chronic Effects	***Acute Effects***	***With Drinking Water Intake***	***Without Intake***											
Sampling Date								2010-09-05	2010-09-05	2010-09-06	2010-09-05	2010-09-05	2010-09-04	2010-09-04	2010-09-05	2010-09-05	2010-09-04	2010-09-04
UTM (NAD 83, Zone 18) East								688 981	688 608	689 592	688 756	689 864	687 984	688 179	688 643	688 581	687 830	687 902
UTM (NAD 83, Zone 18) North								5 855 865	5 856 005	5 857 055	5 855 374	5 855 497	5 854 221	5 853 438	5 855 701	5 855 516	5 855 799	5 856 100
Lake Name or Number								F3303	F3296	F3297	Lake Lagopede (32302)						Lake Lagopede (32302)	
Basic Physicochemical Parameters																		
Dissolved Oxygen	% Saturation	*In Situ*	-	54 to 63[k]	-	-	-	86.1	88	86.9	90.3	83.2	94.9	87	86.1	85	95.6	99.1
	ppm	*In Situ*	6.5 to 9.5[a]	5 to 7[k]	-	-	-	7.58	8.13	8.31	8.17	7.68	8.55	8	7.92	7.88	8.64	8.97
Water Temperature	°C	*In Situ*	-	Statement[j]	-	-	-	18.4	15.19	13.65	15.8	15.18	15.99	15.1	14.82	15.4	15.83	15.84
pH	pH Value	*In Situ*	6.5-9.0	6.5-9.0[m]	5.0-9.0[kk]	6.5-8.5[yy]	-	6.73	6.74	***5.6***	***5.9***	***5.6***	***6.14***	***5.73***	6.8	***5.6***	***5.83***	**6.08**
Total Alkalinity	mg/L	1	-	Statement[n]	-	-	-	6	2	<1	2	2	<1	<1	1	1	<1	<1
Turbidity	NTU	*In Situ*	over 2 to 8 or 10%[b]	over 2 to 8 or 10%[o]	over 8[ll]	-	-	***29.53***	0	0.18	0	0.88	0.32	0	0	0.88	0	0
Conductivity	µS/cm	*In Situ*	-	-	-	-	-	18.1	11	10.9	9.6	10.3	7.9	9.6	12.2	10.3	8.1	8.9
Total Suspended Solids	mg/L	2	over 5 to 25[c]	over 5 to 25[p]	over 25[mm]	-	-	***19***	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Dissolved Solids	mg/L	10	-	-	-	-	-	39	23	16	13	10	13	23	23	23	<10	<10
Oxidation-Reduction Potential	mV	*In Situ*	-	-	-	-	-	219.9	224.2	293.3	233.5	233.3	258.7	258.1	220.8	233.3	232.9	261.5
Total Hardness	mg/L	1	-	-	-	-	-	14	3	<1	<1	<1	<1	<1	3	<1	<1	<1
Major Ions and Nutrients																		
Total Kjeldahl Nitrogen	mg/L	0.15	-	-	-	-	-	0.72	0.25	0.32	0.22	0.26	0.27	0.3	0.28	0.27	0.23	0.24
Nitrates and Nitrites	mg/L	0.02	NO_3: 13, NO_2: 0.197	NO_3: 2.9[qi]; NO_2: 0.02[r]	NO_2: 0.06[r]	10[yy, zz]	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrites	mg/L	0.01	0.197	0.02[r]	0.06[r]	1[yy]		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammoniacal Nitrogen	mg/L	0.02	0.767[s]	1.23[s]	17.9[s]	0.2[A] and 1.5[B]	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Phosphorous	mg/L	0.005	0.004-0.01[d]	0.02[t], 0.03[u] or >50 %[v]	-	-	-	**0.022**	<0.005	0.005	<0.005	0.009	<0.005	0.008	<0.005	<0.005	<0.005	0.005
Calcium	mg/L	0.1	-	Statement[w]	-	-	-	1.9	0.9	0.8	0.8	0.8	0.7	0.7	0.9	0.7	0.5	0.6
Magnesium	mg/L	0.1	-	-	-	-	-	2.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2
Sodium	mg/L	0.03	-	-	-	200[B]	-	0.87	0.57	0.55	0.47	0.44	0.4	0.5	0.52	0.41	0.31	0.32
Potassium	mg/L	0.1	-	-	-	-	-	0.9	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1
Sulphates	mg/L	0.1	-	500[x]	500[x]	500[C]		1	1	0.8	1	1	0.9	0.7	0.9	0.9	0.8	0.9
Chlorides	mg/L	0.05	-	230[y]	860[nn]	250[B]	-	0.28	0.48	0.3	0.26	0.31	0.17	0.12	0.48	0.35	0.13	0.14
Metals and Nonmetals																		
Aluminium	mg/L	0.03	0.005 to 0.1[e]	0.087[z]	0.75[oo]	0.2[D]	-	***0.87***	**0.12**	***0.2***	**0.08**	***0.12***	**0.08**	***0.23***	**0.13**	**0.07**	**0.06**	**0.06**
Antimony	mg/L	0.006	-	0.24	1.1	0.006[E]	0.64	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Arsenic	mg/L	0.002	5.0[f]	0.15	0.34	0.003[E]	0.021[J]	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	mg/L	*0.001*	0.000005[f]	0.000049[aa]	0.00021[pp]	0.005[yy]	0.13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	mg/L	0.03	CrIII: 0.0089; CrVI: 0.001	0.013[bb]	0.27[qq]	0.05[yy]	CrVI: 9.4	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Cobalt	mg/L	0.03	-	0.1	0.37	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	mg/L	0.003	0.002[g]	0.0013[cc]	0.0016[rr]	1 and 1.3[B]	38	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Iron	mg/L	0.1	0.3	1.3[dd]	3.4[ss]	0.3[G]	-	**0.8**	<0.1	0.1	<0.1	0.1	<0.1	0.2	0.1	<0.1	<0.1	<0.1
Manganese	mg/L	0.003	-	0.26[ee]	0.55[tt]	0.05[G]	59	0.012	<0.003	<0.003	0.005	0.004	0.004	<0.003	<0.003	0.003	0.003	0.004
Mercury	mg/L	*0.0001*	0.000026[h]	$9.1x10^{-4}$[ff]	0.0016[ff]	$1.8x10^{-6}$ H	$1.8x10^{-6}$ H	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.03	0.073	3.2	29	0.04[I]	10	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	mg/L	0.01	0.025[i]	0.0074[gg]	0.03[uu]	0.07[I]	4.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	mg/L	0.001	0.001[j]	0.00017[hh]	0.0044[vv]	0.01[yy]	0.19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.001	0.001	0.005	0.062[ww]	0.01[yy]	4.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.03	0.017[ii]	0.017[ii]	5[B]	26	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Other Parameters																		
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/L	0.100	-	0.01[jj]	0.11[xx]	-	-	***0.42***	<0.100	–	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

[1] *Notes on the surface water quality protection criteria are presented in Appendix 6.8.3.*

[2] Stations AQR8 and AQR9 were sampled in duplicate, and the results correspond to the average of the two results obtained. QAQC results are given in Appendix 6.8.2.

[3] *The positions of these stations were modified slightly between the July 2010 and September 2010 sampling campaigns in order to facilitate sample collection from lakeshore.*

bold	**Result exceeding the Canadian water quality guidelines for the protection of aquatic life**
italics	*Result exceeding the Quebec criterion for the protection of aquatic life from chronic effects*
underlined	*Result exceeding the Quebec criterion for the protection of aquatic life from acute effects*
in red	Result exceeding the Quebec criterion for the prevention of contamination (with water intake)
in grey	Result exceeding the Quebec criterion for the prevention of contamination (without water intake)
	Result exceeding the Quebec critierion for the protection of piscivorous land animals

Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

MDDEP (Ministère du Développement Durable, de l'Environnement et des Parcs). 2009. Critères de qualité de l'eau de surface. Direction du suivi de l'état de l'environnement, Gouvernement du Québec

The criteria were updated in August 2011.

Table 6.8.2 Surface Water Quality Results from 26 Samples Collected between September 4 and September 6, 2010 in the Renard Project Study Area

Area			Water Quality Guidelines and Criteria [1]					Lynx	Airstrip		Descriptive Statistics					
Type of Waterbody								Lake	Lake	Stream						
Sampling Station	Unit	Analytical Method Detection Limit (DL)	Federal (CCME)	Provincial (MDDEP)				AQL1	AQP1	AQP2	Number of Values	% < DL	Criteria Exceeded	Minimum	Median	Maximum
Station Characteristics																
Sampling Date			Guidelines for the Protection of Aquatic Life	Protection of Aquatic Life		Contamination Prevention		2010-09-06	2010-09-04	2010-09-04						
UTM (NAD 83, Zone 18) East								685 721	687 213	686 271						
UTM (NAD 83, Zone 18) North				Chronic Effects	Acute Effects	With Drinking Water Intake	Without Intake	5 855 142	5 845 902	5 845 690						
Lake Name or Number								F3312	F3291	-						
Basic Physicochemical Parameters																
Dissolved Oxygen	% Saturation	*In Situ*	-	54 to 63[k]	-	-	-	90.7	86.5	82.5	24	0%	0%	60.6	86.85	99.1
	ppm	*In Situ*	6.5 to 9.5[a]	5 to 7[k]	-	-	-	8.94	7.77	7.59	24	0%	4%	***5.84***	8.085	9.32
Water Temperature	°C	*In Situ*	-	Statement[l]	-	-	-	16.8	16.24	15.16	24	0%	-	11.22	15.015	18.4
pH	pH Value	*In Situ*	6.5 to 9.0	6.5 to 9.0[m]	5.0 to 9.0[kk]	6.5 to 8.5[yy]	-	***5.53***	***5.76***	***5.3***	25	0%	84%	***4.73***	***5.6***	7.93
Total Alkalinity	mg/L	1	-	Statement[n]	-	-	-	1	<1	<1	25	60%	-	<1	<1	6
Turbidity	NTU	*In Situ*	over 2 to 8 or 10%[b]	over 2 to 8 or 10%[o]	over 8[ll]	-	-	0.87	0	0	25	0%	4%	0	0	***29.53***
Conductivity	µS/cm	*In Situ*	-	-	-	-	-	17.3	10.8	11.3	25	0%	-	7.9	11	28.1
Total Suspended Solids	mg/L	2	over 5 to 25[c]	over 5 to 25[p]	over 25[mm]	-	-	<2	<2	<2	25	92%	-	<2	<2	***19***
Total Dissolved Solids	mg/L	10	-	-	-	-	-	46	18	38	25	8%	-	<10	30	57
Oxidation-Reduction Potential	mV	*In Situ*	-	-	-	-	-	289.3	241.3	250.9	25	0%	-	219.9	242.4	297.8
Total Hardness	mg/L	1	-	-	-	-	-	<1	<1	3	25	76%	-	<1	<1	14
Major Ions and Nutrients																
Total Kjeldahl Nitrogen	mg/L	0.15	-	-	-	-	-	0.59	0.42	0.42	25	0%	-	0.22	0.335	0.72
Nitrates and Nitrites	mg/L	0.02	NO_3: 13, NO_2: 0.197	NO_3: 2.9[q]; NO_2: 0.02[r]	NO_2: 0.06[r]	10[yy, zz]	-	<0.02	<0.02	<0.02	25	96%	0%	<0.02	<0.02	0.03
Nitrites	mg/L	0.01	0.197	0.02[r]	0.06[r]	1[yy]		<0.01	<0.01	<0.01	25	100%	0%	<0.01	<0.01	<0.01
Ammoniacal Nitrogen	mg/L	0.02	0.767[s]	1.23[s]	17.9[s]	0.2[A] and 1.5[B]	-	<0.02	<0.02	<0.02	25	92%	0%	<0.02	<0.02	0.02
Total Phosphorous	mg/L	0.005	0.004-0.01[d]	0.02[t], 0.03[u] or >50 %[v]	-	-	-	0.008	0.007	0.006	25	24%	8%	<0.005	0.007	**0.022**
Calcium	mg/L	0.1	-	Statement[w]	-	-	-	0.9	<0.1	1.2	25	4%	-	<0.1	0.8	2.5
Magnesium	mg/L	0.1	-	-	-	-	-	0.3	<0.1	0.4	25	4%	-	<0.1	0.2	2.3
Sodium	mg/L	0.03	-	-	-	200[B]	-	0.46	0.09	0.56	25	0%	-	0.09	0.48	1.1
Potassium	mg/L	0.1	-	-	-	-	-	0.2	<0.1	0.2	25	12%	-	<0.1	0.2	0.9
Sulphates	mg/L	0.1	-	500[x]	500[x]	500[C]		0.7	0.2	0.7	25	0%	0%	0.2	0.7	5.3
Chlorides	mg/L	0.05	-	230[y]	860[nn]	250[B]	-	0.05	0.07	0.1	25	0%	0%	0.05	0.14	0.48
Metals and Nonmetals																
Aluminium	mg/L	0.03	0.005 to 0.1[e]	0.087[z]	0.75[oo]	0.2[D]	-	***0.33***	<0.03	***0.14***	25	4%	96%	<0.03	***0.19***	***0.87***
Antimony	mg/L	0.006	-	0.24	1.1	0.006[E]	0.64	<0.006	<0.006	<0.006	25	100%	0%	<0.006	<0.006	<0.006
Arsenic	mg/L	0.002	5.0[f]	0.15	0.34	0.003[F]	0.021[J]	<0.002	<0.002	<0.002	25	100%	0%	<0.002	<0.002	<0.002
Cadmium	mg/L	*0.001*	0.000005[f]	0.000049[aa]	0.00021[pp]	0.005[yy]	0.13	<0.001	<0.001	<0.001	25	100%	0%	<0.001	<0.001	<0.001
Chromium	mg/L	0.03	CrIII: 0.0089; CrVI: 0.001	0.013[bb]	0.27[qq]	0.05[yy]	CrVI: 9.4	<0.03	<0.03	<0.03	25	100%	0%	<0.03	<0.03	<0.03
Cobalt	mg/L	0.03	-	0.1	0.37	-	-	<0.03	<0.03	<0.03	25	100%	0%	<0.03	<0.03	<0.03
Copper	mg/L	0.003	0.002[g]	0.0013[cc]	0.0016[rr]	1 and 1.3[B]	38	<0.003	<0.003	<0.003	25	100%	0%	<0.003	<0.003	<0.003
Iron	mg/L	0.1	0.3	1.3[dd]	3.4[ss]	0.3[G]	-	0.2	<0.1	0.3	25	28%	12%	<0.1	0.2	**0.8**
Manganese	mg/L	0.003	-	0.26[ee]	0.55[tt]	0.05[G]	59	<0.003	<0.003	0.004	25	52%	0%	<0.003	<0.003	0.012
Mercury	mg/L	*0.0001*	0.000026[h]	$9.1x10^{-4}$[ff]	0.0016[ff]	$1.8x10^{-6}$ H	$1.8x10^{-6}$ H	<0.0001	<0.0001	<0.0001	25	100%	0%	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.03	0.073	3.2	29	0.04[I]	10	<0.03	<0.03	<0.03	25	100%	0%	<0.03	<0.03	<0.03
Nickel	mg/L	0.01	0.025[I]	0.0074[gg]	0.03[uu]	0.07[I]	4.6	<0.01	<0.01	<0.01	25	100%	0%	<0.01	<0.01	<0.01
Lead	mg/L	0.001	0.001[j]	0.00017[hh]	0.0044[vv]	0.01[yy]	0.19	<0.001	<0.001	<0.001	25	100%	0%	<0.001	<0.001	<0.001
Selenium	mg/L	0.001	0.001	0.005	0.062[ww]	0.01[yy]	4.2	<0.001	<0.001	<0.001	25	100%	0%	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.03	0.017[ii]	0.017[ii]	5[B]	26	<0.005	<0.005	<0.005	25	100%	0%	<0.005	<0.005	<0.005
Other Parameters																
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/L	0.100	-	0.01[jj]	0.11[xx]	-	-	<0.100	<0.100	<0.100	25	92%	4%	<0.100	<0.100	*0.42*

[1] *Notes on the surface water quality protection criteria are presented in Appendix 6.8.3.*

[2] Stations AQR8 and AQR9 were sampled in duplicate, and the results correspond to the average of the two results obtained. QAQC results are given in Appendix 6.8.2.

[3] *The positions of these stations were modified slightly between the July 2010 and September 2010 sampling campaigns in order to facilitate sample collection from lakeshore.*

bold	**Result exceeding the Canadian water quality guidelines for the protection of aquatic life**
italics	*Result exceeding the Quebec criterion for the protection of aquatic life from chronic effects*
underlined	*Result exceeding the Quebec criterion for the protection of aquatic life from acute effects*
in red	Result exceeding the Quebec criterion for the prevention of contamination (with water intake)
in grey	Result exceeding the Quebec criterion for the prevention of contamination (without water intake)
	Result exceeding the Quebec critierion for the protection of piscivorous land animals

Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

MDDEP (Ministère du Développement Durable, de l'Environnement et des Parcs). 2009. Critères de qualité de l'eau de surface. Direction du suivi de l'état de l'environnement, Gouvernement du Québec (French
The criteria were updated in August 2011.

Table 6.8.3 Descriptive Statistics regarding the Quality of Water Sampled at 26 Stations in 2010 in the Renard Project Study Area

Parameter	Unit	Analytical Method Detection Limit (DL)	Number of Values	Minimum	5th percentile	Median	95th percentile	Maximum
Basic Physicochemical Parameters								
Dissolved Oxygen	% Saturation	*In Situ*	39	60.6	68.2	87	100.5	106
	ppm	*In Situ*	39	***5.28***	**6.29**	7.88	9.257	11.33
Water Temperature	°C	*In Situ*	43	9.6	11.919	15.99	24.8	26.7
pH	pH Value	*In Situ*	44	***4.73***	***4.97***	***5.865***	6.987	7.93
Total Alkalinity	mg/L	1	44	<1	<1	1	5.275	7
Turbidity	NTU	*In Situ*	30	0	0	0.88	2.3545	***29.53***
Conductivity	µS/cm	*In Situ*	44	6.1	7.36	10.75	26.69	28.4
Total Suspended Solids	mg/L	2	44	<2	<2	<2	<2	***19***
Total Dissolved Solids	mg/L	10	44	5	10.45	29	50.85	57
Oxidation-Reduction Potential	mV	-	44	100	120	228.4	292.7	297.8
Total Hardness	mg/L	1	44	<1	<1	<1	6.925	14
Major Ions and Nutrients								
Total Kjeldahl Nitrogen	mg/L	0.15	44	0.22	0.2415	0.445	0.69	0.72
Nitrates and Nitrites	mg/L	0.02	44	<0.02	<0.02	<0.02	<0.02	0.025
Nitrites	mg/L	0.01	25	<0.01	<0.01	<0.01	<0.01	<0.01
Ammoniacal Nitrogen	mg/L	0.02	44	<0.02	<0.02	<0.02	0.02	0.04
Total Phosphorous	mg/L	0.005	44	<0.005	<0.005	0.006	0.01085	**0.022**
Calcium	mg/L	0.1	44	<0.1	0.33	0.8	2.5	2.85
Magnesium	mg/L	0.02-0.1	44	<0.1	0.1275	0.2	0.817	2.3
Sodium	mg/L	0.03	44	0.015	0.242	0.515	1.085	1.25
Potassium	mg/L	0.1	44	<0.1	<0.1	0.2	0.9	1
Sulphates	mg/L	0.1	44	0.2	0.5	0.9	5.255	6.75
Chlorides	mg/L	0.05	44	0.05	0.0615	0.205	0.48	0.85
Metals and Nonmetals								
Aluminium	mg/L	0.01-0.03	44	<0.03	<0.03	***0.115***	***0.464***	***0.87***
Antimony	mg/L	0.006	44	<0.006	<0.006	<0.006	<0.006	<0.006
Arsenic	mg/L	0.001-0.002	44	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	mg/L	0.0005-0.001	44	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	mg/L	0.001-0.03	44	<0.03	<0.03	<0.03	<0.03	<0.03
Cobalt	mg/L	0.001-0.03	44	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	mg/L	0.001-0.003	44	<0.003	<0.003	<0.003	***0.003***	***0.0035***
Iron	mg/L	0.02-0.1	44	<0.1	<0.1	0.2	**0.538**	**0.8**
Manganese	mg/L	0.001-0.003	44	<0.003	<0.003	<0.003	0.00585	0.012
Mercury	mg/L	0.0001	44	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001-0.03	44	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	mg/L	0.001-0.01	44	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	mg/L	0.001	44	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.001	44	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.002-0.005	44	<0.005	<0.005	<0.005	<0.005	<0.005
Other Parameters								
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/L	0.1	43	<0.100	<0.100	<0.100	<0.100	*0.42*

[1] Criteria are presented in Table 8.3.1 and Table 8.3.2

bold	**Result exceeding the Canadian water quality guidelines for the protection of aquatic life**
italics	*Result exceeding the Quebec criterion for the protection of aquatic life from chronic effects*
underlined	*Result exceeding the Quebec criterion for the protection of aquatic life from acute effects*
in red	Result exceeding the Quebec criterion for the prevention of contamination (with water intake)
in grey	Result exceeding the Quebec criterion for the prevention of contamination (without water intake)
	Result exceeding the Quebec critierion for the protection of piscivorous land animals

Sources:

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Summary Table. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

MDDEP (Ministère du Développement Durable, de l'Environnement et des Parcs). 2009. Critères de qualité de l'eau de surface. Direction du suivi de l'état de l'environnement, Gouvernement du Québec (French only).

The criteria were updated in August 2011.

The various studies carried out in the region (Amyot, 2002; Roche 2003, 2005, and 2011; Strateco Resources, 2009) generally indicate that the surface water has the following characteristics:

- The water is well oxygenated with a pH varying from acidic to neutral. Most of the values are more acidic than the water quality criteria for the protection of aquatic life;
- The water is generally very soft with low alkalinity, which makes it more vulnerable to acid input (Wetzel, 2001);
- It has low turbidity, presents low concentrations of total suspended solids and dissolved solids, and has low conductivity;
- Nutrient concentrations (nitrogen, phosphorus) are low and generally characteristic of an oligotrophic[18] or ultra-oligotrophic[19] environment;
- Concentrations of sulphate, calcium, magnesium, sodium, potassium and chloride ions are low compared to those measured in other Quebec rivers located in more northern regions;
- The most abundant metal in the water is generally iron. Higher concentrations of other metals such as aluminium can also be measured, but most metals are present at very low concentrations, close to the detection limits.

6.8.1.2 Mine Infrastructures Site

The hydrographical network of the study area is characterized by the presence of several small streams with low or intermittent flow, small, rather shallow lakes, and Lake Lagopede (4.8 km²), which is the largest lake in the study area. Lake Lagopede (32302) receives all of the water from the subwatersheds influenced by the project. An aquifer is present in the bedrock and in the surficial deposits. Groundwater flows mainly toward the various surface waterbodies, which suggests that there is groundwater seepage in the various lakes, while groundwater recharge occurs from topographical high points (Roche, 2011). Photos 6.8.1 through 6.8.3 illustrate the main types of aquatic environment found in the study area.

➢ *PHYSICOCHEMICAL CHARACTERISTICS*

The physicochemical characteristics of the surface water in the Renard Project study area are generally favorable to support aquatic life adapted to cold water. Species that are sensitive to changes in water quality, such as brook trout, are present in the study area, which demonstrates the high quality of the surface water.

Water Temperature

Figure 6.8.1 illustrates the range of water temperatures measured in streams, in Lake Lagopede, and in other lakes in the study area in July (9.6 to 26.7°C) and September 2010 (11.2 to 18.4°C).

[18] Oligotrophic: Describes a lake whose water contains low levels of dissolved nutrients but is rich in oxygen. These waters have a low biomass (Parent, 1986). The MDDEP considers a lake whose water has, on average, a phosphorous concentration between 0.004 and 0.010 mg/L, a chlorophyll concentration between 0.001 and 0.003 mg/L, and a transparency of 12 m to 5 m (MDDEP, 2010a) to be an oligotrophic environment.

[19] Ultra-oligotrophic: The MDDEP considers a lake whose water has, on average, a phosphorous content below 0.004 mg/L, a chlorophyll *a* concentration below 0.001 mg/L, and a transparency of above 12 m (MDDEP, 2010a) to be an ultra-oligotrophic environment.

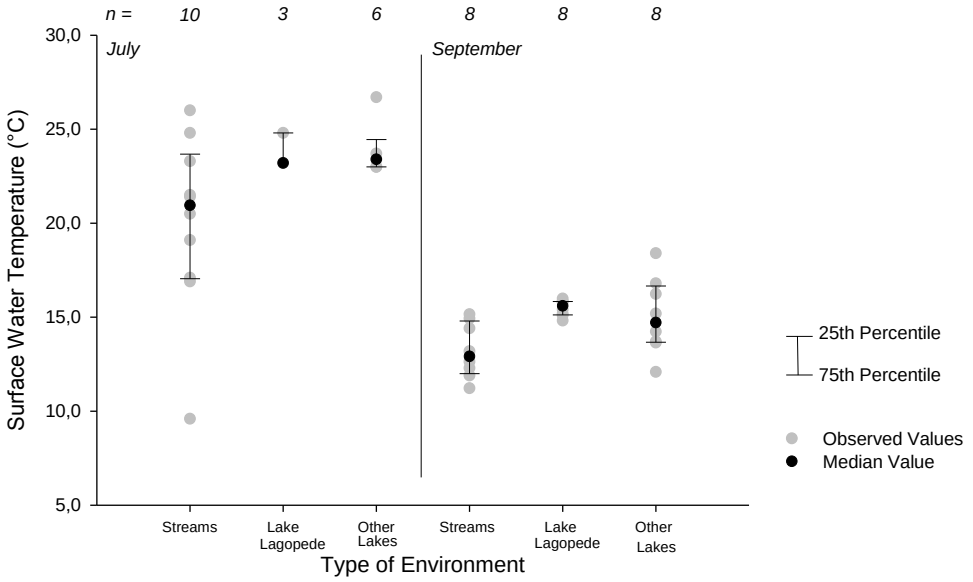


Figure 6.8.1 Water Temperature Recorded in July and September in the Renard Project Study Area

Continuous measurements of surface water temperature of streams and lakes in the area of the mine infrastructures generally showed that the range of daily water temperature variations is wider in small streams (a difference of 0.5°C to 5.2°C between the maximum and minimum temperatures within one day) than in larger streams (0°C to 1.5°C) and lakes (0 °C to 2.5°C). Given their larger water volumes, the lakes and the largest streams have greater thermal inertia and are generally more resistant to temperature variations (hot or cold water inflow, increased exposure to sunlight, etc.) than the small streams.

In September 2010, the temperature of Lake Lagopede was higher and less variable than the temperature of the streams (Kruskal-Wallis test, p=0.014).

In the outlet of Lake F3303 (station AQR-32, Map 6.8.1), less significant temperature variations and colder water were observed. These specific conditions could be explained by the presence of groundwater seepage.



Photo 6.8.1 Stream Located in the Mine Area (AQR15), on July 7$_{th}$ 2010



Photo 6.8.2 View of Lake Lagopede (32302), in July 2010



Photo 6.8.3 A small Lake (F3303) Located Near Camp Lagopede (AQR13) on July 7$_{th}$ 2010

In the study area, temperature and dissolved oxygen measurements were taken at various depths in the water columns of eight lakes. The two deepest of these lakes (depth > 6 m), that is, Lake Lagopede and lake F3295, showed the presence of thermoclines. The absence of thermoclines in the other lakes is explained by their low depth, which promotes complete water mixing.

Dissolved Oxygen

Surface water in the study area is well oxygenated and dissolved oxygen is not generally a limiting factor for aquatic life.

In August 2004, dissolved oxygen concentration was measured at the surface of ten lakes, including eight lakes where measurements were also taken at the lake bottom. Concentrations ranged from 9.4 ppm to 10.9 ppm, with a saturation of 90% to 104%. These values generally meet the provincial and federal criteria for coldwater species (MDDEP, 2009; CCME, 2007).

In July and September 2010, values measured varied from 5.28 ppm to 11.33 ppm and from 60.6% to 106% saturation, and there were no significant differences between streams and lakes.

In general (95% of cases), concentrations of dissolved oxygen measured in 2010 were above the federal criterion for all life stages (except early stages), which is set at 6.5 ppm. Only concentrations measured in lake F2607 in July 2010 (station AQR-3, 5.28 ppm) and concentrations measured in September 2010 in a small channel in the centre of a wetland (station AQR7, 5.8 ppm, Map 6.8.1) showeded values below this criterion. Water with limited circulation or waters containing significant quantities of organic matter may naturally present lower oxygen concentrations than clear water.

In 2010, the vast majority (98%) of the oxygen measurements were below the criteria of 9.5 ppm set out by the CCME (2007) for early life stages. However, this criterion is specific to initial life stages and to periods of time and sites where salmonid spawning or invertebrate emergence have been observed (CCME, 1999a).

The degradation of organic matter at the bottom of lakes or wetlands can reduce available dissolved oxygen concentrations, particularly where surface exchanges are limited by the presence f a thermocline. It is also possible that seepage of less oxygenated groundwater could explain the low values observed. Vertical profiles conducted in August and September 2010 in lake F3295 and in the western bay of Lake Lagopede (32302) showed a relatively significant decrease in dissolved oxygen concentrations from the surface to the bottom of these lakes, as follows:

- A surface dissolved oxygen concentration of 7.16 ppm (78.9% saturation) decreasing to 5.74 ppm (59.7% saturation) at a depth of 7 m in lake F3295;
- A surface dissolved oxygen concentration of 7.91 ppm (88.9% saturation) decreasing to 3.42 ppm (28.8% saturation) at a depth of 13 m in the western bay of Lake Lagopede.

pH and Alkalinity

The streams and lakes of the study area have a pH ranging from acidic (4.7) to basic (8.0) depending on the location and when the measurement was taken (Tables 6.8.1 and 6.8.2).

In July 2010, all of the samples collected in streams had acidic pH levels, below the pH range (between 6.5 and 9.0) that corresponds to a CCME and MDDEP criterion for the protection of aquatic life from chronic effects. Only 56% of the water samples collected in the lakes had a pH below this range. In September 2010, the majority of pH values (84%) were below the pH range (6.5 to 9.0) used as a criterion for the protection of aquatic life and contamination prevention (Table 6.8.2)

Low pH values are often found in Northern Quebec and in the Côte Nord region, and exceedances of pH criteria are frequent, particularly in water naturally rich in dissolved organic matter (Wetzel, 2001). For example, the pH of lakes sampled as part of of the environmental monitoring of the La Grande complex varies from 5.9 to 6.9 (Schetagne *et al.*, 2005). Samples collected on the Matoush Property (Strateco Resources, 2009) and along the road alignment of Route 167 North extension (Roche–SNC-Lavalin Consortium, 2010) also show a large proportion of surface water samples with more acidic pH values than the guidelines recommended by the federal (CCME, 2007) and provincial (MDDEP, 2009) governments. According to the MDDEP (2009), it is unlikely that a pH of between 5.0 and 9.5 is harmful to any fish species.

The pH levels measured in September 2010 (median=5.60) are lower than in July 2010 (Figure 6.8.2, median=6.10, analysis of variance by ranks, p=0.043). In 2010, the pH of streams (4.97 to 7.93, median=5.82) was slightly lower than that of lakes (4.73 to 7.10, median=5.90). The results obtained for the Matoush Property also show a more acidic pH in streams (3.9 to 5.0) than in lakes (4.6 to 5.4, Strateco Resources, 2009). In September 2003, pH measurements were taken at the surface and the bottom of the lakes on the Foxtrot Property, and they showed that water at the bottom is slightly more acidic than at the surface (Appendix 6.8.3).

None of the pH values measured in July 2010 were below the criterion for the protection of aquatic life against acute effects (5.0) but, in September 2010, three values measured in a stream (AQR7: 4.97) and lakes F2607 (AQR-3: 4.97) and F3301 (AQR6: 4.73, Map 6.8.1) were slightly below this criterion. When pH value is below 6.5, it can lead to metal corrosion problems in watermains (MDDEP, 2009).

Along the Route 167 North extension alignment, the pH of the 38 samples collected in streams ranged from 5.78 to 7.29. About half of these pH results are below the lower limit of the pH range (6.5 to 9.0) used as criteria for the protection of aquatic life.

Alkalinity is the ability of water to neutralize an acid (McNeely *et al.*, 1980). As for pH, bicarbonates, carbonates, and hydroxides determine water alkalinity (Wetzel, 2001). There are no criteria for alkalinity, but low values (<10 mg of $CaCO_3$/L) such as those observed in the study area indicate greater vulnerability of the water to acidification (MDDEP, 2009). The values measured in streams and lakes in

2002 and 2003 on the Foxtrot Property and those observed on the Matoush property (<2,5 mg/L) also show that the water in this region is vulnerable to acidification.

Turbidity and Total Suspended Solids

The water in the lakes and streams has low concentrations of total suspended solids (<1 mg/L). The turbidity values measured are also low, both during low flow periods (0.78 to 2.41 NTU, median=1.18 NTU) and during abundant rainfall periods (0.00 to 2.41 NTU, median=0.00 NTU). In addition, many lakes in the hydrographical network are likely to retain a large portion of the sediment that may be transported.

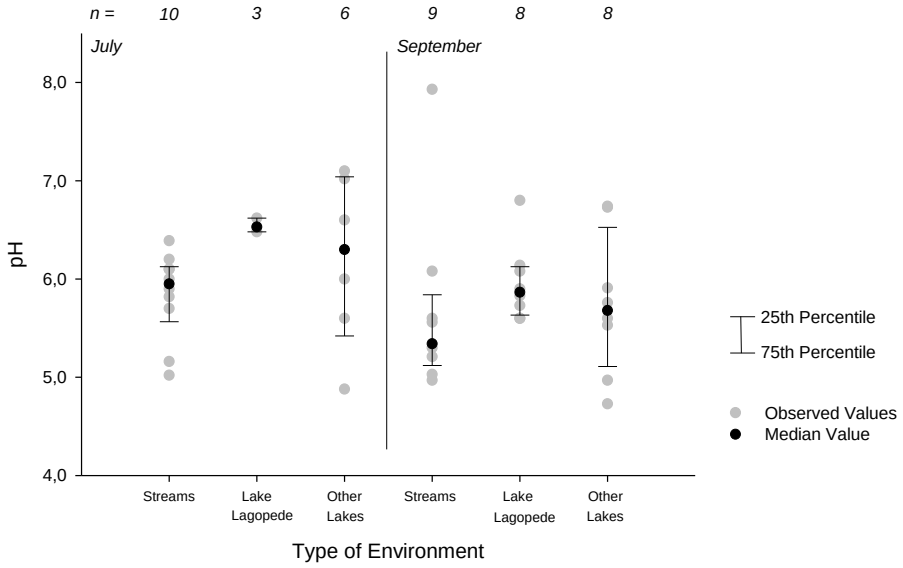


Figure 6.8.2 pH Values Recorded in July and September 2010 in the Renard Project Study Area

Turbidity values measured in the lakes of the La Grande complex are also low (0.42 to 1.82 NTU) (Schetagne *et al.*, 2005). The 38 streams characterized along the proposed Route 167 North extension project also show low turbidity values (0 to 3.35 NTU) (Roche-SNC-Lavalin Consortium, 2010).

The highest total suspended solids and turbidity values were measured in lake F3303 (station AQR13, Map 6.8.1) in September 2010. During the surveys, the sampling team identified the source of this elevated turbidity as coming from a defect in a retention basin for drilling water. At this location, the water quality characterization program lead to the detection of an increase in concentrations of total suspended solids (19 mg/L) and turbidity (29.53 NTU). These values are higher than the criterion for protection of aquatic life from acute effects. Higher values of nutrients (total phosphorus, total Kjeldahl nitrogen), metals (aluminium, iron) and petroleum hydrocarbons were also observed at this station in September 2010 (Table 6.8.2).

Once the contamination source was identified, preventive and remedial actions were taken by Stornoway to prevent this type of incident from happening again. The construction of small retention basins was reworked with the drilling company, and measures were taken to promote awareness about the importance of environmental protection among all of the team members. Since these measures were implemented, no other similar incidents have been reported.

- *NUTRIENTS*

In the Renard Project study area, nitrogen is present mainly in the form of total Kjedahl nitrogen, that is, the sum of organic nitrogen and ammonia which mainly comes from nitrogenous organic detritus (e.g. proteins, polypeptides, amino acids, and urea). Concentrations of total Kjedahl nitrogen measured (0.22 mg/L to 0.72 mg/L) are characteristic of streams that receive little organic matter (McNeely *et al.*, 1980). Concentrations measured in lakes and streams on the Matoush Property are comparable (0.1 mg/L to 0.5 mg/L, Strateco Resources, 2009), but they are higher than those measured in the lakes of the La Grande complex (0.08 mg/L to 0.27 mg/L) (Schetagne *et al.*, 2005). For all of the sampling campaigns, concentrations of other nitrogenous compounds (ammoniacal nitrogen, nitrites, and nitrates) are low, that is, close to the detection limit of the analytical method.

Concentrations of total phosphorus (<0.005 mg/L to 0.011 mg/L) are very low and characteristic of ultra-oligotrophic (<0.0004 mg/L) to oligotrophic lakes (0.004 mg/L to 0.01 mg/L, MDDEP, 2010a). Total phosphorus concentrations measured in the lakes of the La Grande complex are also low and generally vary from 0.004 mg/L to 0.0012 mg/L (Schetagne *et al.*, 2005). On the Matoush Property, total phosphorus concentrations were also characteristic of ultra-oligotrophic to oligotrophic conditions (Strateco Resources, 2009).

- *MAJOR IONS*

The most abundant ion in the surface water samples is sulphate ion, followed by calcium, magnesium, chlorides, sodium and potassium (Table 6.8.4). Concentrations of calcium, magnesium, sodium and potassium measured in 2010 are comparable to values measured in the study area in 2003 and 2004 (Table 6.8.4). The concentrations are relatively low, similar to the lowest surface water concentrations found in Quebec rivers located further south.

Due to low mineral concentrations, the surface water in the study area is very soft (with a hardness ranging from <1 mg to 19 mg of $CaCO_3$/L) and have low conductivities (6.1 to 28.4 µS/cm). The average water hardness of streams and lakes on the Foxtrot Property is very low, that is, 1 mg of $CaCO_3$/L. Hardness is a factor that influences the toxicity of certain metals. When the hardness value is low, the toxicity of certain metals (cadmium, chromium, copper, manganese, nickel, lead, and zinc) increases (MDDEP, 2009).

Table 6.8.4 Minimum and Maximum Concentrations of Major Ions Measured at Various Sites

Parameter	Foxtrot Property (July and September 2010)	Foxtrot Property (July 2003 and September 2004)	Monitoring of the La Grande Complex[1]	Other Quebec Rivers[2]
Sulphates (mg/L)	0.3 to 6.8	Not Measured	0.3 to 1.8	2.65 to 110.34
Calcium (mg/L)	<0.1 to 2.9	0.4 to 1	1.2 to 3.5	1.17 to 46.80
Magnesium (mg/L)	<0.02 to 2.3	0.08 to 0.35	0.22 to 0.65	0.32 to 19.29
Chlorides (mg/L)	0.05 to 0.85	<2	<0.2 to 1.0	Not Measured
Sodium (mg/L)	<0.03 to 1.3	<0.4 to 0.7	0.3 to 1.8	0.83 to 19.29
Potassium (mg/L)	0.1 to 1.0	<0.1 to 0.2	0.3 to 0.4	0.24 to 7.54

[1] From Table 3.2 in Schetagne *et al.*, 2005

[2] According to Landry and Mercier, 1984

- *METALS*

Like nutrient and ion concentrations, metal concentrations in the surface water sampled in the Renard Project study area were generally low.

Metals with the highest concentrations are, in descending order, iron, manganese, and copper. In addition, aluminium was measured in higher concentrations than certain other metals in the samples collected in September 2010.

All of the water samples collected in the study area show concentrations of antimony, cadmium, chromium, cobalt, mercury, molybdenum, lead, selenium, and zinc lower than the detection limit of the analytical method. Concentrations of arsenic are all equal to or less than the limit of quantification (three times the detection limit). Between 2002 and 2004, concentrations of arsenic, cadmium, chromium, mercury, nickel, lead, and zinc were also equal to or below the limit of quantification (three times the detection limit).

From 2002 to 2004, the federal and provincial criteria for the protection of aquatic life and the provincial criteria for protection from contamination were exceeded for iron and copper (Table 6.8.5). In 2010, aluminium, a parameter that was not measured from 2002 to 2004, also exceeded the criterion. The implications of these levels exceeding the criteria are explained below. Levels of nickel and zinc also exceeded the federal and provincial criteria for the protection of aquatic life, but these results should be interpreted carefully because results close to the limit of quantification are less precise and fall into the area of uncertainty of the analytical methods.

Aluminium

Although several values exceed the criteria for the protection of aquatic life, (47% in July and 96% in September), it is important to note that concentrations of aluminium exceeding the criteria are often reported in waters of the Canadian Shield (Schetagne *et al.*, 2005).

In July 2010, concentrations measured in water in the study area varied from <0.01 to 0.20 mg/L, while in September 2010, they were higher and varied from <0.03 to 0.87 mg/L (Figure 6.8.3; analysis of

variance by ranks, p=0.000). It is possible that aluminium concentrations were higher due to lower pH in September (median=5.60) than in July (median=6.10).

Most of the values exceed the Canadian guideline for the protection of aquatic life, which is 0.005 mg/L (47% in July and 96% in September).

In July 2010, 3 of the 19 values (16%) obtained were above the criterion for the protection of aquatic life from chronic effects for aluminium, while in September, 15 of the 25 values (60%) were above the criterion. The Quebec criteria for the protection of aquatic life were developed for water with a pH of 6.5 to 9.0 and a hardness value below 10 mg/L (MDDEP, 2009). In 2010, the majority of samples had a hardness value below 10 mg/L (96%) and a pH below 6.5 (84%). When the environment does not meet the conditions for the application of a criterion, the MDDEP recommends not using that criterion (MDDEP, 2009). In addition, according to the MDDEP, "*Some good quality surface water may have natural levels that exceed the water quality criteria. In these cases, the natural background should be considered as the reference value rather than the quality criterion. A site-specific quality criterion can also be determined on a case by case basis.*"

In September 2010, 11 of the 25 values measured (44%) exceed the criterion for the prevention of the contamination of sites with water intake. This criterion is a guide for optimizing water treatment processes (MDDEP, 2009).

Iron

In 2010, iron was the metal measured in the highest concentrations in surface water (0.05 mg/L to 0.80 mg/L). The values measured are typical of water found in the James Bay territory (Magnin, 1977). Iron was also measured in higher concentrations than other metals in the samples collected from 2002 to 2004 (0.06 to 0.35 mg/L).

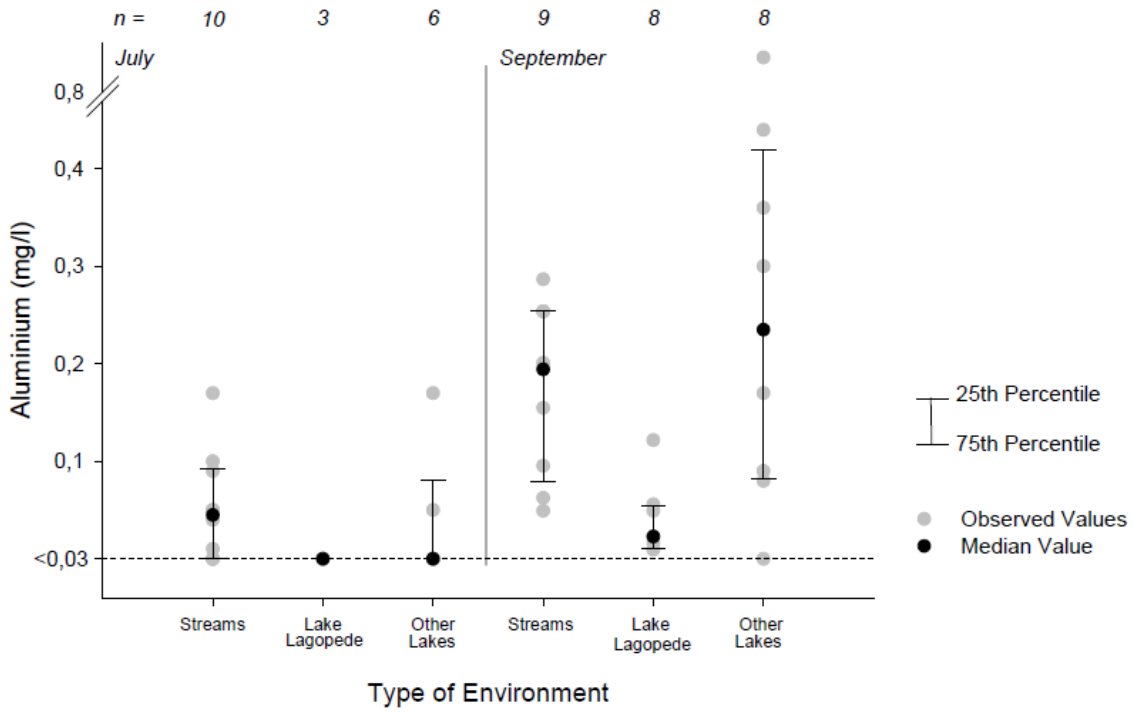


Figure 6.8.3 Aluminium Concentrations Measurements for Different Aquatic Environments and Sampling Periods

The data collected at the following stations (Map 6.8.1) in September 2010 indicate levels exceeding the MDDEP criterion for prevention of contamination and the CCME guidelines for the protection of aquatic life:

- AQR15 (0.40 mg/L) in a stream that flows into lake F3295, near R-1;
- AQR-3 (0.70 mg/L) in lake F2607;
- AQR13 (0.80 mg/L) in lake F3303, where accidental spillage of drilling water was observed;
- At the outlet of the F2607 waterbody in September 2002 (AQR4, 0.35 mg/L).

At levels above 0.3 mg/L, the organoleptic (taste) or esthetic properties of water for consumption may be altered.

These values are typical of the iron-rich water of the Canadian Shield. Similar iron concentrations are often found in waters of the region. Ion concentrations ranging from 0.07 mg/L to 0.43 mg/L were measured in the lakes sampled as part of the monitoring program of the La Grande complex (Schetagne *et al.*, 2005). According to McNeely *et al.* (1980), well oxygenated water contains iron concentrations of under 0.5 mg/L. Iron solubility increases when the pH or the dissolved oxygen concentrations decrease (McNeely *et al.*, 1980). Iron solubility is very low at pH values varying from 5 to 8 (Wetzel, 2001), so it is mainly associated with total suspended solids.

Table 6.8.5 **Concentrations of Metals Measured in the Hydrographical Network of the Foxtrot Property from 2002 to 2010 and Exceedance frequency of the Criteria for the Protection of Aquatic Life**

Sampling Period	Most Restrictive Criteria for the Protection of Aquatic Life and the Prevention of Contamination[2]	Number of Values Measured		Limit of Detection of the Analytical Method (LOD)[1] (mg/L)	Range of the Values (min-max) (mg/L)	Median (mg/L)	Exceedance Frequency of Criteria
		Lake	Stream				
Aluminium							
September 2002	0.005 mg/L	Not Measured		-	-	-	-
July 2003		Not Measured		-	-	-	-
August-September 2004		Not Measured		-	-	-	-
July 2010		10	9	*0.01*	<0.01-0.20	<0.01	47%
September 2010		16	9	*0.03*	<0.03-0.87	0.19	96%
Iron							
September 2002	0.3 mg/L	4	10	0.02	0.08-0.35	0.14	7%
July 2003		Not Measured		-	-	-	-
August-September 2004		10	0	0.02	0.06-0.29	0.1	0%
July 2010		10	9	0.02	0.05-0.55	0.19	11%
September 2010		16	9	0.1	<0.1-0.8	0.2	12%
Copper							
September 2002	0.002 mg/L	4	10	*0.01*	<0.01-0.01	<0.01	**14%**
July 2003		14	5	0.001	<0.001-0.003	<0.001	**16%**
August-September 2004		10	0	0.001	<0.001	<0.001	0%
July 2010		10	9	0.001	<0.001-0.004	0.002	58%
September 2010		16	9	*0.003*	<0.003	<0.003	0%
Nickel							
September 2002	0.0074 mg/L	4	10	*0.05*	<0.02-0.05	<0.02	**29%**
July 2003		14	5	0.001	<0.001-0.003	<0.001	0%
August-September 2004		10	0	0.003	<0.001-0.002	<0.001	0%
July 2010		10	9	0.001	<0.001-0.005	<0.001	0%
September 2010		16	9	*0.01*	<0.01	<0.01	0%
Zinc							
September 2002	0.017 mg/L	4	10	0.01	<0.01-0.02	0.01	**14%**
July 2003		14	5	0.002	0.004-0.015	0.006	0%
August-September 2004		10	0	0.002	0.003-0.006	0.004	0%
July 2010		10	9	0.002	<0.002	<0.002	0%
September 2010		16	9	0.005	<0.005	<0.005	0%

[1] *In Italics = Limit of detection above the most restrictive criterion*

[2] The criteria are given in Tables 6.8.1 and 6.8.2. The criteria vary according to water hardness. Values shown are calculated based on a hardness of ≤10 mg/L of $CaCO_3$.

[3] **In bold** = Values below the limit of quantitation (3 x the limit of detection of the analytical method)

Copper

Copper present in surface water largely comes from soil erosion, and natural concentrations generally vary from 0.001 to 0.010 mg/L (INERIS, 2005). Values measured in the study area are low (≤0.004 mg/L), but some values exceed the MDDEP criteria for the protection of aquatic life (chronic and acute effects). Most of the values that exceed the criteria are below the limit of quantification (that is, three times the detection limits of the analytical method). Only one value was measured above this limit in July 2010, a concentration of 0.004 mg/L recorded in Lake Lagopede at station AQR11 (Map 6.8.1). However, during the July 2010 campaign, test results for copper did not meet the analytical performance criteria expected for quality control. Values measured in duplicates showed discrepancies when compared to regular samples.

- *PETROLEUM HYDROCARBONS*

Concentrations of petroleum hydrocarbons (C_{10}-C_{50}) are all below the detection limit of the analytical method. In September 2010, petroleum hydrocarbons were measured in lake F3303 at station AQR13 (Map 6.8.1) at a concentration exceeding the criterion for the protection of aquatic life from acute effects (see Section 6.8.1.2 under the subheading Total Suspended Solids for a detailed description of the source of this contamination and the measures taken to manage the situation).

6.8.1.3 Airstrip

The streams and lakes that receive runoff water from the plateau where the proposed airstrip site will be located are part of the Misask River watershed.

In July and September 2010, surface water samples were taken in a stream located in the airstrip area (AQP2) and in the small lake F3291 (AQP1) located 500 m north of the airstrip and surrounded by a bog.

The test results show that the physicochemical characteristics of the water in this area are similar to those in the mine area. The criteria for the protection of aquatic life from chronic effects are exceeded in this area for pH, aluminium, iron, and copper. In this area, in July 2010, a lower pH value (4.88) than the criterion for the protection of aquatic life from acute effects was measured in the stream. The criteria for prevention against contamination were exceeded for pH and iron. The presence of iron in the water can modify the taste, smell, or colour of the water but does not constitute a health risk.

Iron concentrations measured in July 2010 were higher in the airstrip area than in the mine area. Values measured at stations AQP1 (0.47 mg/L) and AQP2 (0.55 mg/L) are above the Canadian guideline for the protection of aquatic life. This result was not observed in September 2010, when the water level was higher.

6.8.2 Impacts during the Construction Phase

6.8.2.1 Description of Impacts

The following project components are likely to affect water quality during the construction phase:

- Site preparation and development (clearing, drilling, blasting, cut, fill, drainage, material confinement area and stockpiles, borrow pits, and secondary roads) for all facilities;
- Quarry and borrow pit operation - Material extracted from the borrow pits will only be necessary for the development of the airstrip. To prevent and limit related impacts, the majority of materials will come from the crushing of waste rock extracted from pit R-65 and overburden. The borrow pits for the project will be developed close to the airstrip and they will be operated jointly with the MTQ. The preparation, development, and operation of the borrow pits is likely to alter water quality particularly through sediment transport to the waterways if erosion is not controlled at source;
- Dewatering of lakes and water and sediment management - Site preparation and development and dewatering of small lakes F3302 and F3303 are likely to temporarily alter water quality through erosion and sediment transport to the waterways;
- Water management on the construction site - Sediment transport and an increased concentration of phosphorus to the waterways could potentially be caused by water management on the construction site.
- In addition, effluent from the domestic wastewater treatment facilities may release nutrients, organic matter, or fecal coliforms at the outfall discharge point in Lake Lagopede.
- The use of aircraft de-icing fluid could increase the quantity of propylene glycol present at the discharge point for water from the airstrip if not controlled;
- Traffic and the use and maintenance of machinery and power generating sets;
- Storage and management of fuel and hazardous materials - The use and maintenance of machinery and power generating sets and the storage of fuel and hazardous materials such as used oils will increase the probability of water contamination with hydrocarbons or other contaminants;
- Solid waste storage and management system and the trench landfill site - water from the trench landfill site is likely to leach contaminants into the hydrological network if not controlled;
- Water supply - due to the large volume of water available and the low rate of withdrawal during the construction phase, the withdrawal of water from Lake Lagopede is not likely to modify water quality.

➢ *SITE PREPARATION AND DEVELOPMENT*

Site preparation and development activities, such as clearing, excavation, earthworks, and the construction of access roads will expose the soil to inclement weather, making it more vulnerable to erosion. Grubbing and the circulation of machinery will affect the integrity of soil, increasing its vulnerability to erosion. If not adequately managed, the transportation and storage of bulk construction materials will lead to the possibility of greater quantities of materials being introduced into the waterways.

Activities carried out directly in or on the banks of streams and waterbodies, such as the diversion of streams and the installation of culverts, are the most likely to lead to significant changes in surface water quality. Some secondary roads will be developed on the Renard Project site, but the diversion of

certain streams carried out ahead of time and the dewatering of lakes F3302 and F3303 will reduce the number of stream crossings on the site.

If soil erosion is not controlled at source, it is likely to lead to sediment transport to the hydrological network and therefore increase the water turbidity. Despite the implementation of erosion and sediment transport control measures, it is possible that, during storm events, an increased concentration of total suspended solids (TSS) could be observed in the streams or waterbodies located near the work areas. In addition to increased turbidity levels, soil particles from erosion may transport various nutrients (nitrogen, phosphorus), organic matter, or metals that could influence several surface water quality parameters (humic acids, pH, nutrients, BOD_5).

Based on water samples collected in July and September 2010, TSS concentrations in the study area are generally below 1 mg/L and turbidity is low (0.00 to 2.41 NTU) (Table 6.8.3). Nutrients concentrations are very low and characteristic of ultra-oligotrophic (<0.0004 mg/L) to oligotrophic (0.004 mg/L to 0.01 mg/L; MDDEP, 2010a) lakes. Considering the low concentrations of phosphorus and organic matter in the receiving environment, conditions could be favourable to the development of periphyton and algae in small streams bordering the construction site due to proportionally more significant inflow of these compounds.

Decreased forest cover and possible increases in TSS concentrations could potentially contribute to raising water temperature in small streams or waterbodies.

- *Quarry and Borrow Pit Operation*

Operation of the borrow pits will be reduced by the use of overburden and waste rock extracted from pit R-65 and other sites to provide the necessary materials for civil engineering. This approach will allow for a reduction of the project footprint and sediment transport to the hydrological network. Some additional borrow pits (69 ha) are planned, and they will be used jointly with the MTQ. The borrow pit operation and the crushing of borrow material have the potential to foster sediment transport to the hydrological network if not controlled. Pumped and drained water may transport suspended solids to the surrounding streams and waterbodies.

- *Lake Dewatering and Water and Sediment Management*

The operation of pits R-2/R-3 and R-65 requires the dewatering of lakes F3302 and F3303. Water that will be pumped from these lakes will contain fine sediment. The water from dewatering will be pumped to a sedimentation pond located in the footprint of R-65, then to the first unit of the water treatment plant before being released into Lake Lagopede.

Runoff

In addition to phosphorus bind to soil particles that could be transported to the aquatic environment, the main sources of phosphorus and organic matter expected are the following: treated domestic effluent, input from the mine site's drainage water, ammonia input from explosives waste if it is not managed properly, and leachate from the trench landfill site.

Several runoff management measures are planned to preserve surface water quality during the construction phase. A derivation ditch will be constructed to redirect water from areas upstream of the mine area to preserve water integrity. In addition, a peripheral system of ditches to collect runoff will be connected to the sedimentation ponds adjacent to the camp. This water management system will be built as soon as construction activities begin. These ponds will receive runoff from the work areas to retain particulate matter. Water quality monitoring of the sedimentation ponds will be carried out before this water is released into Lake Lagopede. A mobile treatment unit for runoff will also be used to remove fine particles before the water is released into the lake.

Domestic Wastewater Management

The domestic wastewater treatment station is likely to emit contaminants (phosphorus, nitrogen, fecal coliforms, organic matter) that may modify the characteristics of Lake Lagopede within the effluent dispersion plume.

Phosphorus is often the nutrient found in lowest concentrations in waterbodies, and it is often the limiting factor for the development of algae. When phosphorus suddenly becomes available (as phosphates) in greater quantities in the environment, it may lead to algae proliferation and increase the productivity of the aquatic environment. For this reason, the domestic wastewater treatment system will include a phosphate removal system using alum.

Treated domestic effluent is also likely to carry additional organic matter that could temporarily increase the productivity of the environment and contribute to an increase in bacterial activity to decompose the excess of organic matter. Locally, at the discharge point, the increase in bacterial activity may lead to a decrease in dissolved oxygen levels in the water. In the absence of disinfection, treated domestic effluent could contribute to an increase in concentrations of coliform bacteria at the discharge point. The treatment station includes three lagoons to increase disinfection performance, as recommended by the MDDEP (2010b).

During the construction phase, up to 500 workers could be present at the mine site. Wastewater produced at the camp will be treated in aerated facultative lagoons composed of three lagoons (see Section 3.10.1 for a detailed description of the treatment system). The domestic wastewater treatment plant will be able to treat 330 m³/day (maximum daily flow). The treated effluent quality criteria

are presented in Table 6.8.6. These treatment units will ensure compliance with the effluent environmental quality objectives for discharge defined by the MDDEP within the framework of the environmental authorization process.

The treated domestic wastewater discharge point is located in a portion of Lake Lagopede located south of the accommodation and services complex (Figure 3.10.2). The location of the outfall discharge point and of the domestic wastewater treatment plant were selected based on various technical, environmental, physical (morphology of the lake, depth, dominant wind direction, etc.), biological (fish habitat, migration routes), and human (fishing site, water intake, etc.) criteria. They were also selected to ensure that the depth and hydrodynamic conditions at the discharge point would contribute to effluent dispersion and the protection of water uses (water intake, aquatic life, fishing, etc.).

Respecting the effluent discharge objectives established by the MDDEP and the surface water quality criteria for the protection of aquatic life (at the boundary of the mixing zone) will limit these impacts, and modifications of lake water and sediment quality should be confined to the initial discharge mixing zone.

Results of treated domestic effluent plume modelling (Appendix 3.10.1) indicate that the initial concentration of treated effluent will reach a dilution of 1:100 at a distance of 52 m to 130 m from the discharge point, based on average estimated flow and peak flow (details in Section 3.10.5 and Figure 3.10.3). At the boundaries of the plume, contaminant concentrations will be in the range of concentrations currently measured in the receiving environment. According to the results of dilution limits and CE-QUAL-W2 model calculations, the domestic effluent will not have a significant influence on water quality in the lake. Its influence will be limited to the area surrounding the discharge point.

Wastewater generated in the airstrip area will be treated locally by a septic tank system and an absorption field in accordance with regulations.

Use of Aircraft De-icing Fluid

When temperatures hover around the freezing point, as in fall and spring, the use of aircraft de-icing fluid will be required. De-icing consists of spraying a hot solution of glycol ethers. Given that the airstrip will be located far from any de-icing fluid providers, a 500-gallon reservoir (1,900 l) will be installed in a closed shed.

There are two large families of glycol ethers, that is, those derived from ethylene glycol and those derived from propylene glycol. Ethylene glycol and propylene glycol are substances currently used as antifreeze agents (aircraft wing de-icing) in the aeronautic field. The former is toxic for humans (exposure through pulmonary and cutaneous routes) and aquatic life. Unlike ethylene glycol, propylene glycol is not toxic because it oxidizes into pyruvic and acetic acids (Health Canada, 2004b). To de-ice aircraft, propylene glycol will be used. Even though it is not considered toxic, propylene glycol can affect aquatic organisms when it is present in too great a concentration (>500 mg/L, CCME, 2007). It is estimated that over half of the quantity of glycol sprayed on airplanes ends up on airstrips and

eventually reaches streams if it is not recovered. It is the aquatic pollutant most closely associated with the presence of an airport. Based on the product used, certain additives could potentially pose a risk for the environment.

Considering that planes will only be on the ground for short periods and that the frequency of flights will be low (about twice a week) during the construction phase, the need for de-icing will be much less than that of a commercial airport. To limit the dispersion of propylene glycol, all de-icing activities will take place in the same location. Given the low toxicity of propylene glycol and the small quantities that will be used, estimated at about 1,000 L per year, no toxicity problems or increase in BOD_5 associated with the degradation of propylene glycol are expected in the aquatic environment.

Residual propylene glycol that may remain in spring will quickly be diluted by snowmelt and spring rainfall and carried into streams during spring flood. To ensure that the surrounding streams and lakes are not contaminated and that there are no impacts on dissolved oxygen concentrations associated with the use of propylene glycol, a surface water quality monitoring program will include the analysis of this compound, as well as dissolved oxygen levels and BOD_5 in the surface water downstream of the airstrip.

- *Traffic and the Use and Maintenance of Machinery and Power Generating Sets*

Traffic and the presence, use, and maintenance of power generating sets will increase the probability of accidental spillage or leakage of petroleum products on the site.

The MDDEP recommends a concentration of less than 0.01 mg/L of hydrocarbons in surface water for the protection of aquatic life (chronic effects). Following an accidental hydrocarbon spill in the aquatic environment, a large proportion of the hydrocarbons evaporate into the atmosphere. The soluble fraction of the hydrocarbons, which includes aromatic compounds, can solubilize and contaminate surface water and, eventually, sediment. For this reason, several preventive and remedial actions are planned to limit the risk of accidental spillage or leakage and quickly identify, confine, and recover leaks and spills and dispose of them at an authorized site.

Potential sources of water contamination related to the use of hydrocarbons include the following:

- Accidental spillage and leakage of hydrocarbons from machinery, generators, or fuel storage areas;
- Contaminated water from storage containers of materials contaminated with hydrocarbons or other waste or hazardous materials.

Table 6.8.6 Criteria for the Protection of Aquatic Life, Surface Water Quality Background Levels, and Design Criteria Recommendations for Domestic Wastewater Treatment Facilities

Parameter	Unit	Analytical Method Detection Limit (DL)	Water Quality Guidelines and Criteria					Theoretical Effluent Discharge Objective (Design Criterion)	Results (Lake Lagopede)			Results (Study Area)		
			Guidelines for the Protection of Aquatic Life (CCME)	Surface Water Quality Criteria					Number of Values	Median	95th percentile	Number of Values	Median	95th percentile
				Protection of Aquatic Life		Contamination Prevention								
				Chronic Effects	Acute Effects	With Water Intake	Without Intake							
Total Suspended Solids	mg/L	2	over 5 to 25[a]	over 5 to 25[c]	over 25[d]	-	-	-	5	<2	<2	44	<2	<2
Total Phosphorus	mg/L	0.005	0.004-0.01[b]	0.02[e], 0.03[f] or >50%[g]	-	-	-	1	5	<0.005	0.008	44	0.006	0.011
Fecal Coliforms	CFU/100 mL	-	-	-	-	1000[i]	-	10 000				-	-	-
Biochemical Oxygen Demand (BOD_5)	mg/L	-	-	3[h]	-	-	-	25-35				-	-	-

[a] For clear water, a maximum increase of 25 mg/L from background concentrations for short-term exposure (e.g. a 24-hour period), and an average maximum increase of 5 mg/L frpm background concentrations for long-term exposure (e.g. 24 hours to 30 days). For peak flows, the maximum increase at all times is 25 mg/L from background concentrations when background is between 25 and 250 mg/L. This increase should not exceed 10 % of the background concentrations when background is >250 mg/L.

[b] The values presented represent the range of phosphorus concentrations of an oligotrophic environment. If the upper limit is exceeded, this may indicate potential environmental problem. See the CCME information leaflet on phosphorus for more information.

[c] During dry weather, the quality criterion is defined by an average maximum increase of 5 mg/L from natural concentrations. During high flow periods (rain, snowmelt), the quality criterion is defined by either a maximum increase of 25 mg/L from background concentrations at all times when background concentrations are between 25 and 250 mg/L or by a 10 % increase from background concentrations when background concentrations are measured above 250 mg/L at any given time.

[d] During dry weather, the quality criterion is defined by an average maximum increase of 25 mg/L from background concentrations.

[e] This quality criteria applies to streams flowing into lakes whose environmental context is not problematic. It is focused on avoiding habitat modification in these lakes by limiting the growth of algae and aquatic plants.

[f] This quality criteria is focused on limiting the excessive growth of algae and aquatic plants in streams and rivers.
Certain factors influence the potential effects of phosphorous. The main physical factors are type of substrate, depth, water transparency and temperature, current speed, and shading. These characteristics are not taken into account by the quality criteria. For this reason, the phosphorous quality criteria must be used judiciously according to the environment assessed.

[g] For oligothrophic lakes with natural concentrations that are or were below 0.01 mg/L, the quality criteria is defined by a maximum increase of 50 % from natural concentrations without exceeding 0.01 mg/L.

[h] This value corresponds to the maximum tolerable oxygen deficit for aquatic life at an average summertime temperature of 21 °C.

[i] This quality criteria applies to raw water for drinking water supply where there will be complete treatment, i.e. flocculation, filtration, and disinfection.

During the construction phase, generators with a capacity of 1,800 kW will be necessary to provide electricity. The airstrip site will also have its own 80 kW generator. The use and maintenance of these generators and heavy machinery has the potential to introduce hydrocarbons into the hydrological network if they are not quickly confined and recovered.

Management of equipment including preventive maintenance and a program encouraging employees to detect and report leaks and operating problems will be implemented to reduce the extent and total volume of any accidental spill or leak. In addition, a clear and efficient environmental management plan will be implemented. The measures to be put in place are described in more detail in Section 3.12 of this impact assessment. These measures include collecting runoff from the area of the mine truck and light vehicle repair workshop in an oil-water separator and collecting recovered oils using a vacuum truck (SNC-Lavalin, 2010), then storing the oils at the mine site until their eventual transportation south where they will be taken to a designated site for contaminant management.

- *Solid Waste Storage and Management System and the Trench Landfill Site*

The Renard Project's solid waste management plan includes a trench landfill site for solid waste that will not be recovered, reused, or transported south to an authorized disposal site.

Infiltration of precipitation and water table circulation in the trench landfill site have the potential to transport various contaminants, such as dissolved solids and metals, to the groundwater table. These contaminants could eventually seep into surface water. Domestic waste generates leachate characterized by significant quantities of organic matter and certain metals (Table 6.8.7). This leachate may also contain other contaminants (e.g. hydrocarbons) associated with the presence of hazardous materials or waste burned locally or incinerated before burial.

The trench landfill site will meet the design criteria set out in Division 3 of the *Regulation respecting the landfilling and incineration of residual materials* (c. Q-2, r. 19). The leachate produced by this site will be treated by infiltration on the site, and the following natural processes will contribute to the treatment: physical (filtration, capillary retention), biochemical (biodegradation), and chemical (precipitation, ion exchange, and absorption) processes. The dilution process will also contribute to decreasing the concentration of contaminants present in the leachate. In addition, several measures will be taken to reduce the quantity of solid waste produced at source, such as recycling of metal, wood, paper, and glass. A detailed description of solid waste management is provided in Section 3.11 of this impact assessment.

Table 6.8.7 Range of Concentrations of Various Compounds Observed in the Leachate of Landfill Sites

Parameter	Range of Concentrations in Landfill Sites (mg/L)
Total Dissolved Solids	584 – 44,900
Total Chromium	0.02 – 18
Nitrates	0 – 51
Phosphates	0.2 – 130
Sulphate	10 – 3,240
Calcium	60 – 7,200
Magnesium	17 – 15,600
Cadmium	0.03 – 17
Copper	0.005 – 9.9
Lead	0.001 – 2
Nickel	0.02 – 79
Iron	4 – 2,820
Zinc	0.06 – 370
Biochemical Oxygen Demand (BOD_5)	4 – 57,700
Chemical Oxygen Demand (COD)	39 – 89,250

Source: Ministère du Développement durable, de l'Environnement et des Parcs, 2011. Guide relatif à la construction sur un lieu d'élimination désaffecté, document available on Internet [http://www.mddep.gouv.qc.ca/matieres/construction/guide-construction-desaffecte.pdf] (French only), August 12, 2011.

- *HAZARDOUS WASTE MANAGEMENT*

Hazardous waste will temporarily be stored in places designed for this purpose until they can be transported south and disposed of at an authorized site.

These hazardous waste materials include the following:

- Oil and grease waste (contaminated rags and absorbents, used oils and lubricants, used solvents, oil filters);
- Light bulbs containing mercury;
- CFCs and other halides, various aerosol cans;
- Explosives and explosives packaging, nuclear sources (hydrometer, flowmeter in piping);
- Oily water and batteries.

A detailed description of the hazardous waste management plan is provided in Section 3.12 of this impact assessment.

- *WATER SUPPLY*

During the construction phase, water withdrawal from Lake Lagopede will be necessary for the following activities: fire protection, water supply source for dust control, cleaning, and for the needs of the accommodation and services complex. Given the low rate of withdrawal from Lake Lagopede during the construction phase (average daily withdrawal of 150 m^3/day, daily maximum of 300 m^3/day, maximum peak withdrawal of 417 L/min), the large volume of Lake Lagopede (21 Mm^3), and its hydraulic

residence time (53 days), the withdrawal of water will not lead to significant changes to water level or water quality in the lake.

6.8.2.2 Mitigation Measures

The work methods used will help mitigate the impacts on water quality by reducing the quantity of fine particles present in runoff and in streams. In addition, they aim to avoid all water contamination from accidental spillage of hydrocarbons or other possible contamination sources.

- *Site Preparation and Development: Clearing, Drilling, Blasting, Cut, Fill, Drainage, Materials Confinement Area and Stockpiles, Borrow Pits, and Secondary Roads for All Facilities*

Erosion Control at Source

- The project footprint was reduced to limit clearing as much as possible;
- The work areas will be clearly identified on the land to limit interventions to the necessary areas;
- No sand pits will be developed within 75 m of a lake, stream with permanent flow, or fish habitat, except under conditions in accordance with the *Regulation respecting pits and quarries* (c. Q-2, r. 7);
- Installation of devices at source to control soil erosion and sediment transport to streams and waterbodies using strategies adapted to the site and the environmental conditions (e.g. sediment barriers, riprap, geotextile, hay bales, sedimentation ponds);
- No debris will be dumped into the aquatic environment, and any debris introduced accidentally will be removed as quickly as possible;
- Service areas and cut and fill material storage areas will be stripped, and the layer of topsoil will be set aside and replaced during site rehabilitation;
- Clearing, earthworks, and levelling activities will be carried out, whenever possible, immediately before infrastructure installation begins;
- Slopes will be stabilized as quickly as possible to prevent soil erosion;
- No earthworks or excavation activities will be carried out near streams during peak flows or heavy rain;
- Preventive stabilization activities will be carried out if certain activities must be suspended during winter;
- Plant cover will be maintained and kept in a riparian strip of 30 m from the natural high water mark (NHWM);
- If necessary, manual woodcutting will be carried out near aquatic environments (less than 30 m) and wood debris will be disposed of beyond the natural high water mark;
- All of the drainage ditches that receive runoff from the construction site will be stabilized before construction activities begin and will be maintained until the end of construction activities;
- Sediment barriers will be placed at all locations where the soil must be disturbed, and additional barriers will be added where there is a risk of fine sediment transport;
- Bulk materials storage areas (cement, sand, etc.) will be protected with plastic tarps for small areas and sediment barriers for large areas;
- Excess dirt removed during levelling will be disposed in such a way that runoff of fine particles to streams or waterbodies will be avoided;

- At less than 60 m from a lake or stream with permanent flow and less than 30 m from a stream with intermittent flow, plant cover and stumps will be preserved, except where a road is to be constructed (including road pavement, shoulders, and slopes of fill) and where cutting is required for the road.

➢ *LAKE DEWATERING AND WATER AND SEDIMENT MANAGEMENT*

- Lake dewatering water will be treated by the mobile treatment units to remove suspended solids before the water is released into Lake Lagopede.

➢ *QUARRY AND BORROW PIT OPERATION*

- Erosion will be controlled at source and sediment transport to lakes and streams will be limited (see mitigation measures during the construction phase);
- Runoff water will be directed to a vegetation area located at a distance of at least 20 m from a lake or stream measured from the natural high water mark;
- In the case of a sand pit, the slopes of the pit surface will be no greater than 30 degrees from the horizontal to prevent erosion and settling of the land;
- Water released into the environment through quarry or sand pit operation or by crushing or screening processes will not contain contaminant concentrations greater than 15 mg/L of oil, grease, or tar of mineral origin or greater than 25 mg/L of total suspended solids. The pH of water released into the environment through quarry or sand pit operation or through crushing or screening processes must be between 5.5 and 9.5 unless it is shown that the pH of the natural environment is outside of this range, which is the case for the Renard Project site.

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS*

- Atmospheric emissions from non-point sources (e.g. dust) will be mitigated at source;
- Inspection of trucks and machinery used will be carried out ahead of time and on a regular basis to ensure that they are in good condition, clean, and free of any hydrocarbon leaks;
- Machinery will not be cleaned or washed in lakes, streams, or fish habitat, or within 60 m of those areas. Traffic and parking of machinery will not take place on plant cover within at least 30 m of streams, measured from the natural high water mark;
- Work with heavy machinery will be limited, if possible, to firm soil in order to avoid rut formation. Use of machinery with large tires or tracks will be preferred;
- There will be gravel areas at the exits of the construction site to reduce sediment transport on roads.

➢ *WATER MANAGEMENT ON THE CONSTRUCTION SITE*

- During construction activities, the natural drainage of the environment will be respected as much as possible and all appropriate measures will be taken to allow for normal water flow;
- Drainage ditches will be diverted to areas with stable vegetation and located more than 20 m from the natural high water mark;
- A sedimentation pond will be constructed for the drainage ditches at least 20 m from a receiving stream and the pond will be emptied when the water level above the sediment is less than 30 cm over at least 50% of the area of the pond;
- The culverts will be installed according to the Fisheries and Oceans Canada guidelines (DFO, 2010);
- All fording of streams with machinery will be prohibited unless the required infrastructures have been installed and the required authorizations have been obtained from the appropriate ministries. Bridges will be installed for stream or fish habitat crossing and will be removed at the end of construction activities;

- The installation of culverts in streams will preferably be carried out during low flow periods and as quickly as possible;
- If necessary, water accumulations in the work area will be pumped to a vegetation area and at a distance of at least 20 from streams;
- After the installation of a culvert, any other structure required for its construction will be removed from the water and the stream bed will be stabilized at entry and exit. The stream bed must then be rehabilitated according to its natural profile with materials similar to the original materials, and the banks must be stabilized and, if necessary, revegetated;
- Shallow ditches or waterbars will be installed across the decks of secondary roads to limit erosion;
- When necessary, the lower third method will be used for ditch maintenance (MTQ, 1997).

➢ *SOLID WASTE STORAGE AND MANAGEMENT SYSTEM AND TRENCH LANDFILL SITE*

- Solid waste will be managed in accordance with the regulations in force (*Regulation respecting the application of the Environment Quality Act* (Q-2, r.3), *Regulation respecting the landfilling and incineration of residual materials* (Q-2, r.19), *Regulation respecting the environmental and social impact assessment and review procedure applicable to the territory of James Bay and Northern Quebec* (Q-2, r.25), *Regulation respecting the quality of the atmosphere* (c. Q-2, r. 38), and *Regulation respecting used tire storage* (c.Q-2, r.20)).

➢ *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

- Hazardous materials will be managed in accordance with the *Regulation respecting hazardous materials* (c. Q-2, r. 32), the *Transportation of dangerous goods regulations* (c. C-24.2, r. 43), and the *Regulation respecting biomedical waste* (c. Q-2, r. 12). Petroleum products will be managed in accordance with the *Petroleum Products Act* (L.R.Q., c. P-30.01) and the *Petroleum Products Regulation* (R.Q. c. P-30.01, r.1) for management of petroleum material and products;
- Minimize the use of and use alternatives to hazardous materials;
- Containment and runoff treatment structures will be installed in fuel storage and handling areas;
- Areas for the storage of new and used petroleum products will be equipped with a containment pad with a capacity sufficient to contain accidental spills and leaks;
- An emergency response plan in the case of spills (intervention procedures and methods) and spillage prevention and intervention procedures (e.g. confinement structures, treatment of runoff water in the fuel storage and handling areas) will be implemented;
- Any accidental spill will be reported immediately to the person in charge of the mine's emergency response plan;
- Underground areas designed as permanent places for routine maintenance activities, lubrication, and refuelling will be covered with a concrete block to prevent the flow of petroleum products beyond the area or equipped with an automatic, leak-free filling system;
- All mobile production equipment will be equipped with an express filling system with overfill protection;
- An emergency kit for petroleum and hazardous materials recovery that is complete, permanent, and easily accessible at all times will be present on the construction site. Absorbents will be used to retain used oils;
- There will be clearly identified, waterproof containers available on site to contain waste soiled by petroleum products;
- Absorbents soiled with hydrocarbons will be disposed of securely.

6.8.2.3 Residual Impacts

Considering the environmental design and mitigation measures, the impacts of the Renard Project on water quality during the construction phase can be considered to have medium intensity. The impacts will be local, within the Renard Project study area, for a short duration (that is, the duration of the construction phase). The significance of the impacts on water quality during the construction phase is therefore considered moderate.

6.8.3 Impacts during the Operation Phase

6.8.3.1 Description of Impacts

Some of the main environmental issues at stake for the mining industry are the management of surface water and groundwater following the extraction and the management of mine water and runoff, and of processed kimberlite and waste rock. In the case of the Renard Project, a set of environmental design and mitigation measures is planned to minimize the impacts of the project on surface water quality in the study area.

The project components that are likely to affect water quality during the operation phase are the following:

- Pit development (clearing, drilling, blasting, cut, fill, and drainage) - Site preparation and development are likely to affect water quality particularly through sediment transport to the hydrological network if erosion is not controlled at source;
- Management of materials from mining operations (overburden, waste rock, and kimberlite) - Increased sediment transport from runoff in contact with the overburden and waste rock stockpiles and the processed kimberlite confinement area is likely to occur. Sediment transport is also likely to increase due to the expected hydrological changes related to changes in topography and the increased surface sealing of the site;
- Water management - The release of treated mine effluent may modify water quality near the outfall discharge point in Lake Lagopede by introducing fine particles into the aquatic environment. However, at the limit of the plume, concentrations of the various contaminants will be within the range of concentrations measured in Lake Lagopede as part of the Environmental Baseline Study (Roche, 2011), with the exception of total phosphorus, concentrations of which could be slightly higher at the boundary of the plume (0.01 mg P/L) in the northern basin of the lake than in the lake (95^{th} percentile, 0.007 mg P/L). Effluent from the domestic wastewater treatment facility will release nutrients, organic matter, and fecal coliforms at the discharge point in Lake Lagopede;
- Ore extraction, handling, and storage - The use of explosives for mining may generate ammonium nitrate, which is likely to affect water quality if it is not adequately managed;
- Water supply - Due to the large volume of water available and the low withdrawal rate during the operation phase, withdrawal of water from Lake Lagopede is not likely to modify water quality;
- Traffic and the use and maintenance of machinery;
- Solid waste storage and management system and the trench landfill site;
- Storage and management of fuel and hazardous materials - Road maintenance in summer and the spreading of abrasives in winter are likely to cause the transportation of gravel and sand to surface water. Road transportation, the use and maintenance of machinery and power

generating sets, and the storage of fuel, solid waste, and hazardous materials such as used oils increase the risk of water contamination with hydrocarbons or other contaminants.

- Leachate from the solid waste and hazardous materials management sites has the potential to transport several contaminants to the hydrological network if it is not controlled;
- Airstrip operation - The use of aircraft de-icing fluid has the potential to increase the quantity of propylene glycol at the discharge point of water from the airstrip area.

➢ *PIT DEVELOPMENT*

Work necessary for pit development includes clearing, blasting, cut, fill, and drainage activities. These activities will expose the soil to inclement weather and therefore make them more vulnerable to erosion. If the sites are not adequately developed and erosion is not controlled at source, particulate matter is likely to be carried to the hydrological network and therefore increase water turbidity, especially during storms. Soil particles from erosion can also transport various nutrients (nitrogen, phosphorus), organic matter, and metals and influence several surface water quality parameters (humic acids, pH, nutrients, BOD_5). Given the low concentrations of phosphorus and organic matter in the receiving environment, the development of periphyton and algae in small streams could be promoted by input of these compounds proportionally more significant. The decrease in forest cover and the possible increase in TSS concentrations could potentially contribute to an increase in water temperature in small streams or waterbodies.

➢ *MANAGEMENT OF MATERIALS FROM MINING OPERATIONS (OVERBURDEN, WASTE ROCK, AND KIMBERLITE)*

During the operation phase, the Renard Project will generate a large quantity of materials that will be stored in areas developed specifically for ore, waste rock, overburden, and processed kimberlite (Table 6.8.8). Runoff and exfiltration water in contact with these materials has the potential to affect surface water quality.

Exposing ore to weather conditions during extraction and processing treatment activities could enhance the oxidation of rocks exposed to inclement weather and the mobility of metals and salts from the rocks to runoff water. When exposed to air, certain rocks, such as sulfide minerals, undergo a relatively slow chemical oxidation that tends to acidify the environment. This acidification leads to the proliferation of bacteria that accelerate the oxidation reactions, causing water acidification that may dissolve heavy metals contained in the sulphide minerals.

Table 6.8.8 Estimated Infiltration Rates in Overburden and Waste Rock Stockpiles, and Processed Kimberlite Confinement Area

Infrastructure	Approximate Quantity of Material (over 20 years)	Area	Estimated Infiltration Rate
	(mt)	(m²)	(L/m²/jour)
Overburden Stockpile	3.6	161,693	-
Processed Kimberlite Confinement Area	44.3	784,556	0.9
Waste Rock Stockpile	28.8	393,805	1.2

Given the low alkalinity of the water in the study area, this issue is particularly important to consider in the context of the Renard Project because, since the water has limited buffering capacity, it could easily be altered by acid input (Wetzel, 2001).

For this reason, tests assessing the acid mine drainage potential[20] and leaching tests[21] recommended by the MDDEP were conducted on 214 samples of the various materials that will be excavated (overburden, waste rock, processed kimberlite). In addition, kinetic tests reproducing conditions observed on the site were conducted on 12 samples over a period of 20 weeks to ensure that no contaminants are likely to be leached from these materials at concentrations that could be toxic for aquatic life. Results from these tests are presented in detail in Section 3.6.5. The conclusions of these tests are that the materials tested do not present a risk of acid mine drainage, and they are not likely to leach metals at concentrations that could represent a risk for aquatic life or consumption of water or of aquatic organisms by humans.

The materials that will be excavated as part of the Renard Project show the following characteristics:

- **Overburden** is made up of soil, glacial surficial deposits, sand, and sediment covering the bedrock. These materials will be removed from the sites before being stripped and confined in the areas designated for this purpose. Tests conducted as part of the Renard Project show that the soil is not likely to generate acid (see Section 6.5 of the present impact assessment). In addition, geochemical background levels[22] of metals in the soil show concentrations that are generally below criteria A of the *Soil Protection and Contaminated Sites Rehabilitation Policy*. According to the Policy, when all concentrations are below criteria A, the soil does not constitute a new source of contamination for the environment, and it can be used without restriction. Therefore, the most significant issue related to water from the overburden stockpile is

[20] The potential for acid generation was determined in accordance with the MA. 110-PGA 1.0 approach. According to Guideline 019, mine tailings are considered acidifying when they contain sulfides in quantities greater than 0.3% and their acid generating potential is confirmed by kinetic prediction tests, or in the absence of such tests, by statistical prediction showing that the net potential for acid neutralization is below 20 kg $CaCO_3$/tonne of tailings or that the ratio of acid neutralization potential over acid generation potential is less than three.

[21] Leaching tests according to TCLP (USEPA-1311), SPLP (USEPA-1312), and CTEU-9 (Environment Canada) procedures were conducted on all samples in accordance with the MA.100-Lix.com.1.0 approach. According to Guideline 019, mine tailings are considered leachable if, when they are tested in accordance with the leachate method of analysis MA.100-Lix.com.1.0 (TCLP), they produce a leachate containing a contaminant with a concentration above the applicable criteria for the protection of groundwater without producing a leachate containing a contaminant with concentrations above the criteria specified in Table 1 of Guideline 019.

[22] Background level: Natural concentrations currently measured in soil or water.

controlling the transportation of fine particles to the hydrological network. For this reason, a water management plan will be implemented. It is described in detail in Section 3.10;

- The mining facilities include a **processed kimberlite confinement area**. These tailings are from ore processing. They are composed of water (about 16%) and finely milled ore no longer containing diamond-bearing materials for mining. The majority of the particles from processing are larger (84% of the tailings, from 0.125 mm to 6 mm according to Golder, 2011c) and 16% are finer particles (<0.125 mm in diameter, according to Golder, 2011a). Kinetic leaching tests conducted on processed kimberlite and waste rock show that they are not acid generators and that the metal leaching potential in acidic conditions is below the Guideline 019 criteria (Golder, 2011c). Controlling sediment transport to the hydrological network is therefore the main concern for water quality. However, mine water may also contain other contaminants, such as hydrocarbons or ammonia. For this reason, the Renard Project has implemented prevention measures to limit the risk of accidental hydrocarbon leaks or spills. Mitigation measures are also planned for the choice of explosives and their management to prevent input of ammonia in concentrations that could affect aquatic life;
- **Waste rock** is rock that does not contain diamonds in sufficient quantity for economically viable mining activities. For water quality, apart from low diamond extraction potential and the large size of the particles (varying from dust to boulders weighing several tonnes), waste rock essentially presents the same characteristics as kimberlite before processing. Sediment transport is therefore the greatest concern for water quality. Considering the larger size of the materials compared to processed kimberlite, fine sediment concentrations found in the water exiting the stockpile will be lower than those of water exiting the processed kimberlite confinement area.

Precipitation and runoff will flow through the confinement area and the stockpiles and exit after remaining there for a varying period of time (Table 6.8.8). The flow of water through the stockpiles will result in decantation of solids to some extent. All of the water in contact with the mine will be collected by a network of ditches and directed to a sedimentation pond developed in pit R-65, then to the treatment plant, before being discharged into Lake Lagopede after quality control.

To keep the mine dry and to carry out mining activities, **mine water** will be pumped to the surface. This water may contain high concentrations of total suspended solids and contaminants released during blasting activities.

Based on the various leaching tests and modellings that have been performed, the majority of the Policy's groundwater protection criteria will be met, both right at the exit of the confinement area and stockpiles and in groundwater seepage areas in the respective receiving environments (Lake Lagopede, lakes F3297 and F3298, peripheral ditches, pits R-2/R-3 and R-65). Only the criteria for phosphorus, sulphides, copper, and zinc will be exceeded because background levels for these elements are naturally higher than the applicable criteria.

Negative impacts on water quality should be even less extensive because the various modellings conducted by Golder are conservative since they do not take into account the phenomena of adsorption, precipitation and degradation. In addition, the scenarios used during modelling can be considered conservative because they use groundwater flow conditions after pit filling. It is therefore

reasonable to believe that the effects of pumping during mining will decrease the total contaminant load because mine water will be treated prior to being discharged into the receiving environment.

The explosives used for rock extraction are in the form of a liquid emulsion of ammonium nitrate. This type of explosive is composed of about 20% nitrogen as ammonium nitrate. Among the various types of nitrogen, the release of nitrate and ammonia represents the greatest concern for water quality due to their effects on health and aquatic life (Forsyth *et al.*, 1995). Concentrations of the various forms of nitrogen generally depend on pH and water temperature. In the Renard Project study area, natural concentrations of the various forms of nitrogen are low (ammonia <0.02 mg/L, nitrites <0.01mg/L, nitrites and nitrates <0.02 mg/L). However, this type of explosive is partly composed of oil and its solubility in water is therefore very low (Forsyth *et al.*, 1995). The thin layer of oil that surrounds the salts that make up the explosives decreases the surface area in contact with water.

However, during loading or blasting, small quantities of ammonium nitrate may be released. The quantity released varies based on the type of explosive used, loading method, and the efficiency of the explosion (Forsyth *et al.*, 1995). Certain environmental measures for explosives management will be implemented to prevent and limit these impacts. Measures will also be taken to optimize blast design and the techniques used for explosive hole loading and cleaning to reduce the impacts of the use of explosives on surface water quality. Measures will also be taken to meet the effluent discharge objectives for the final effluent set out by the governmental authorities.

- *WATER MANAGEMENT*

Mine Water

The discharge of treated mine effluent may modify water quality near the discharge point in Lake Lagopede. Water quality criteria used for the design of the mine water treatment plant are presented in Section 3.10.5.2. With a dilution of 1:5, the design criteria meet the criteria set out in Guideline 019 and the *Metal Mining Effluent Regulations*. The criteria for final effluent will be adjusted based on the effluent discharge objectives set out by the MDDEP regional office during the authorization process under Section 32 of the *Environmental Quality Act* and under Guideline 019. When the final effluent meets the MDDEP guidelines, the treated mine water will be released into Lake Lagopede. The mine wastewater treatment facility will include a treatment system planned to limit total phosphorus discharge to 0.07 g/L. This system is significantly more efficient than the one-step chemical dephosphatation systems used by municipalities, which on average generate treated water with 1 mg/L of total phosphorus (Environment Canada, 2001b). Currently, there is very little commercial technology that can achieve further reduction of phosphorus concentrations.

The treated mine effluent outfall has been positioned in Lake Lagopede in a way to enhance rapid effluent dispersion and dilution (Figure 3.10.4). Effluent will be discharged 13 m below the surface. Modelling results of the treated mine effluent plume (Appendix 3.10.1) indicate that under severe low

flow conditions, initial concentrations of treated effluent will reach a dilution of 1:10 at a distance of 750 m from the discharge point (Figure 3.10.7) and 300 m during fall turnover (see Section 3.10.5.2 and Figure 3.10.8). The specific bathymetry of the lake divides it into two distinct basins: the northern basin, which receives the mine effluent, and the southern basin, located at the downstream portion of the lake (Figure 6.8.4). The sill that separates the northern and southern basins is such that the southern basin of the lake is not greatly affected by the treated mine discharge (Figure 3.10.7). In the northern basin, at the edge of the plume, concentrations of the various contaminants are within the range of the concentrations measured in the environment during the Environmental Baseline Study (Roche, 2011), with the exception of total phosphorus, concentrations of which could be slightly higher (0.01 mg P/L) at the limit of the plume than in the lake (95th percentile=0.007 mg P/L). The mine effluent's phosphorus input could have the effect of a temporary (around the month of August), local increase of total phosphorus concentrations in the northern basin corresponding to levels found in oligo-mesotrophic lakes (typically 0.007-0.013 mg/L of total phosphorus, MDDEP, 2007). Depending on the proportion of total phosphorus that is bioavailable in the form of orthophosphates, this input could possibly contribute to a limited and temporary increase in the productivity in this area of Lake Lagopede as well as its fisheries potential. Given the hydraulic residence time in Lake Lagopede of about 50 days and the low temperatures that generally occur in September, the effects will be short in duration and possibly completely limited to the month of August. The mine and domestic effluent plumes do not overlap (Environnement Illimité, 2011).

Ore processing will require little water use. The water used will come from the ore itself, and any additional water required will be withdrawn from sedimentation pond R-65. Therefore, no additional withdrawal from the hydrological network will be carried out. Water will be recovered within the plant and reused for subsequent processing. If water must be discharged outside of the plant, it will be redirected to the sedimentation pond in pit R-65 before being transferred to the mine water treatment plant.

Once the mine site is in operation, the presence of hard, rocky surfaces with low permeability instead of vegetation and overburden may increase the imperviousness of the site. The increased velocity of runoff may potentially contribute to the transportation of particulate matter present in excavated areas if erosion and sediment transport are not controlled at source. For this reason, mine water will be collected by the network of peripheral ditches and sent to sedimentation pond R-65, with the exception of runoff water from the accommodation complex. This water will be diverted to sedimentation pond S-18, developed during the construction phase, to remove suspended solids prior to being released into Lake Lagopede.

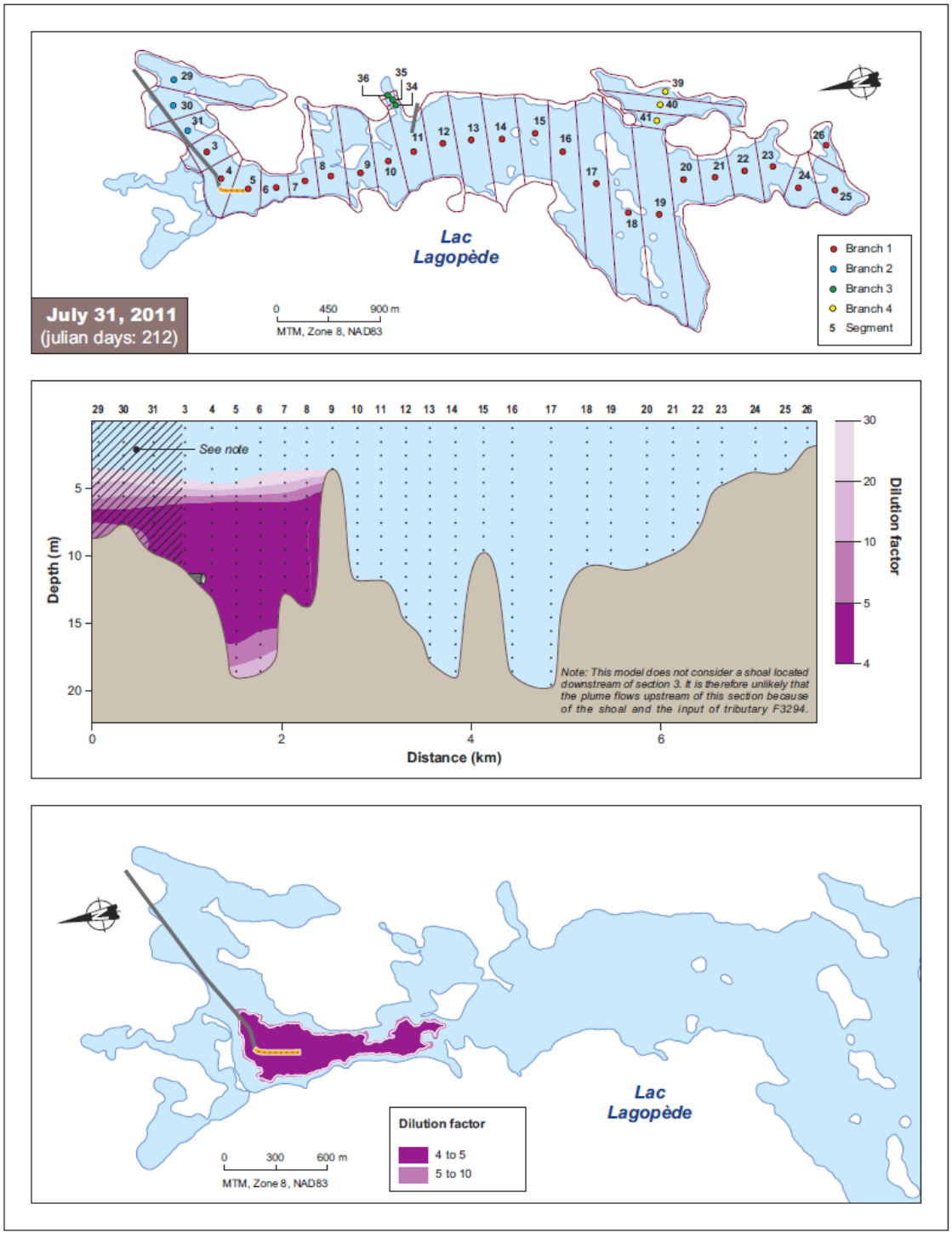


Figure 6.8.4 Treated Mine Effluent Plume Modelled Under Severe Low Flow Conditions (July 31, 2011)

Domestic Wastewater

The domestic wastewater treatment facility planned for the mine camp is likely to release phosphorus, nitrogen, fecal coliforms, organic matter, etc. These contaminants, if not controlled, could affect the water quality of Lake Lagopede.

During the operation phase, it is expected that two groups of 230 workers each will be present in rotation at the camp, that is, half as many workers as during the construction phase. A system of 3 facultative aerated lagoons will be used during this period to treat effluent so that it complies with applicable quality criteria. The environmental design criteria used for effluent are presented in Table 6.8.6 and in Section 3.10.5.1. Meeting the effluent discharge objectives established by the MDDEP and the surface water quality criteria for the protection of aquatic life (at the limit of the mixing zone) will limit impacts on the water quality of Lake Lagopede. Changes to the lake water quality should be confined to within the discharge mixing zone.

During the operation phase, domestic effluent flow rates will be less important than those expected during the construction phase. Initial dilution limits and the 1:100 dilution limit will therefore be close to the discharge point. The 1:100 dilution limit will be obtained at about 38 m downstream of the discharge point at average flow rates, while it could reach 83 m during peak hourly flows (Figure 3.10.5).

The plume will not rise to the surface within the 1:100 dilution zone. It will remain in the water column at a depth of about 4 m to 6 m.

Domestic wastewater generated in the area of the airstrip will be treated locally using a septic tank system and an absorption field in accordance with regulations.

- *ORE EXTRACTION, HANDLING, AND STORAGE*

Kimberlite (or ore) is a rock containing diamond-bearing material in sufficient quantities for commercial mining. For water quality, apart from the potential for diamond extraction and the size of the material (highly variable size from dust to boulders weighing several tons, it essentially has the same characteristics as processed kimberlite. Tests evaluating the acid mine drainage potential and leaching tests conducted on 46 samples and a series of kinetic leaching tests conducted on 4 samples over a period of 20 weeks show that they are not acid generators and that no contaminants from these materials are likely to be leached and affect the different water uses. The results of these tests are presented in detail in Section 3.6.5.

Controlling sediment transport to the hydrological network is therefore the main concern for water quality. Precipitation and runoff will flow through the stockpile and exit after remaining there for a varying period of time (Table 6.8.7). The flow of water through the stockpile will result in the collection of solids to some extent. Ore mining, handling, and storage activities are also likely to emit dust. All of the water in contact with ore and the majority of dust emitted will be confined in a network of ditches directed to a

sedimentation pond developed in pit R-65, then to the treatment plant, before being released into Lake Lagopede after quality control.

- *WATER SUPPLY*

During the operation phase, water withdrawal from Lake Lagopede will be necessary for the following activities: fire protection, water supply source for dust control, cleaning, and for the needs of the accommodation complex. Given the limited flow withdrawn from Lake Lagopede during the operation phase (average daily flow of 92 m³/day, maximum daily flow of 184 m^3/day, maximum peak flow of 256 L/min), the large volume of Lake Lagopede (21 Mm³), and its hydraulic residence time (53 days), water withdrawal will not lead to any significant modifications of water levels or water quality in the lake.

- *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

Summer road maintenance will consist of the grading of road gravel to ensure an adequate profile grade. Grading and the accidental discharge of gravel and sand into the hydrological network through ditches and culverts could occasionally cause a limited increase in water turbidity if sediment transport prevention structures are not regularly maintained. The use of abrasives on mining roads during winter for road safety reasons, may result, in the spring, in sand and gravel transport to waterways. During spring rains and periods of melting snow, abrasives spread during winter will be transported to the ditches and eventually to streams and waterbodies downstream of the mine roads.

Considering the long duration of the snow cover period (seven months), the large quantities of snow removal in certain areas (roads, ore processing plant) represent an important environmental and technical challenge to consider. For this reason, three sites will be specifically designed as snow storage area to limit impacts on water quality and the hydrological regime. These snow storage areas will be located in the same watersheds as those from which the snow will be removed.

- *SOLID WASTE STORAGE AND MANAGEMENT SYSTEM AND TRENCH LANDFILL SITE*

The Renard Project's solid waste management plan includes the development of a trench landfill site. Infiltration of precipitation and percolation of rain water through the waste buried in the trench landfill site have the potential to transport various contaminants, such as dissolved solids and metals, to the groundwater table (Table 6.8.6).

The trench landfill site will meet the design criteria set out in Division 3 of the *Regulation respecting the landfilling and incineration of residual materials* (c. Q-2, r. 19). Leachate produced by this site will be treated by infiltration on site and the following natural processes will contribute to its treatment: physical (filtration, capillary retention), biochemical (biodegradation), and chemical (precipitation, ion exchange, and absorption) processes. The proces of dilution will also contribute to decreasing concentrations of contaminants present in the leachate. In addition, several measures will be taken to decrease the quantity of solid waste produced at source, such as recycling of metal, wood, paper, glass, plastic, and

used tire. A detailed description of waste management is provided in Section 3.11 of the present impact assessment.

➢ *MANAGEMENT OF FUEL AND HAZARDOUS WASTE MATERIALS*

Hazardous waste materials will be stored temporarily in locations designed for this purpose before being transported south by specialized companies and disposed of in an authorized site (see section on the construction phase for a description of treatment). There will therefore be no impacts on water quality as a result of these activities. In addition, in order to limit the risk of leakage or accidental spillage of hazardous waste materials, prevention and mitigation measures will be implemented.

Traffic and the presence, use, and maintenance of machinery and power generating sets will increase the possibility of accidental spillage or leakage of petroleum products on site. Possible sources of water contamination related to the use of hydrocarbons include the following:

- Accidental spillage and leakage of hydrocarbons from machinery, generators, and/or fuel storage areas;
- Contaminated water from storage containers for material contaminated with hydrocarbons and other waste or hazardous materials.

During the operation phase, generators with a capacity of 1,800 kW will be necessary to provide electricity. The airstrip site will also have its own 80-kW generator. The use and maintenance of these generators and heavy machinery are likely to release hydrocarbons into the hydrological network if they are not confined and recovered quickly following an accidental spill or leak.

The MDDEP recommends hydrocarbon concentrations of less than 0.01 mg/L in surface water in order to protect aquatic life (from chronic effects). Following an accidental hydrocarbon spill in the aquatic environment, a large proportion of the hydrocarbons evaporate into the atmosphere. The soluble fraction of the hydrocarbons, especially aromatic compounds, can solubilize and contaminate surface water and, eventually, sediment. For this reason, several preventive and remedial actions are planned to limit the risk of accidental spills or leaks and quickly identify, confine, and recover leaks and spills and dispose of them at an authorized location.

Management of equipment including preventive maintenance and a program encouraging employees to detect and report leaks and operating problems will be implemented to reduce the extent and total volume of any accidental spill or leak. In addition, a clear and efficient management plan will be implemented. The measures to be put in place are described in more detail in Section 3.12 of this impact assessment. These measures include collecting runoff from the area of the mine truck and light vehicle repair workshop in an oil-water separator and collecting recovered oils using a vacuum truck (SNC-Lavalin, 2010), then storing the oils at the mine site until their eventual transportation south where they will be taken to a designated site for contaminant management.

➢ *OPERATION OF THE AIRSTRIP*

When outside temperatures are close to the freezing point, an aircraft wing de-icer will be used. Given that the airstrip will be located far from any de-icing fluid providers, a 500-gallon reservoir (1,900 L) will be installed in a closed shed. Propylene glycol will be used (see the section on the construction phase for a more detailed description). Unlike ethylene glycol, this compound is not toxic (Santé Canada, 2004b). However, it can affect aquatic organisms when it is present in too great a concentration (>500 mg/L, CCME, 2007). For this reason, management measures for aircraft de-icing will be put in place.

Considering that the planes will only be on the ground for short periods and that the frequency of flights will be low during the operation phase, the need for de-icer will be much less than that of a commercial airport. To limit the dispersion of propylene glycol, all de-icing activities will take place in the same location.

Residual propylene glycol will quickly be diluted in the spring by snowmelt and spring rainfall and carried into streams during freshet. The volume of propylene glycol used is estimated at about 1,000 L per year, and no toxicity problems or increase of BOD_5 associated with propylene glycol are expected in the aquatic environment.

In order to ensure that there will be no contamination of surrounding streams and lakes and no impacts on dissolved oxygen concentrations associated with the use of propylene glycol, analysis of this compound, dissolved oxygen levels, and BOD_5 in surface water downstream of the airstrip will be included in the surface water quality monitoring program.

6.8.3.2 Mitigation Measures

In order to prevent and limit the extent of the impacts, several mitigation measures will be put in place and will minimize the repercussions of mining activities on the hydrological network.

➢ *PIT DEVELOPMENT*

For pit preparation and development during the operation phase, the same mitigation measures mentioned for the construction phase will be implemented.

The following specific measures will also be implemented for pit development during the operation phase:

- A riparian strip of at least 30 m along streams and waterbodies will be maintained;
- A strip of land on the site periphery will be kept for the storage of stripped organic matter;
- Segregation of topsoil (organic fraction) and conservation of this material for rehabilitation activities;
- Removal and storage of organic matter at more than 20 m from lakes, streams or fish habitat for future reuse;
- Control measures will be implemented if necessary.

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

For impacts related to traffic and the use and maintenance of machinery, the same mitigation measures mentioned for the construction phase will apply.

During the operation phase, road infrastructures such as culverts will be regularly inspected to ensure maintenance and effectiveness.

➢ *ORE EXTRACTION, HANDLING, AND STORAGE*

The following activities will be carried out in accordance with the *Explosives Act* (R.S.C., 1985, ch. E-17), the *Regulation under the Act respecting explosives* (R.R.Q., c. E-22, r. 1), and Guideline 019:

- Regular optimization of blast design and explosive volume to minimize the quantity of explosive residue;
- Best practices will be used to handle explosives and fill explosive holes (Forsyth, 1995; Wright and Hopky, 1998);
- Any accidental explosives spill will be thoroughly cleaned.

➢ *ORE PROCESSING*

- The use of mine water generated on the site will be maximized, the discharge of liquids will be reduced to a minimum (e.g. use of runoff and recirculating treated water for the needs of the facilities) and the effluent flow rate will be reduced.

➢ *MANAGEMENT OF MATERIAL FROM MINING OPERATIONS (OVERBURDEN, WASTE ROCK, AND PROCESSED KIMBERLITE)*

- Runoff and exfiltration water from the ore, waste rock, and overburden stockpiles and the processed kimberlite confinement areas will be managed according to the dispositions set out in Guideline 019;
- Materials storage areas will be designed so as to reduce the risk of erosion as much as possible;
- A collection network of percolation water, including drainage ditches around the waste rock stockpiles, will be constructed to direct water collected to the treatment facilities;
- The processed kimberlite confinement area will be located at a distance of at least 60 m from the natural high water mark of all streams and waterbodies;
- Only the designated materials will be disposed of in the waste rock and overburden stockpiles and the processed kimberlite confinement area;
- When required, measures will be taken to protect soil from wind and water erosion (see mitigation measures during the construction phase);
- The mine effluent will meet the effluent discharge objectives defined by the MDDEP, Guideline 019, and the *Metal Mining Effluent Regulations*, which aim to protect fish habitat. Monitoring will be conducted and, if necessary, treatment will be applied before water is released into the environment;
- At least once per season, surveillance visits for the physical stability of confinement structures and adjacent structures will be conducted. A log noting these visits will be updated and accessible at all times;
- In addition to water quality monitoring downstream of the activities, a visual water quality surveillance program for lake water will be carried out during activities in order to allow for quick action in the case of unexpected sediment input.

Overburden

- Uncontaminated overburden, removed during mine site preparation, will be kept and stored so as to preserve the physical and biological characteristics of the soil and protected from water and wind erosion for its future use during progressive revegetation.

➢ *WATER SUPPLY*

- Water withdrawals from the hydrological network and liquid discharge will be minimized (e.g. using runoff, recirculating treated water for facilities needs, collecting rain water) and the use of mine water generated on site will be maximized.

➢ *WATER MANAGEMENT*

- Water in contact with mine material, including water from the ore processing plant, drainage water, and water from the waste rock and overburden stockpiles and processed kimberlite confinement area will be collected and controlled;
- Runoff from areas that represent potential sources of contaminants will be reduced to a minimum (e.g. by limiting impervious surfaces);
- Peak flows will be reduced (e.g. channelling water to retention basins during peak flows) to avoid flooding at the treatment facility;
- Wastewater treatment and septic facilities will be operated in accordance with the regulations in force.

➢ *SOLID WASTE STORAGE AND MANAGEMENT SYSTEM AND THE TRENCH LANDFILL SITE*

For impacts related to the storage and management of solid waste, the same mitigation measures mentioned for the construction phase will also apply during the operation phase.

➢ *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

For impacts related to the storage and management of fuel and hazardous materials, the mitigation measures mentioned for the construction phase will also apply during the operation phase.

During the operation phase, hydrocarbon separators in the mechanical workshops and grease separators in the kitchen will be subject to a systematic and regular maintenance program.

➢ *OPERATION OF THE AIRSTRIP*

In order to limit propylene glycol dispersion, all de-icing activities will take place in a single location, and small quantities estimated at a total of about 1,000 L per year will be used. To ensure that there will be no contamination of the surrounding streams and lakes and no impacts on concentrations of dissolved oxygen associated with the use of propylene glycol, analyses of this compound, oxygen levels, and BOD_5 in surface water upstream of the airstrip will be included in the surface water quality monitoring program.

6.8.3.3 Residual Impacts

With the implementation of all of the mitigation measures, the impacts of the project on water quality can be considered to be of moderate intensity. The impacts will be felt locally, in the Renard Project study area for a moderate duration (that is, the duration of the operation phase). The significance of the impacts on water quality is therefore considered moderate.

6.8.4 Impacts during the Closure Phase

6.8.4.1 Description of Impacts

The following project components are likely to have an effect on water quality during the closure phase:

- Water management—The rehabilitation of the site's drainage pattern and the filling of pits R-2/R-3 and R-65 are the activities most likely to have an impact on the mine site's water quality. Initially, the mine site rehabilitation activities could temporarily affect water quality through the input of soil or sediment particles during activities related to the stabilization and restoration of the site topography and the rehabilitation of the drainage pattern. At the end of the revegetation activities and the discharge of treated domestic wastewater and treated mine effluent, a gradual improvement in surface water quality should be observed;
- Site rehabilitation and revegetation - Activities related to the revegetation and the stabilization and rehabilitation of the site's topography are likely to temporarily affect water quality through the introduction of soil particles or sediment into the hydrological network. However, the closure of the trench landfill site, the transportation of hazardous materials away from the site, and site revegetation will contribute to a global improvement of surface water quality;
- Traffic and the use and maintenance of machinery - The use and maintenance of machinery for closure and rehabilitation activities nearby the hydrological network have the potential to contaminate water through accidental spillage or leakage of hydrocarbons.

➢ *WATER MANAGEMENT*

Water withdrawal, domestic and mine wastewater treatment facilities, the airstrip, and the trench landfill site will be kept operational during the closure phase. Due to the lower number of workers than during the operation phase (about 50 workers are expected during the closure phase) and the termination of mining activities, flows at the treatment facilities will be lower than during the operation phase. However, to maintain water quality conditions, the same environmental design and mitigation measures mentioned for the operation phase will be maintained.

Water management facilities, that is, ditches, retention basins, and domestic and mine wastewater treatment facilities will remain in operation until the closure activities are completed and monitoring shows that the quality of water in contact with the mine site is in accordance with the effluent discharge objectives (Guideline 019; MDDEP, 2005) and no longer requires treatment (Golder, 2011e). At that time, the drainage pattern of streams and lakes located around the mine site may be re-established as closely as possible to return the site to conditions similar to those observed before the beginning of operations. For example, pits R-2/R-3 and R-65 will no longer be dewatered and, over time, will become "lakes," and once R-2 and R-3 have been filled, a hydraulic connection with the natural environment will

be constructed. According to data on precipitation and inflow from groundwater, the time required for pit filling and complete rehabilitation of the hydrological regime is estimated at 7 years.

Activities related to the rehabilitation of the drainage pattern will be carried out near water and are likely to introduce soil particles and sediment or other contaminants into the aquatic environment. Erosion control at source and appropriate management of sediment transport related to the transportation of materials necessary for restoration will therefore be implemented in order to minimize the impacts on water quality.

Following rehabilitation activities, mine closure will bring about the end of treated domestic wastewater and treated mine effluent discharge. The rehabilitation will therefore have a positive effect on water quality by restoring the water properties to conditions that prevailed before the construction of the Renard mine.

- *SITE REHABILITATION AND REVEGETATION*

Activities related to dismantling and reclamation, such as the installation of security embankments around pits or the transportation of organic matter for revegetation of the stockpile areas (overburden and waste rock stockpiles, temporary ore stockpile, etc.) are likely to temporarily cause sediment transport to the hydrological network. The possible increase in TSS concentrations and organic matter may contribute to a temporary increase in water turbidity and nutrient (nitrogen, phosphorus) and metal concentrations during these activities.

Ultimately, the rehabilitation activities will contribute to an improvement in water quality due to the elimination of several sources of contaminants such as hydrocarbons, the closure of the trench landfill site, and the covering of the trench landfill site with a 0.5 m layer of overburden and a 0.3 m to 0.5 m layer of topsoil before revegetation. The revegetation activities will be carried out using mixes that foster the rapid growth of native vegetation. The site should be covered with vegetation the same year as the rehabilitation or the following year (see Section 3.18). By encouraging infiltration of runoff into the soil, the site revegetation will decrease the quantity of impervious areas present and, as a result, the vulnerability of the soil to erosion. It should be noted that forests and wetlands contribute to flood mitigation by producing 30% to 50% less runoff than areas covered with grass, which produce less runoff than impervious areas (Capiella *et al.*, 2005; CIC, 2004).

- *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY*

Traffic and the maintenance of machinery during rehabilitation activities could affect surface water quality through accidental spills and leaks of hydrocarbons into the hydrological network if they are not confined and recovered quickly. However, the probability that such leaks will occur is lower than during the operation phase given that the fleet of vehicles will be much smaller. Mitigation measures planned for operation will be implemented during closure.

6.8.4.2 Mitigation Measures

Mitigation measures planned for the closure phase will be put in place to reduce the risk of increased sediment transport and contamination of the hydrological network with hydrocarbons. The mitigation measures implemented for domestic and mine water management, solid waste and hazardous materials storage and management, and operation of the airstrip will be maintained during the closure phase until these sites are dismantled and rehabilitated.

- *Water Management*
  - As much as possible, surface drainage will be re-established to conditions similar to those observed before the beginning of mine operations.

- *Site Rehabilitation and Revegetation*
  - Structures will be constructed for controlling at source soil erosion and sediment transport to streams and waterbodies, using strategies adapted to the site and environmental conditions (e.g. sediment barriers, riprap, geotextile, sedimentation ponds);
  - Grading and levelling activities will be carried out, whenever possible, immediately before revegetation activities are carried out;
  - Cleared areas within the riparian strip will quickly be stabilized to avoid any risks of sediment input to the aquatic environment;
  - No debris will be dumped into the aquatic environment, and any debris accidentally introduced into the aquatic environment will be removed as quickly as possible;
  - No earthworks or excavation activities will be carried out near streams during periods of peak flow or heavy rain;
  - Preventive stabilization activities will be carried out if certain activities must be suspended during winter;
  - The surface of the sites to be revegetated must be free of all debris, waste, unusable materials, machine parts, or other elements that were not located on the site before work began;
  - Rehabilitation and revegetation will be carried out as quickly as possible;
  - Slopes will be softened and stabilized;
  - Previously stored organic matter will be spread over the site.

- *Traffic and the Use and Maintenance of Machinery*
  - Fording of streams with machinery will be prohibited unless the required infrastructures have been installed and the required authorizations have been obtained from the appropriate ministries. Bridges will be installed for stream or fish habitat crossing and will be removed at the end of construction activities;
  - Air emissions from non-point sources (e.g. dust) will be mitigated at source;
  - Inspection of trucks and machinery used will be carried out ahead of time and on a regular basis to ensure that they are in good condition, clean, and free of any hydrocarbon leaks;
  - Machinery will not be washed or cleaned in lakes, streams, or fish habitat, or within 60 m of those areas, and traffic and parking of machinery will not occur on plant cover within at least 30 m of streams, measured from the natural high water mark;
  - Work with heavy machinery will be limited, if possible, to firm soil in order to avoid rut formation. Use of machinery with large tires or tracks will be preferred;
  - There will be gravel areas at the exits of the construction site to reduce sediment transport on roads.

6.8.4.3 Residual Impacts

With the implementation of all of the mitigation measures, the impacts of the project on water quality during the closure phase can be considered positive with low intensity. The impacts will be felt locally, within the area of the Renard Project study area, and for a long duration. The impacts on water quality are therefore considered moderate.

6.9 Sediments

6.9.1 Current Conditions

The sediment quality characterization in the Renard Project study area was conducted as part of the Renard Project Environmental Baseline Study (Roche, 2011). Sediment sampling was carried out in September and October 2010 at 25 stations. Sediment sampling stations were positioned at the same location as the water quality stations in order to obtain a representative coverage of the streams and lakes in the study area, and to characterize the control stations located upstream of the proposed infrastructures. Table 6.9.1 shows the sediment quality results obtained for the mine site and the airstrip area.

Data obtained in 2010 were compared to the results of sampling campaigns previously conducted by Roche in 2003 and 2004 at 21 stations located in a radius of about 15 km of Camp Lagopede. The results were also compared to data provided in the Matoush Project impact study for sediment sampled in 2007, 2008, and 2009 (Strateco Resources, 2009).

The results were also compared to the Canadian sediment quality guidelines for the protection of aquatic life (CCME, 2002). These guidelines provide scientific reference points, or reference values, for the risk assessment of potential adverse biological effects in aquatic systems (CCME, 2002). Two values were established by the CCME for the protection of aquatic life:

- The concentrations resulting in a probable effects level (PEL) correspond to concentrations above which adverse biological effects are frequently observed;
- The interim sediment quality guidelines (ISQG) correspond to concentrations above which adverse biological effects are rarely observed. These guidelines are referred to as interim because the minimum data requirements were met for interim guidelines, but they cannot be associated to sediment type and/or specific characteristics as it is required for the formulation of definitive guidelines (CCME, 1995).

The ISQG and PEL of the Canadian guidelines are meant to be used jointly with a set of complementary data that may include, for example, natural concentrations measured at each location. According to Environment Canada and the MDDEP (2007), "*A concentration is said to be 'natural' when the sediment has not undergone any anthropogenic chemical alteration or modification. In practical terms, natural concentrations are those measured in pre-industrial sediments*."

Table 6.9.1 Sediment Quality Results from Samples Taken in September and October 2010

Area			Sediment Quality CCME[1]		Renard Mine																
Type of Waterbody					Streams								Waterbodies								
Sampling Station	Unit	Method Detection Limit	Interim Freshwater Sediment Quality Guidelines (ISQG)	Concentrations producing a probable effects level (PEL)	*AQR1*	*AQR2*	*AQR4*[3]	*AQR5*	*AQR7*	*AQR9*[2]	*AQR12*	*AQR15*	*AQR3*	*AQR6*[3]	*AQR8*[2]	*AQR13*	*AQR14*	*AQR10*	*AQR11*[3]	*AQR16*	*AQR19*	*AQR20*[3]	*AQR21*
Station Characteristics																							
Sampling Date					2010-09-04	2010-09-04	2010-09-05 2010-10-07	2010-09-05	2010-09-05	2010-09-06	2010-09-05	2010-09-05	2010-09-05	2010-09-05 2010-10-07	2010-09-06	2010-09-05	2010-09-05	2010-09-05	2010-09-05 2010-10-07	2010-09-04	2010-09-04	2010-09-05 2010-10-07	2010-09-05
UTM (NAD 83, Zone 18) East					688 244	688 532	689 202	689 496	689 834	688 884	688 958	688 994	689 278	690 074	689 190	688 981	688 608	688 756	689 864	687 984	688 179	688 637	688 581
UTM (NAD 83, Zone 18) North					5 853 543	5 853 955	5 854 543	5 854 578	5 855 352	5 855 038	5 855 615	5 856 407	5 854 659	5 855 138	5 855 220	5 855 865	5 856 005	5 855 374	5 855 497	5 854 221	5 853 438	5 855 701	5 855 516
Lake Name					-	-	-	-	-	-	-	-	F2607	F3301	F3302	F3303	F3296	Lake Lagopede (32302)					
Basic Physicochemical Parameters																							
pH (laboratory)	pH	–	–	–	–	4.53	5	5.13	3.9	4.85	5.3	4.43	4.86	5.01	5.64	4.82	5	4.7	5.2	5.38	4.8	5.63	–
Nutrients																							
Sulphur (S)	%	0.01	–	–	0.14	0.19	0.33	0.14	0.32	0.11	0.17	0.08	0.16	0.46	0.115	0.09	0.09	0.09	0.19	0.07	0.07	0.14	0.09
Sulphides (S_2)	mg/kg	0.0003-2	–	–	–	–	0.0059	–	0.0096	–	–	–	–	<0.0003	–	–	–	–	–	–	–	–	–
Total Phosphorus	mg/kg	20	–	–	210	550	690	290	920	205	180	210	170	690	565	400	330	390	780	170	360	380	340
Granulometry and Sedimentology																							
Gravel (>2 mm)	%	0.1	–	–	23	1.2	2.8	0.3	2.9	21	5.3	6	0.9	4.5	25	32	30	<0.1	0.2	3.8	13	1.8	0.1
Sand (0.062-2 mm)	%	0.1	–	–	73	38	12	85	23	76	87	91	56	35	67.5	62	51	82	4.6	90	82	51	68
Silt (0.031-0.062 mm)	%	0.1	–	–	1.5	22	19	5.5	17	1	3.8	1.6	18	21	3.6	3.6	12	14	56	4.7	3.3	33	25
Clay (<0.0020 mm)	%	0.1	–	–	2.7	39	67	9.5	57	1.8	4.3	1.2	24	39	4.35	2.3	6.8	3.9	39	1.6	1.5	14	6.9
Metals and Nonmetals																							
Arsenic (As)	mg/kg	0.5	5.9	17	1.1	1	0.8	<0.5	0.5	0.8	<0.5	<0.5	<0.5	0.7	3.55	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium (Cd)	mg/kg	0.2	0.6	3.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (Cr)	mg/kg	1	37.3	90	**210**	21	16	12	5	**110.5**	70	3	18	6	76.5	23	35	11	28	7	17	16	10
Cobalt (Co)	mg/kg	1	–	–	3	2	1	<1	<1	4	1	<1	<1	1	23	3	2	2	3	<1	<1	1	2
Copper (Cu)	mg/kg	1	35.7	197	6	7	11	4	10	4	4	1	5	9	25.5	12	21	3	9	1	3	3	2
Iron (Fe)	mg/kg	10	–	–	8 300	11 000	3 700	3 200	2 200	6 550	2 800	1 200	4 700	820	30 000	4 700	5 900	5 200	7 100	1 900	2 800	3 400	3 600
Magnesium (Mg)	mg/kg	10	–	–	1 500	1500	460	680	340	1 400	770	300	720	760	8 850	1 300	2 300	970	1 300	640	790	1 100	810
Manganese (Mn)	mg/kg	1	–	–	47	35	10	13	7	48	20	11	12	6	490	52	31	39	39	16	18	20	36
Mercury (Hg)	mg/kg	0.01	0.17	0.486	<0.01	0.1	0.16	0.05	0.11	0.01	<0.01	<0.01	0.03	0.09	0.015	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	0.01
Molybdenum (Mo)	mg/kg	1	–	–	4	2	1	1	1	2.5	1	<1	<1	6	6	<1	<1	1	2	<1	<1	1	<1
Nickel (Ni)	mg/kg	0.5	–	–	81	9.9	9.5	4.5	5.1	45.5	29	2	4.4	15	52.5	9.7	13	5.9	12	3.5	4.2	6.2	4.5
Lead (Pb)	mg/kg	1	35	91.3	6	10	11	6	8	9.5	3	3	3	7	6.5	3	4	4	4	2	4	5	5
Selenium (Se)	mg/kg	0.5	–	–	<0.5	0.5	1	<0.5	<0.5	<0.05	<0.5	<0.5	<0.5	0.6	<0.05	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	mg/kg	5	123	315	9	13	7	6	6	9	6	<5	7	20	55	7	11	11	22	<5	5	8	7
Organic Compounds																							
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/kg	100	–	–	<100	<100	<100	<100	<100	130	<100	<100	<100	160	<100	<100	<100	<100	190	<100	<100	<100	<100
Total Organic Carbon	mg/kg	500	–	–	13 000	120 000	210 000	19 000	240 000	20 000	13 000	3 300	58 000	280 000	11 050	4 300	8 800	6 000	72 000	3 800	8 500	30 000	11 000
Volatile Solids (550°C)	% g/g	–	–	–	0.89	35	57	11	80	1.95	5.2	0.95	23	67	3.195	0.83	1.9	21	1.8	1.3	1.3	13	4.1

[1] *Source: Canadian Council of Ministers of the Environment. 2002. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Table, updated. In Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. 6 pages.*

[2] *Stations AQR8 and AQR9 were sampled in duplicate and the results given correspond to the average of the two results obtained. QAQC results are available in Appendix 6.9.1*

[3] *Stations AQR4, AQR6, AQR11, AQR20, AQP1, and AQP2 were sampled on two occasions. See the Certificates of Analysis in Appendix 8.3.1 of the sectoral report on the physical environment of the EBS (Roche 2011) for more details on the parameters analyzed during sampling.*

Value exceeding the ISQG

bold Value exceeding the PEL

Table 6.9.1 Sediment Quality Results from Samples Taken in September and October 2010

Area			Sediment Quality CCME[1]		*Hibou*		*Lynx*	*Témoin*	*Airstrip*		Descriptive Statistics					
Type of Waterbody					*Lake*		*Lake*	*Lake*	*Lake*	*Stream*						
Sampling Station	**Unit**	**Method Detection Limit**	**Interim Sediment Quality Guidelines (ISQG)**	**Concentrations producing a probable effects level (PEL)**	*AQH1*	*AQH2*	*AQL1*	*AQR34*	*AQP1*[3]	*AQP2*[3]	**Number of Values**	**% < DL**	**Criteria Exceeded**	**Minimum**	**Median**	**Maximum**
Station Characteristics																
Sampling Date					2010-09-04	2010-09-04	2010-09-06	2010-09-06	2010-09-04 2010-10-07	2010-09-04 2010-10-07						
UTM (NAD 83, Zone 18) East					687 830	687 902	685 721	689 592	687 213	686 271						
UTM (NAD 83, Zone 18) North					5 855 799	5 856 100	5 854 142	5 857 055	5 845 902	5 845 690						
Lake Name					Lake Lagopede (32302)		F3312	F3297	F3291	-						
Basic Physicochemical Parameters																
pH (laboratory)	pH	–	–	–	5.03	4.9	5.01	4.5	4.76	4.62	23	0%	0%	3.90	4.90	5.64
Nutrients																
Sulphur (S)	%	0.01	–	–	0.08	0.08	0.45	0.07	0.41	0.17	25	0%	0%	0.07	0.14	0.46
Sulphides (S_2)	mg/kg	0.0003-2	–	–	–	-	0.039	–	0.008	–	5	20%	0%	<0.0003	0.0080	0.0390
Total Phosphorus	mg/kg	20	–	–	450	280	710	150	420	150	25	0%	0%	150	360	920
Granulometry and Sedimentology																
Gravel (>2 mm)	%	0.1	–	–	35	3.5	14	29	3	12	25	4%	0%	<0.1	4.5	35
Sand (0.062-2 mm)	%	0.1	–	–	60	94	17	69	36	70	25	0%	0%	4.6	67.5	94
Silt (0.031-0.062 mm)	%	0.1	–	–	2.5	0.9	11	1.4	26	7.4	25	0%	0%	0.9	7.4	56
Clay (<0.0020 mm)	%	0.1	–	–	2.8	1.3	57	1.1	35	11	25	0%	0%	1.1	6.8	67
Metals																
Arsenic (As)	mg/kg	0.5	5.9	17	<0.5	0.5	0.5	<0.5	2.2	<0.5	25	56%	0%	<0.5	<0.5	3.6
Cadmium (Cd)	mg/kg	0.2	0.6	3.5	<0.2	<0.2	0.4	<0.2	0.5	<0.2	25	88%	0%	<0.2	<0.2	0.5
Chromium (Cr)	mg/kg	1	37.3	90	96	**180**	12	11	12	62	25	0%	28%	3	17	210
Cobalt (Co)	mg/kg	1	–	–	6	4	3	<1	<1	1	25	32%	0%	<1	1	23
Copper (Cu)	mg/kg	1	35.7	197	10	9	24	5	8	4	25	0%	0%	1	6	26
Iron (Fe)	mg/kg	10	–	–	14 000	7 500	6 000	2 800	1 300	2 700	25	0%	0%	820	3 700	30 000
Magnesium (Mg)	mg/kg	10	–	–	2 000	1 500	650	760	170	850	25	0%	0%	170	810	8 850
Manganese (Mn)	mg/kg	1	–	–	140	81	27	17	15	26	25	0%	0%	6	26	490
Mercury (Hg)	mg/kg	0.01	0.17	0.486	0.01	<0.01	0.09	<0.01	0.11	0.01	25	44%	0%	<0.01	0.01	0.16
Molybdenum (Mo)	mg/kg	1	–	–	2	3	<1	<1	2	2	25	36%	0%	<1	1	6
Nickel (Ni)	mg/kg	0.5	–	–	36	70	17	3.5	8.2	24	25	0%	0%	2	9.7	81
Lead (Pb)	mg/kg	1	35	91.3	7	4	7	3	22	3	25	0%	0%	2	5	22
Selenium (Se)	mg/kg	0.5	–	–	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	25	84%	0%	<0.5	<0.5	1.1
Zinc (Zn)	mg/kg	5	123	315	16	9	13	<5	13	17	25	12%	0%	<5	9	55
Organic Compounds																
Petroleum Hydrocarbons (C_{10}-C_{50})	mg/kg	100	–	–	<100	<100	<100	<100	<100	130	25	84%	0%	<100	<100	190
Total Organic Carbon	mg/kg	500	–	–	8 700	4 000	350 000	5 700	390 000	55 000	25	0%	0%	3 300	13 000	390 000
Volatile Solids (550°C)	% g/g	–	–	–	0.74	0.7	82	1	87	9.8	25	0%	0%	0.7	4.1	87

[1] *Source: Canadian Council of Ministers of the Environment. 2002. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Table, updated. In Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. 6 pages.*

[2] *Stations AQR8 and AQR9 were sampled in duplicate and the results presented correspond to the average of the two results obtained. QAQC results are presented in Appendix 6.9.1*

[3] *Stations AQR4, AQR6, AQR11, AQR20, AQP1, and AQP2 were sampled on two occasions. See the Certificates of Analysis presented in Appendix 8.3.1 of the sectoral report on the physical environment of the EBS (Roche 2011) for more details on the parameters analyzed during sampling.*

Value exceeding the ISQG

bold Value exceeding the PEL

The following sections first describe the sediment quality at the regional level. Then, a more detailed description of results obtained for the study area is given.

6.9.1.1 Regional Environmental Context

Sediments collected in freshwater aquatic ecosystems generally include a mineral fraction from the erosion of the bedrock, a fraction from soil erosion, and an organic fraction mainly from the production and decomposition of organic matter in the environment (Wetzel, 2001). In addition to being a component of aquatic ecosystems, sediments are recognized act as a sink for contaminants, metals, and organic matter. Sediment monitoring is therefore an important step in the environmental assessment of mining activities.

Comparing the results obtained in the Renard Project study area to those obtained in the Matoush Project area (Strateco, 2009), a wide variety of sediment quality is noted. For example, maximum concentrations of metals measured in sediments collected on the Matoush Property in 2007, 2008, and 2009 are in general much lower than those observed in the Renard Project study area since 2003. Only cadmium exceed the range of concentrations measured in the Renard Project study area, and only on one occasion. The variability observed may be related to the proportion of fine sediments or organic matter in the sample. In fact, metals generally tend to be associated with fine particles in sediments and sediments containing a greater proportion of organic matter. The bedrock composition may vary greatly from one region to another.

6.9.1.2 Mine Infrastructures Area

No significant difference was detected in the sediment quality collected in lakes and those collected in streams of the Renard Project study area. Therefore, these results were grouped together for the characterization of the concentrations of the various parameters measured.

- *GRANULOMETRY*

The granulometry (particle size) of the sediments collected in the study area is highly variable between samples (Figure 6.9.1), although sand and gravel are predominant most of the time. For example, sediments collected at 19 stations in September 2010 contain over 50% of sand and gravel. Samples from the six other stations contained sediments composed of more than 50% of fine silt and clay particles. The content in fine sediments is correlated with the concentrations of volatile compounds (r_s=0.828), total organic carbon (r_s=0.898), sulphur (r_s=0.896), total phosphorus (r_s=0.641), and certain metals, like mercury (r =0.828), lead (r_s=0.558), and selenium (r_s=0.511).

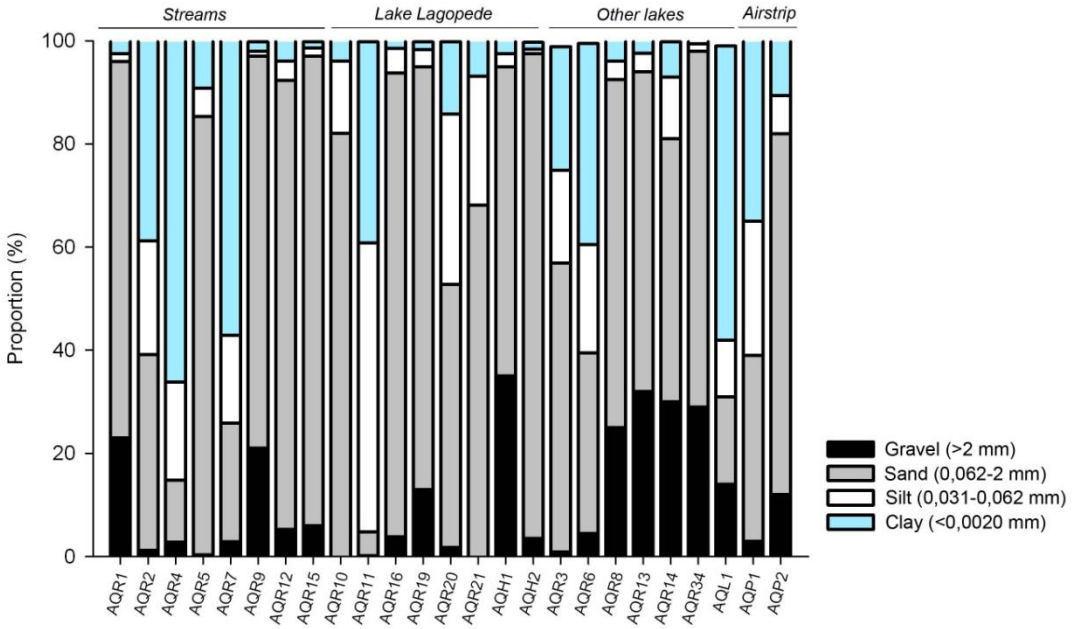


Figure 6.9.1 Granulometry of 25 Sediment Samples taken in the Renard Project Study Area in September and October 2010

- *pH*

In 2010, sediments sampled in streams and lakes of the study area were particularly acidic, with pH values varying from 3.90 to 5.64.

- *Organic Matter*

Sediments of the study area contain highly variable quantities of organic matter (3,300 mg/kg to 390,000 mg/kg of total organic carbon, which is the equivalent of TOC levels of 0.33% to 39% g/g). Organic matter concentrations are higher in sediments with a larger proportion of fine particles, and, more specifically, of clay.

Organic matter content seems to influence sediment quality. For example, concentrations of TOC and volatile solids are strongly correlated to sediment sulphur levels (r_s=0.94) but less, to their total phosphorus content (r_s=0.51). Sediments that contain more organic matter seem more likely to show higher concentrations of certain metals. Among all metals, mercury concentrations show the strongest correlation with organic matter content of sediments (r_s=0.84). Medium correlations are also observed between concentrations of TOC and volatile solids and concentrations of lead (TOC: r_s=0.66, volatile compounds: r_s=0.52), selenium (TOC: r_s=0.57, volatile compounds: r_s=0.55), and cadmium (TOC: r_s=0.57, volatile compounds: r_s=0.55) (Appendix 6.9.2).

These correlations may be explained by the fact that organic matter is part of the composition of fine sediments and that certain elements, such as phosphorus, sulphur, and some metals (e.g. mercury) tend to be absorbed by fine sediments and organic matter (Wetzel, 2001).

- *NUTRIENTS*

Total phosphorus concentrations are highly variable in the sediments of the study area. In 2010, they varied from 150 mg/kg to 920 mg/kg of sediments (Table 6.9.1). These concentrations are higher than those measured in July 2003 and August 2004, when they varied from <20 mg/kg to 620 mg/kg (Appendix 6.8.3b). These samples came from 5 streams and 16 waterbodies located within a radius of about 15 km of camp Lagopede.

- *SULPHUR CONTENTS*

The sediments sampled in 2010 in the study area contain from 0.07% to 0.46% of sulphur (Table 6.9.1), values on the same order of magnitude as those from 2003 and 2004 (<0.009% to 0.45%) (Appendix 6.8.3b). In 2010, the five samples analyzed for sulphides showed concentrations varying from <0.0003 mg/kg to 0.039 mg/kg.

- *METALS*

Metal concentrations measured in 2010 in the sediments of the study area vary greatly from one station to another. The most abundant metals are, in descending order: iron, magnesium, manganese, chromium, nickel, and zinc (Table 6.9.1).

Only chromium concentrations do not meet the Canadian sediment quality guidelines for the protection of aquatic life. Chromium concentrations exceeded the freshwater interim sediment quality guidelines (ISQG, 37.3 mg/kg) seven times (28% of cases), three of which also exceeded concentrations producing a probable effects level (PEL, 90 mg/kg) (CCME, 2002).

Maximum chromium concentrations were measured at the following stations (Map 6.8.1):

- AQR1 (210 mg/kg) - at the mouth of lake F3300 outflow stream in Lake Lagopede. Lake F3300 is located downstream of the proposed mine facilities;
- AQH2 (180 mg/kg) - in Lake Lagopede at the mouth of the outflow stream of lake F3294;
- AQR9 (111 mg/kg) - in the outflow stream of lake F3302, which is located downstream of the R-2 site.

Natural average chromium concentrations, indexed in the Geological Survey of Canada's (GSC) National Geochemical Reconnaissance Program (NGRP) database, are 47 mg/kg for lacustrine sediments from various streams and waterbodies in Canada (British Colombia, Manitoba, Saskatchewan, Ontario, Labrador, New Brunswick, and Nova Scotia) (CCME, 1999b). In the study area, mean chromium concentrations in the sediments of lakes and streams are 36 mg/kg and 57 mg/kg,

respectively. Almost everywhere in Canada, background concentrations of chromium exceed the ISQG, which is 37.3 mg/kg (CCME 1999b).

Since mercury, lead, selenium, cadmium, and zinc concentrations vary in relation with the organic matter content of sediments, it is not surprising that they are also correlated with clay, sulphur, and total phosphorus contents of sediments (Appendix 6.9.3). Chromium, iron, magnesium, manganese, and nickel concentrations are not correlated with clay and organic matter contents of sediments. However, they are highly ot moderately correlated with each other.

Median concentrations of metals measured in sediments of the Renard Project study area in 2003 and 2004 are similar to those observed in 2010. At that time, chromium concentrations exceeded the ISQG at some occasions (7% of the measurements), but did not exceed the PEL in any case, unlike in 2010. Cadmium levels also exceeded the ISQG, but only once. Maximum concentrations of iron, magnesium, and nickel were lower in 2003 and 2004 (Appendix 6.8.3b) than in 2010.

- *PETROLEUM HYDROCARBONS*

In 2010, petroleum hydrocarbons (C_{10}-C_{50}) were measured in concentrations reaching or exceeding the detection limit (100 mg/kg) at five stations (20% of stations, Table 6.9.1), as follows:

- A concentration of 160 mg/kg in lake F3301 (AQR6);
- A concentration of 130 mg/kg in a small channel, upstream of the R-2 site, which is the outlet of lake F3302 (AQR9);
- A concentration of 130 mg/kg in a stream near the airstrip (AQP1);
- A concentration of 190 mg/kg in the northeast bay of Lake Lagopede near the R-2 site (AQR11; Map 6.8.1).

AQR11 is the station where the highest hydrocarbon concentrations were measured (190 mg/kg). This station is located immediately downstream of areas that are subject to drilling. The other stations, however, do not seem to have been affected by past human activity. Hydrocarbon concentrations observed are low, around the detection limit of the analytical method. None of the values exceed the Criterion A of the *Soil Protection and Contaminated Sites Rehabilitation Policy*, which is 300 mg/kg.

6.9.1.3 Airstrip Area

In September 2010, sediments were collected in a lake and a stream in the area of the airstrip. The results presented characteristics similar to those found in sediments taken from the mine area.

6.9.2 Impacts during the Construction Phase

6.9.2.1 Description of Impacts

The following project components are likely to affect sediment quality during the construction phase:

- Site preparation and development: Clearing, drilling, blasting, cut, fill, drainage, materials confinement area and stockpiles, borrow pits, and secondary roads for all facilities;

- Quarry and borrow pit operation - The operation of the borrow pits and crushing of borrow material have the potential to enhance sediment transport to the hydrological network if not controlled;
- Dewatering of lakes, and water and sediment management - Site preparation, development, and construction and lake dewatering are likely to modify sediment quality through increased soil particle or sediment transport to the hydrological network if erosion is not controlled at source;
- Water management of worksite - Increased sediment transport and higher concentrations of phosphorus could potentially be measured if site runoff water is not managed and controlled appropriately; in addition, effluent from the domestic wastewater treatment station may release nutrients and an organic load that are likely to modify locally the sediment composition at the discharge point into Lake Lagopede;
- Traffic and the use and maintenance of machinery and power generating sets;
- Storage and management of fuel and hazardous materials - The use and maintenance of machinery and power generating sets and the storage of fuel and hazardous materials such as used oils increase the probability of water contamination with hydrocarbons or other contaminants likely to affect sediment quality.

➢ *SITE PREPARATION AND DEVELOPMENT*

Site preparation and development activities such as clearing, excavation, earthworks, and the construction of access roads will expose the soil to inclement weather and therefore make it more prone to erosion. The storage and transportation of bulk construction materials will bring additional quantities of materials that may be introduced into the hydrological network. Activities carried out directly on streambanks or lakeshores, such as the diversion of streams and the installation of culverts, are the most likely to cause significant modifications of water level and to lead to bank erosion in some places and to sediment deposition in others. These changes are likely to cause site-specific modifications of sediment granulometry or composition by the following processes:

- Modifying the quantity and granulometric distribution of the sediments - A change in the quantity and granulometry of the sediments present may be beneficial or not for aquatic organisms like benthos and fish. For example, inflow and accumulation of gravel or pebbles may create good habitats for benthic invertebrates or spawning areas for salmonids. However, a too great accumulation of sand or fine sediments may degrade these habitats. In addition, when fine sediments are no longer in a cohesive form, it remains suspended in the water for longer before settling further away.
- Through the transportation of nutrients, metals, and other contaminants related to mining activity - Soil particles from erosion may transport various nutrients (nitrogen, phosphorus) and metals that may influence sediment quality. In the study area, according to samples collected in September 2010, nutrient concentrations in the sediments are variable in time and space. For example, in 2010, concentrations of total phosphorus varied from 150 mg/kg to 920 mg/kg (Table 6.9.1), while in 2003 and 2004, concentrations varied from <20 mg/kg to 620 mg/kg (Appendix 6.8.3b).

➢ *QUARRY AND BORROW PIT OPERATION*

In general, operation of the borrow pits will be greatly limited by the extraction of overburden and waste rock from pit R-65, from which material will be crushed as necessary and used for civil engineering

activities on the mine site. For the airstrip, materials will be extracted from borrow pits located near the airstrip.

Operation of borrow pits and crushing of borrow materials have the potential to enhance sediment transport to the hydrological network if not controlled. Pumping and drainage waters may also carry suspended solids to the surrounding streams and waterbodies.

- *DEWATERING OF LAKES AND WATER AND SEDIMENT MANAGEMENT*

The operation of pits R-2/R-3 and R-65 will require the dewatering of lakes F3302 and F3303. As part of the characterization of the receiving environment, a sediment sample was taken in each of these lakes. The sediments collected at these locations are mostly constituted of sand and gravel. The probability of observing harmful biological effects related to the management of these sediments is relatively low because the test results are all below the occasional effect level (OEL) defined by Environment Canada and the MDDEP (2007).

Water pumped from the lakes will be loaded with fine sediments likely to modify the granulometry of sediments and transport organic matter, nutrients, or metals to the dewatering water discharge point. The dewatering water will therefore be pumped and directed to mobile water treatment units before being discharged into Lake Lagopede. Bottom lake waters, which are susceptible to contain high concentrations of suspended solids, will be treated if necessary with EnviroBags before being discharged into Lake Lagopede. Lake bottom sediments will be excavated at the beginning of winter in order to minimize sediment transport to the hydrological network. Then, sediments will be deposited on a drying bed developed nearby. The frozen sediments will then be disposed of in the overburden stockpile for future use during progressive site rehabilitation to add nutrients to the soil.

- *WATER MANAGEMENT OF WORKSITE*

Runoff Water

Several runoff water management measures are planned to preserve the integrity and quality of the sediments of Lake Lagopede tributaries during the construction phase. A diversion ditch will be constructed to redirect water from areas located upstream of the mine toward watershed SBVR1. In addition, a peripheral collection system for mine site runoff water, consisting of drainage ditches, and the sedimentation pond R-65 will also be developed at the beginning of the construction phase. A system of drainage ditches and a sedimentation pond will also be developed to manage runoff water from the accommodation complex site. These sedimentation ponds will receive runoff water from work areas and will help to decrease the sediment load in these waters. In addition, mobile runoff water treatment units will also be used to remove fine particles before release treated water into Lake Lagopede, until the permanent treatment station is operational.

Domestic Wastewater

Before the installation of the domestic wastewater treatment system, temporary sanitary facilities will be used.

During the construction phase, up to 500 workers could be present on the mine site. The domestic wastewater treatment system will generate sludge with a very large quantity of water (96-98%). In summary, sludge from wastewater treatment will be dried, disposed of in the trench landfill site, and used for final site covering or reused for revegetation activities if the environmental requirements are met. The water collected will be directed to the domestic wastewater treatment system before being released into Lake Lagopede after treatment. The domestic wastewater will be treated in three aerated facultative lagoons (see Section 3.10.1 for a detailed description of the treatment system).

The discharge point for treated domestic wastewater is located in the southern portion of Lake Lagopede (Figure 3.10.2). Meeting the discharge objectives established by the MDDEP and the surface water criteria for the protection of aquatic life (at the limit of the mixing zone) will limit the modifications of Lake Lagopede sediment quality within the discharge mixing zone.

Results of the domestic effluent plume modelling for the construction phase indicate that a dilution limit of 1:100 will be reached at 52 m downstream of the outfall for average flows, while it may extend up to 130 m downstream of the discharge point for peak hourly flows (details in Section 3.10.5 and in Figure 3.10.5). At the limit of the plume, contaminant concentrations will be of the same order of magnitude as concentrations currently measured in the receiving environment and therefore should not have an impact on sediment quality. A site-specific increase in the organic matter load as well as in nutrient and fine particle concentrations could be observed in the sediments within the mixing zone.

- *Traffic and the Use and Maintenance of Machinery and Power Generating Sets and the Storage and Management of Fuel and Hazardous Materials*

During an accidental hydrocarbon leak or spill in the aquatic environment, a large proportion of the hydrocarbons evaporate into the atmosphere. The soluble fraction of the hydrocarbons, which mainly includes aromatic compounds, can solubilize and bond with suspended solids that will eventually settle on the sediments. These accidental incidents are generally of short duration, but their intensity may be highly variable and have impacts on sediment quality and the aquatic organisms.

Traffic and the presence, use, and maintenance of machinery and power generating sets will increase the probability of accidental spills or leaks of hydrocarbons on the site. If not confined and recovered rapidly after a leak, hydrocarbons may accumulate and contaminate sediments. For this reason, several preventive and remedial actions are planned to limit the risk of accidental spills or leaks and quickly identify, confine, and recover leaks and spills and dispose of them at an authorized location (see Section 3.12 for more details). These measures include collecting runoff water from the area of the mine truck and light vehicle repair workshop in an oil-water separator and collecting recovered oils using

a vacuum truck (SNC-Lavalin, 2010), then storing the oils at the mine site before being transport south where they will be taken to a designated site for contaminant management.

Hazardous solid waste materials will also be generated on the mine site. To prevent the introduction of hazardous solid waste materials into the hydrological network and sediments, a hazardous materials management plan has been developed. It is presented in Section 3.12 of this impact assessment study. Hazardous solid waste materials will be temporarily stored in designated places before being transported south and disposed of in an authorized location.

6.9.2.2 Mitigation Measures

Several mitigation measures are focused on preventing and minimizing erosion and sediment transport to streams (see Section 6.8.2). With the implementation of these measures for the protection of water quality on the construction site, any changes to the granulometry and quality of sediments will be prevented. The risks of sediment contamination will be reduced with the implementation of mitigation measures for traffic, the maintenance of machinery, the storage and management of fuel and hazardous materials, and the disposal of hazardous solid waste and wastewater.

The mitigation measures planned for sediment quality are the same as those mentioned for water quality during the construction phase for impacts related to the following project components:

- Site preparation and development (clearing, drilling, blasting, filling, cutting, drainage, materials confinement area and stockpiles, borrow pits, and secondary roads) for all facilities;
- Quarry and borrow pit operation;
- Dewatering of lakes, and water and sediment management;
- Water management of worksite;
- Traffic and the use and maintenance of machinery and power generatoring sets;
- Storage and management of fuel and hazardous materials.

6.9.2.3 Residual Impacts

During the construction phase, with the implementation of all of the mitigation measures, the impacts of the project on sediment quality can be considered to be of a moderate intensity. The impacts will be site specific to the ditches downstream of the construction work and within the limit of the treated domestic and mine effluent dispersion plumes, and confined to the Renard Project study area with a moderate duration (that is, the duration of the construction phase). The significance of the impacts on sediment quality during the construction phase is therefore considered moderate.

6.9.3 Impacts During the Operation Phase

6.9.3.1 Description of Impacts

The following project components are likely to affect sediment quality during the operation phase:

- Pit development (clearing, drilling, blasting, cut, fill, and drainage) - The pit development is likely to modify sediment quality at the mine effluent discharge point in Lake Lagopede through increased transport of soil particles and sediment into the hydrological network if erosion is not controlled at source;
- Traffic and the use and maintenance of machinery and power generating sets;
- Storage and management of fuel and hazardous materials - Summertime road maintenance and the spreading of abrasives in winter could contribute to the transport of sand and gravel that will settle downstream of stream crossings and possibly modify the sediment grain size. Road transportation, the use and maintenance of machinery and power generating sets, and the storage of fuel and hazardous materials such as used oils are activities likely to increase the probability of sediment contamination by hydrocarbons;
- Material management from mining operations (overburden, waste rock, and kimberlite) - The results of tests conducted on materials from mining operations show that water in contact with these materials is not likely to modify sediment quality, given that these materials are not acid generators and that the metal leaching potential is below the criteria of the Guideline 019;
- Water management - In Lake Lagopede, fine particles of various sizes coming from mine water may settle at the outfall discharge point of the treated mine effluent. Sediment transport to Lake Lagopede at the mine effluent discharge point is also likely to increase due to the expected hydrological changes related to the increase the imperviousness of the site. Discharge of treated domestic effluent is likely to increase nutrient concentrations and the organic load of sediment in the area of the domestic effluent dispersion plume.

➢ *PIT DEVELOPMENT*

Clearing, drilling, blasting, cut, fill, and drainage activities related to pit development will expose the soil to inclement weather and make them more vulnerable to erosion.

Runoff from these activities has the potential to affect the quantity, grain size, and chemical composition of sediment through organic matter, nutrient, and metal input if the sites are not developed properly and erosion is not controlled at source.

➢ *TRAFFIC AND THE USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS*

Summertime maintenance of the mine site roads will mainly consist of grading road gravel to ensure adequate profile grade. Grading and the accidental discharge of gravel and sand into ditches and streams could enhance sediment transport to the hydrological network and modify locally the grain size distribution and chemical composition of the road ditch substrate downstream of crossing points.

The spreading of abrasives in winter could also foster the transport of sand and gravel particles to the hydrological network and modify the quality of streambed substrate downstream of the crossing points of the mine site drainage ditches. During periods of melting snow and spring rain, abrasives spread during the winter will be transported to the ditches and eventually to streams and waterbodies located downstream of the mine roads.

- *MANAGEMENT OF MATERIALS FROM MINING OPERATIONS (OVERBURDEN, WASTE ROCK, AND PROCESSED KIMBERLITE)*

During the operation phase, the Renard Project will generate a large quantity of materials that will be stockpiled in areas specifically developed for ore, waste rock, processed kimberlite and overburden (Table 6.8.7). Precipitation and runoff will flow through the confinement area and stockpiles and exit after a varying period of time. Runoff and exfiltration water in contact with these materials have the potential to modify sediment quality. According to the results of tests conducted on these materials from mining operations (Section 3.6.5), sediment transport control is the main concern related to the management of the water in contact with these materials. These materials are not acid generators and are not leachable (their potential for leaching metals is below the criteria set by the Guideline 019—see Section 6.8.3).

- *WATER MANAGEMENT*

Mine Water

Once the mine site is in operation, the presence of hard, rocky surfaces with low permeability and bare ground instead of vegetation and overburden will increase runoff and, as a result, erosion and sediment transport on the site. If sediment transport is not properly controlled, it could contribute to a change in grain size and chemical composition of streambed substrates in the northeast portion of Lake Lagopede. For this reason, a mine water management plan will be implemented (see Section 3.10). All mine water (runoff, drainage water, water from the waste rock and overburden stockpiles and processed kimberlite confinement area, etc.) will be collected and managed through a network of peripheral ditches that will direct the water to sedimentation pond R-65. Runoff from the accommodation and services complex will instead be directed to sedimentation pond S-18 developed during the construction phase to remove particulate matter from water prior to being released into Lake Lagopede.

Water in sedimentation pond R-65 will be treated at the mine wastewater treatment facility, whose final effluent will be monitored to ensure that it meets the effluent discharge objectives before being released into Lake Lagopede (Section 3.10.5.2). Meeting these objectives will allow to prevent and limit the extent of impacts in the effluent plume dispersion area. The outfall of the mine effluent was positioned in Lake Lagopede so as to enhance rapid dispersion and dilution of the effluent (Figure 3.10.4). The plume dispersion modelling results (Appendix 3.10.1) indicate that during severe low flow conditions, initial concentrations of treated effluent will reach a dilution of 1:10 at a distance of 750 m from the discharge point (Figure 3.10.7) and 300 m during fall turnover (see Section 3.10.5.2 and Figure 3.10.8). The specific bathymetry of the lake divides it into two distinct basins, the northern basin, which receives the mine effluent, and the southern basin, located at the downstream portion of the lake (Figure 3.10.6). The sill that separates the northern basin from the southern basin is such that the southern basin will be affected only slightly by the treated mine effluent (Figure 3.10.7). In the northern basin, at the limit of the

plume, concentrations of the various contaminants will be within the range of concentrations measured in the environment during the Environmental Baseline Study (Roche, 2011), with the exception of total phosphorus, concentrations of which will be slightly higher at the limit of the plume (0.01 mg P/L) than in the lake (95th percentile=0.007 mg P/L). The domestic and mine effluent plumes will not overlap (Environnement Illimité, 2011). Phosphorus inflow could have the effect of a temporary (around the month of August), local increase of total phosphorus concentrations in the northern basin of Lake Lagopede corresponding to values reported for oligo-mesotrophic lakes (typically 0.007-0.013 mg/L of total phosphorus, MDDEP, 2007). Depending on the proportion of the total phosphorus that will be bioavailable as orthophosphates, this inflow could possibly contribute to a limited, temporary increase in the productivity of this area of Lake Lagopede and of fisheries potential. Given the hydraulic residence time in Lake Lagopede of 53 days and the low temperatures that generally occur in September, the effects will be of short duration and possibly completely limited to the month of August. At the limit of the plume, concentrations of the various contaminants will be within the range of concentrations measured in the lake during the Environmental Baseline Study and will therefore not affect sediment quality (Roche, 2011).

Domestic Wastewater

The effluent from the domestic wastewater treatment facility is likely to discharge phosphorus, nitrogen, fecal coliforms, organic matter, etc. These contaminants could modify the sediment quality in Lake Lagopede if not controlled.

During the operation phase, it is expected that two alternating groups of 230 workers each will be present at the camp on a two week rotation basis, that is, half as many workers as during the construction phase. A system of three aerated facultative lagoons will be used during this period to treat effluent so that it is in accordance with applicable effluent discharge objectives. The environmental design criteria used for the effluent are presented in Table 6.8.6 and in Section 3.10.5.1. Meeting the effluent discharge objectives set by the MDDEP and the surface water quality criteria for the protection of aquatic life (at the limit of the mixing zone) will limit impacts on the sediment quality of Lake Lagopede.

During the operation phase, domestic effluent discharge rates will be below those expected during the construction phase. Initial dilution limits and the 1:100 dilution limit will therefore be close to the discharge point. The 1:100 dilution limit will be reached at about 38 m downstream of the discharge point at average flow rates, while it could reach 83 m during peak hourly flows (Figure 3.10.5).

The plume will not reach the surface within the 1:100 dilution zone. It will remain in the water column at a depth of about 4 m to 6 m.

Within the plume area, it is possible that a limited increase in nutrient and organic matter concentrations and the quantity of fine sediment will be observed. At the limit of the plume, contaminant concentrations

will be similar to concentrations currently measured in Lake Lagopede and therefore should not modify the sediment quality. Modifications to lake sediment quality should therefore be confined to within the initial mixing zone.

- *STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

During an accidental hydrocarbon leak or spill in the aquatic environment, a large proportion of the hydrocarbons evaporate into the atmosphere. The soluble fraction of the hydrocarbons may ultimately contaminate sediments by bonding with suspended particles in the water. If they are not confined and recovered quickly, these contaminated particles could settle on lake and stream sediment and alter the quality of sediment.

Traffic and the presence, use, and maintenance of machinery and power generating sets increase the probability of the accidental spills or leaks of petroleum products on the site. Several preventive and remedial actions are planned to limit the risk of accidental spills or leaks (see Section 3.12 of the present impact assessment), and also to quickly identify, confine, and recover leaks and spills and dispose of them in an authorized site.

- *HAZARDOUS SOLID WASTE MANAGEMENT*

Hazardous solid waste will be temporarily stored in places designed for this purpose before being transported south to be disposed of at an authorized site.

This hazardous materials waste consists of the following, among others:

- Oil and grease waste (contaminated rags and absorbents, used oils and lubricants, used solvents, used oil filters);
- Light bulbs containing mercury;
- CFCs and other halides, various aerosol cans;
- Explosives and explosives packaging, nuclear sources (hydrometer, flowmeter in piping);
- Oily water and batteries;
- Contaminated fuel;
- Contaminated equipment.

A detailed description of the plan for hazardous materials management is provided in Section 3.12 of the present impact assessment.

6.9.3.2 Mitigation Measures

Several mitigation measures for water quality are focused on preventing and minimizing the erosion process and sediment transport to waterways (see Section 6.8.3). The implementation of these mitigation measures will allow for the prevention of any modification to sediment grain size and quality. The risk of sediment contamination will be reduced through the implementation of mitigation measures

for the maintenance and operation of machinery, the storage and management of fuel and hazardous materials, and the disposal of hazardous solid waste materials and wastewater.

The mitigation measures listed for the protection of water quality during the construction and operation phases also apply for impacts on sediment related to the following project components:

- Pit development;
- Traffic and the use and maintenance of machinery;
- Water management;
- Storage and management of fuel and hazardous materials;
- Management of hazardous solid waste materials.

The mitigation measures planned for water quality during the operation phase will also apply for impacts related to the management of materials from mining operations (overburden, waste rock, and kimberlite).

6.9.3.3 Residual Impacts

During the operation phase, with the implementation of all of the mitigation measures, the residual impacts of the project on sediment quality are deemed to be of a moderate intensity. The impacts will be site specific, confined to the mine and domestic effluent discharge points with a moderate duration (that is, the duration of the operation phase). The significance of the impacts on sediment quality during the operation phase is therefore considered moderate.

6.9.4 Impacts during Closure Phase

6.9.4.1 Description of Impacts

The following project components are likely to have an effect on sediment quality during the closure phase:

- Water management;
- Site rehabilitation and revegetation - The stabilization and restoration of the site's topography and revegetation activities are likely to cause, initially, some sediment transport to the hydrological network and these particles will eventually settle and cover the bottom sediment in Lake Lagopede. The end of treated mine and domestic effluent discharge will contribute to the improvement of sediment quality. The transportation off site of hazardous materials and site revegetation will contribute to preventing and limiting sediment transport or contaminant input that could modify sediment composition and quality;
- Traffic and the use and maintenance of machinery - During closure, the use and maintenance of machinery may lead to accidental spills or leaks of hydrocarbons, which could contaminate sediments if not confined.

➢ *WATER MANAGEMENT*

The domestic and mine wastewater treatment facilities, the airstrip, and the trench landfill site will remain operational during the closure phase. Due to the lower number of workers than during the operation phase (about 50 workers are planned for the closure phase, compared to 230 workers during

the operation phase) and the termination of mining activities, flow rates as well as sediment, soil particle and organic matter loads within the domestic and mining effluent dispersion plumes will be lower than during the operation phase. However, to maintain sediment quality, the same design and mitigation measures planned for operation phase activities will be maintained.

The restoration of the drainage pattern is likely to cause sediment transport to the hydrological network. For this reason, erosion control at source and appropriate management of sediment transport will be applied to prevent and limit any modification of the sediment grain size or quality. Mine water management facilities, that is, the ditches, retention basins, and water treatment facilities will remain in operation until the closure activities are completed and monitoring shows that the quality of mine water is in accordance with the effluent discharge objectives (Guideline 019, MDDEP, 2005) and that treatment is no longer required (Golder, 2011e).

Following the restoration activities, mine closure will result in the end of the discharge of treated domestic and mine effluents. The restoration will therefore have a positive effect on sediment quality due to the cessation of sediment input from treated domestic and mine effluents. In addition, site revegetation will decrease the quantity of impervious area on the site and will therefore have a positive effect on the sediment transport dynamic as well as on water quality by restoring their initial characteristics as they were before the Renard mine construction activities began.

- *Site Rehabilitation and Revegetation*

Site rehabilitation and revegetation activities are likely to increase quantities of total suspended solids and organic matter present in runoff, which could settle in Lake Lagopede.

Ultimately, the rehabilitation activities will contribute to restore the sediment transport dynamic to conditions observed before the Renard Project through the elimination of several sources of contaminants. In addition, the site revegetation will enhance water infiltration into the soil and will decrease the quantity of impervious surfaces on the site.

- *Traffic and the Use and Maintenance of Machinery*

During closure, the use and maintenance of machinery will include certain risks of accidental spills or leaks of hydrocarbons which could contaminate sediments if not confined. However, the probability that leaks will occur is lower than during the operation phase given the greatly limited fleet of vehicles. The mitigation measures planned for the operation will also be applied for closure.

6.9.4.2 Mitigation Measures

During the closure phase, several mitigation measures planned for the protection of water quality are focused on preventing the risk of increased sediment transport and contamination of the hydrological network with hydrocarbons (see Section 6.8.4). With the implementation of these protection measures, any modification of sediment grain size and quality will be prevented. The risk of sediment

contamination will also be reduced by maintaining the mitigation measures put in place for mine and domestic wastewater management, storage and management of hazardous solid waste materials, and airstrip operation throughout the closure phase until these sites are restored.

The mitigation measures planned for water quality during the closure phase will also apply for impacts on sediment quality related to the following project components:

- Water management;
- Site rehabilitation and revegetation;
- Traffic and the use and maintenance of machinery.

6.9.4.3 Residual Impacts

During the closure phase, with the implementation of all of the mitigation measures, the impacts of the project on sediment quality can be considered as globally positive with a low intensity. The impacts will be local, within the Renard Project study area, and with a long duration. The significance of impacts on sediment quality is therefore considered moderate.

6.10 Summary of the Environmental Analysis of the Physical Environment

The Renard Project was designed so as to prevent and limit potential negative impacts on the environment. However, due to the magnitude of the project, it will generate certain residual impacts requiring follow-up and the implementation of specific mitigation and management measures, despite all of the precautions taken. Figure 6.10.1 presents a summary of the Renard Project's residual impacts, which could persist after the implementation of the project's planned mitigation measures. Chapter 11 presents the environmental management plan that specifies the environmental measures planned to appropriately manage these residual impacts, including a follow-up and monitoring program.

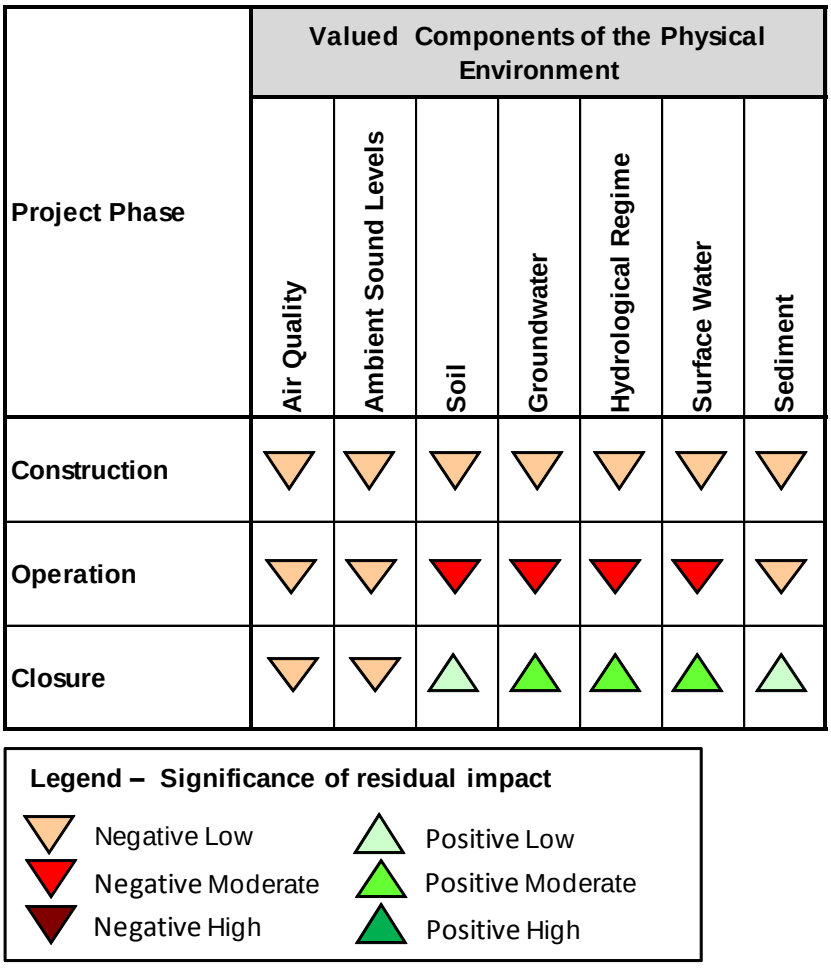


Figure 6.10.1 Summary of Residual Impacts on the Physical Environment by Project Phase

6.10.1 Construction Phase

Given the activities that are specifically associated with residual negative impacts on valued environmental components, impacts on these components of the physical environment are considered low during the construction phase because the activities will be of a short duration and will only have a site specific extent. The impacts will mainly occur during site preparation and development activities, including surface clearing and stripping, drilling, blasting, cut and fill activities, and drainage to develop the platform to install mine facilities, and the development of stockpile and confinement areas and mine roads on site. The main residual impacts are related to the following:

- Soil erosion and sediment transport to the hydrological network, may lead to a temporary and limited decrease in water quality. These changes should not significantly modify sediment quality if they are only limited modifications to sediment grain size in the northern portion of Lake Lagopede;
- Limited modifications of the hydrological and hydrogeological regime in certain small subwatersheds related to modifications of the topography and the nature of surface materials

and the dewatering of two small lakes. These changes will lead to an increase in runoff to Lake Lagopede. The area of the Renard Project mine footprint (226 ha, all phases included) represents only 1.4% of the area of the Lake Lagopede watershed (15,681 ha);

- Risk of accidental spillage or leakage of contaminants associated with traffic or the use of machinery or power generating sets that could potentially modify local soil, surface water, and groundwater quality. The risk of accidental spillage or leakage refers specifically to accidental spillage or leakage of gas or diesel from vehicles, machinery, power generating sets, refuelling areas, the fuel depot, and hazardous materials (paint, solvents, oils, etc.) and hazardous materials solid waste material storage areas. However, the mitigation measures that will be put in place will reduce to a minimum the probability that such events will occur and their extent and consequences should they occur;
- Nuisances, such as noise and dust that will mainly be confined to the construction site. If necessary, these nuisances will be controlled through the use of dust control and noise abatment measures to meet health and safety standards and respect the well being of the workers.

6.10.2 Operation Phase

Although the footprint of the Renard Project will generally be compact, the mine infrastructures developed will have various impacts on the physical environment. During the operation phase, the significance of the expected negative residual impacts varies from low to moderate based on the valued environmental components.

Concerning soil, groundwater, surface water quality, and the hydrological regime, the significance of the residual negative impacts of the project is considered moderate given the extent of the developed areas and water management on site. The areas developed for pit mining and borrow pits are relatively small and represent about 28.6 ha.

The development of these areas will modify the local topography and the degree of water infiltration into the soil. The dewatering activities for pit development will cause drawdown of groundwater levels, mainly near the pits. These modifications will lead to site specific impacts on the hydrological regime of certain small subwatersheds and could also lead to site specific drawdown of the water table. In addition, certain contaminants from mine activities could infiltrate the soil or be transported by surface water and groundwater. Water management on site, in particular surface water (runoff) and groundwater from pit dewatering, will therefore have a significant influence on the site hydrological and hydrogeological regimes that may not be totally mitigated.

Although of moderate significance, residual impacts on water quality will largely be mitigated by the implementation of an integrated water management plan that includes several measures for controlling erosion and sediment transport at source, such as runoff water catchment and treatment and quality control for water that will eventually be released into Lake Lagopede. The results of static and kinetic laboratory tests on all materials that will be excavated allowed for the establishment of the absence of acid mine drainage potential in addition to confirming that the contaminants present in the leachate water do not constitute a risk for aquatic life. Concerns related to water treatment are mainly in regards to total suspended solids and nutrient control, and the domestic and mine wastewater treatment stations

were specifically designed to address these concerns. Treated domestic effluent flows will be at their highest during the construction phase, and the plume dispersion model indicates that the 1:100 dilution limit will be reached at 52 m downstream of the outflall for average flow, while it may reach up to 130 m downstream of the discharge point for peak hourly flows. The results of treated mine effluent plume modeling (Appendix 3.10.1) indicate that in severe low flow conditions, initial concentrations of treated effluent will reach a dilution of 1:10 at a distance of 750 m from the discharge point, and 300 m during fall water mixing. Depending on the proportion of total phosphorous that is bioavailable in the form of orthophosphates, this inflow could possibly contribute to a limited, temporary increase in the productivity and fisheries potential of this area of Lake Lagopede. Given the hydraulic residence time in Lake Lagopede of about 50 days and the low temperatures that generally occur in September, the effects will be of short duration and possibly completely limited to the month of August. The mine and domestic effluent plumes will not overlap (Environnement Illimité, 2011). Within the plumes, limited change in water quality will be noted, but at the boundaries of the plumes, water quality will be comparable to that of the lake.

Concerning the potential negative impacts of the operation phase that are considered low, several of these impacts are similar to those identified for the construction phase. They are nuisances such as noise and dust generated at a lower intensity due to the operation of the R-65 quarry, open pits R-2 and R-3, and the processed kimberlite confinement area. Limited modifications to sediment quality in terms of grain size could also be observed, as some fine dust may settle in the water during excavation and blasting activities or as a result of wind erosion, but in very low quantities. Typically, these residual impacts will be limited with a sites specific extant. These impacts will therefore be similarly managed with appropriate mitigation measures.

6.10.3 Closure Phase

Residual impacts during the site's closure phase are globally considered positive with moderate to low significance.

Infrastructure dismantling activities and restoration and revegetation of the site will allow for the restoration and stabilization of soil, the re-establishment of topography environment, the restoration of plant cover, and of an hydrological network that blend with the surrounding environment. These measures will also allow for the re-establishment of water infiltration and runoff conditions in the soil and that will favour a return to baseline hydrological and hydrogeological conditions. Few changes are expected concerning sediment quality during this phase, given the mitigation measures implemented during the operation phase, which will be maintained until they are no longer necessary.

The termination of mining activities and the restoration of soil and plant cover will also contribute to the improvement of surface water and groundwater quality. Traffic and the use of machinery and motorized equipment may lead to accidental contaminant spillage or leakage. However, given the reduced fleet of vehicles and the low traffic volume as compared to the other phases, these risks are limited and will be

managed in the same way as for the previous phases. Noise and dust generated by infrastructure dismantling and revegetation activities will be of low intensity and short duration and site specific in extent. Some construction debris will be disposed of in the trench landfill site or transported off site for disposal at a site authorized by the MDDEP.

Chapter 7

Current Conditions and Project Impacts on the Biological Environment

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7 Current Conditions and Project Impacts on the Biological Environment

7.1 Regional Ecological Context

In order to fully understand in which type of environment the Renard Project is taking place, and the way it has evolved into its current state, this section looks at the regional ecological context.

- *EVOLUTION OF PLANT COMMUNITIES SUBSEQUENTLY TO THE GLACIAL PERIOD*

Forest stands distribution has evolved in recent millennia in close relation with elements such as the glacial retreat, climate changes and the forest fires cycles. Newly ice-free and gradually colonized by vegetation, central Nord-du-Québec region was, already ca. 6800 years BP (6000 (14C) years BP), occupied by a shrub taiga denser than today's (Richard, 1995). This more diversified early taiga was dominated by black spruce, balsam fir, tamarack and green alder while the ground cover was occupied mainly by shrubs, unlike the currently prevailing lichen cover.

Back then, the area was under a slightly milder, damper climate, which would have promoted the proliferation of fir trees and bushes. The more frequent fire cycles that have prevailed for several thousands of years favoured the current occurrence of black spruce (jack pine in dryer habitats) and the dominance of a lichen floor (Richard, 1995). Fire frequency in the Foxtrot Property area is a fundamental element in the forest regeneration cycle.

- *TERRESTRIAL ENVIRONMENT*

The distribution of living organisms on the territory generally depends on numerous physical and biological parameters. In Quebec, the climatic factor has the greatest influence on species distribution ranges. On the whole, a decrease in species richness can be observed moving northward. Cold, harsh climate conditions significantly affect vegetation presence and composition. The nature of the soil, landscape and disturbances (e.g. forest fires, epidemics, logging) also affect vegetation distribution.

The vast James Bay territory is divided into four distinct bioclimatic domains, which, from south to north, are: the balsam fir-white birch domain, the spruce-moss domain, the spruce-lichen domain and the forest tundra domain (CRRNTBJ, 2010a). The Renard Project study area is located within the spruce-lichen domain, which covers the entire tundra subzone stretching from the 52nd to the 55th parallel. It differs from the Spruce-moss domain, located south of the 52nd parallel, in its sparse forest cover. Black spruce, which reproduces vegetatively due to the harsh climate and low precipitations scatters the lichen floor, while jack pine and balsam fir are in the northern limit of their range (MRNF, 2003-2011).

The Renard Project study area's plant community consists of forests largely dominated by young black spruce-lichen (52 % of the study area), old black spruce-lichen (10 %) and old black spruce-moss (9%)

stands. Old black spruce-sphagnum stands and old jack pine-lichen stands represent 3% and 2% of the study area, respectively. Other forest stands each account for less than 1% of the plant communities.

- *WETLANDS*

Wetlands are important ecosystems' components, providing transition zones between land and aquatic environments, and where biological productivity and diversity are particularly high (CRRNTBJ, 2010). Wetlands cover over 65% of the land surface around James Bay, gradually becoming sparser as we move south, east and north. In the northeast area of the James Bay territory which includes the Renard Project, wetlands cover less than 5% of the land surface. Wetlands presence in the Renard Project study area account for no more than 2% of the total surface are represented by small open or forested peatlands, bogs, riparian fens, swamps and patterned fens which cover a few hectares at most.

- *AQUATIC ENVIRONMENT*

The last ice age profoundly marked the James Bay territory's hydrological network, creating multiple lakes and rivers of diverse sizes (CRRNTBJ, 2010b) that constitute abundant aquatic life habitats. The Renard Project study area is located in the Misask River watershed, one of the upper Eastmain River's many tributaries. This hydrographical network includes lakes of various sizes, ponds, pools, springs and streams, which cover approximately 18% of the Renard Project study area. Water in the study area's lakes and streams is generally acidic, well-oxygenated, nutrient-poor and has low turbidity and mineral content (Roche, 2010, EBS).

A total of 36 freshwater fish species coming from 11 Families are found in the James Bay watershed. The area's most popular sport fish species are brook trout, lake trout, walleye and northern pike (CRRNTBJ, 2010b). The presence of 14 fish species has been confirmed within the Renard Project study area. Amongst them, 5 species are of interest for sport fishing: northern pike, lake whitefish, brook trout, lake trout and burbot. White sucker, pearl dace and brook trout are the study area's most abundant species.

- *ANIMAL COMMUNITIES*

Wildlife communities' distribution on a given territory varies with available habitats and climate, among others. The wildlife species found in the Renard Project study area are above all, those associated with spruce-lichen, spruce-moss and spruce-sphagnum stands, and those able to tolerate harsh climate conditions.

The large mammals mainly found in the James Bay territory are caribou, moose and black bear. Caribou hunting dominates the area's big game sports hunting activities (CRRNTBJ, 2010a). Woodland caribou (Rangifer tarandus caribou), forest-dwelling and tundra ecotypes, are found here. The forest-dwelling caribou is designated "threatened" in Canada (Thomas and Gray, 2002) and "vulnerable" in Quebec (*Act respecting threatened or vulnerable species*, R.S.Q., c. E-12.01). The Renard Project

study area is located in the middle of M11 trapline, which covers the entire Foxtrot Property. The Cree practice subsistence hunting in this area, hunting especially Moose and waterfowl.

Close to 25 fur-bearing animal species are reported for the James Bay territory. Amongst, a dozen are commonly trapped by the Cree on M11 trapline, the most frequent trapped species are: American marten, beaver, American mink and muskrat. Trapping is a traditional activity widely practiced by the Native people.

A total of 238 bird species have been identified in the James Bay territory (CRRNTBJ, 2010a), including forest birds, waterfowl, shorebirds, raptors and seabirds present in summer, in winter or exclusively during migration. Therefore, many of these birds are not likely to be observed in the Renard Project study area. This is especially the case for many seabirds, whose distribution range does not reach the taiga, and for species frequenting large peatlands. A study covering more than 47,000 km² of taiga and forest tundra identified 64 bird species, excluding raptors and waterbirds (Consortium Gauthier & Guillemette - G.R.E.B.E., 1991). In 2010, 30 species of forest birds (songbirds, woodpeckers and Tetraonidae) were observed in the Renard Project study area in addition to 10 species of waterfowl and waterbirds along with 3 raptor species. The species of interest to Native people that were observed during surveys are: spruce grouse, American black duck, common merganser, common loon and Canada goose (in flight). Indicators pointing to the presence of willow ptarmigan (browsing) were also observed.

7.2 Benthos

7.2.1 Current Conditions

Benthic organisms live at the bottom of streams and rivers and are good indicators of aquatic ecosystem health (“bioindicator”) because they are highly sensitive to environmental conditions (water/sediment quality, substrate type).

The goal of the benthos characterization was to determine the composition, richness and relative abundance of the macrobenthic communities (size > 0.5 mm) found in the study area’s aquatic environments. This characterization provides an overall picture of the study area’s baseline conditions for streams and water bodies, and will be used to assess the impacts of the project through the monitoring and surveillance program.

For the Environmental Baseline Study (EBS), a macrobenthos sampling campaign was conducted on September 8-9, 2010 (Roche, 2011). The benthos sampling plan and methods used were based on the recommendations of the G*uide de surveillance biologique basée sur les macroinvertébrés benthiques d’eau douce du Québec* (Moisan and Pelletier, 2008) and *Metal mining guidance documents for aquatic environmental effects monitoring* (Environment Canada, 2002).

The “control–impact” sampling plan type used to study the benthos included sampling streams and water bodies in the two zones located close to the Renard Project mine facilities (“exposed areas”) and in a control zone located in Lake Lagopede’s northern bay, in a sector unlikely to be affected by the project. The EBS (Roche, 2011) contains details on the sampling plan and methods.

Alongside benthos sampling, water and sediment samples were collected at the same stations. Finally, a habitat description of sampling stations completed the benthos sampling and included substrate characterization and water physico-chemical measurements (e.g. temperature, pH, turbidity, etc.).

Data were processed using the environmental descriptors recommended in *Metal mining guidance documents for aquatic environmental effects monitoring* (Environment Canada, 2002): taxum presence/absence, richness, density, relative abundance, Simpson’s diversity index and Bray-Curtis index. In addition, the dominant taxa’s ecological characteristics were documented in the EBS (Roche, 2011).

The following section gives a brief overview of the regional conditions governing the benthic invertebrates and provides a short description of the aquatic habitats available to benthic communities. The macrobenthic communities and their habitats on the planned mine camp site are described using the environmental indicators selected. Finally, the importance of the benthos and main project-related issues for these communities are presented.

7.2.1.1 Regional Environmental Context

Lakes and streams ubiquitous in the James Bay territory, which includes six of Quebec’s largest rivers (La Grande, Nottaway, Rupert, Eastmain, Harricana and Broadback) and countless lakes, including Quebec’s largest natural lake, Lake Mistassini (CRRNTBJ, 2010b). Consequently, benthic organisms can use an extensive network of aquatic habitats (both lacustrine and fluvial). Benthic distribution in these habitats depends primarily on the characteristics of the lake or stream bed’s substrate, water flow (lotic and lentic environments) and the physico-chemical properties of the waters.

The region’s surface waters are generally of good quality. Based on regional studies, notably for major hydroelectric projects (e.g. La Grande, Schetagne *et al.*, 2005; Rupert, JBEC, 2004; Opinaca, Roche, 2007) and mining projects (e.g. Matoush Project, Strateco Resources, 2009), we can say that the waters characteristics are relatively homogenous: clear, well-oxygenated waters that are nutrient-poor with an acid-to-neutral pH level.

Surface water quality and aquatic environment substrate type are closely linked to surficial deposits in the watersheds. The major physiographical units give a good idea of the wide range of surface materials found throughout the James Bay territory: clayey coastal plain in the west, central-northern till zone (surficial deposit gradient from fine to coarser moving eastward) and rocky hills in the east (rock outcrops and minimally erodible surficial deposits) (CRRNTBJ, 2010b).

Habitats available for benthos in the James Bay territory are numerous and relatively diverse, notably in terms of substrate type and water flow. Benthos richness and abundance can potentially be modified by disturbances in the watershed or stream, which, in turn, modify the hydrological regime, sediment transport, surface water quality, substrate grain size and quality (e.g. sediment and organic matter input).

Few recent studies have described the benthic communities in streams and waterbodies of the region. The lake characterization carried out for the Matoush Project's impact assessment, located 96 km south of the Renard Project, revealed low densities (30 to 3,941 organisms/m^2) of lacustrine benthic communities dominated by Chironomidae (Diptera, relative abundance of 80% to 94%) and Naididae or Tubificidae (segmented worms, relative abundance of 1% to 10%) (Strateco Resources, 2009). Benthic invertebrate density is also relatively low (4,815 individuals/m^2) in the Opinaca reservoir, located in the Eastmain River watershed (Roche, 2007). In the impact assessment for the Lake Bloom mine project near Fermont (about 350 km east of the Renard Project), benthic community densities were quite low (1,739 to 3,000 organisms/m^2) and dominated by Chironomidae (Diptera, 35%), Sphaeriidae (bivalves, 26%) and Macrothricidae (brachiopods, 14%) (Genivar, 2006). In the James Bay territory, the large groups of benthic organisms generally found in streams and rivers are mayflies, caddisflies, stone-flies, certain Diptera (black flies) and bivalves, while lakes are usually inhabited by certain Diptera (midges and biting midges), Oligochaeta, amphipods and certain bivalves (Sphaeriidae) (Magnin, 1977).

7.2.1.2 Mine Area

- *MAIN HABITATS AND NATURAL VARIABILITY OF INDICATORS*

The Renard Project study area is characterized by the presence of small, streams with low flow conditions and shallow lakes. Riparian vegetation consists mainly of heath, sphagnum, alder and black spruce. Overall, surface water quality is homogenous among benthos sampling stations and for all aquatic environments sampled in the study area. The surface waters are generally clear, well-oxygenated, nutrient-poor and pollution-free, and have an acid-to-neutral pH (Roche, 2011). The characteristics of the study area's surface waters are thus similar to those of the other aquatic environments characterized in the region.

Substrate type (grain size) and organic matter content of bottom sediment are important parameters of aquatic environments since they generally influence benthic community composition, richness and abundance. In the study area, lakes are characterized by a substrate made up of silt, organic matter, sand and large boulders, while streams are generally characterized by a channel type facies with a sandy, silty substrate or alternating riffles and pools with a substrate of pebbles and boulders.

For fine-grained substrates, sand is the most common grain size class (60 to 94%) in all sites sampled for benthos, except in Lake Lagopede's northeastern bay, where silt-clay predominates (56%). Total organic carbon and organic matter content are generally higher in zones located near the project area

than in the control zone. The sites rich in organic matter are often associated with lower oxygen concentrations near the lake or stream bed. In the six areas sampled for benthos, sediment are relatively poor in total organic carbon (mean about 20,000 mg/kg) and organic matter (mean of 1.8%) compared to the rest of the study area (mean about 78,000 mg/kg and 20.5%, respectively). Overall, organic matter concentrations are higher in sediment containing large proportions of fine particles, more specifically, clay.

Surface water quality and substrate type in aquatic environments vary with sub-watershed surficial deposits, topography, presence of wetlands and seasonal hydrodynamics. The latter is dominated by high spring flooding (increased sediment transport and water acidification due to the input of snowmelt waters) and more or less pronounced summer low flows (Roche, 2011).

Among the water quality parameters measured at the benthos sampling stations, only the pH was outside the Canadian and Quebec water quality criteria pH range. These pH values (which vary from 5.6 to 6.1) are outside the Canadian pH criterion (CCME, 2007) and the provincial criterion for the protection of aquatic life, chronic effects (MDDEP, 2009), which is 6.5 to 9. These low pH values reflect the proximity of peatlands, which generate acidic water, and the low buffering capacity of surface water in this region of Quebec.

- *BENTHIC COMMUNITIES*

The environmental indicators used to characterize benthic communities include: taxum presence/absence, richness, density, relative abundance, Simpson's diversity index and Bray-Curtis index.

The benthic communities for all of the sites sampled (lakes and streams) are essentially dominated by insect larvae (Diptera, Trichoptera and Ephemeroptera), mollusks (Sphaeriidae) and segmented worms (Oligochaeta). Oligochaeta and certain families of Diptera (midges), characteristic of soft beds (WAV, 2007), as well as certain species of Sphaeriidae, are known to tolerate pollution and low dissolved oxygen concentrations (Moisan, 2006). The study area's other dominant taxa, i.e. Trichoptera and Ephemeroptera, are rather sensitive to low dissolved oxygen concentrations (Moisan, 2006) and are characteristic of lotic environments (WAV, 2007). Generally speaking, Ephemeroptera, Trichoptera and Plecoptera are considered the most sensitive to pollution and disturbances and are, therefore, used as bioindicators to calculate the ETP index (Moisan and Pelletier, 2008).

As is typically the case in the James Bay territory (Magnin, 1977), the Renard Project Environmental Baseline Study shows that streams in the study area show higher benthic community richness (35 taxa on average) than lakes (26 taxa on average) (Roche, 2011). The structure of benthic communities in streams and lakes also differs in the study area: streams are characterized by a predominance of several families of insects, mollusks and annelids (Oligochaeta), while lakes are rather dominated by Diptera, crustaceans (zooplankton) and mollusks (Table 7.2.1, Figure 7.2.1).

Table 7.2.1 Relative Abundance (%) of Benthic Invertebrate Taxa Identified in the Study Area (September 2010)

Classification level	Taxum	Stream (%)	Lake (%)
Phylum	Porifera (Spongillidae (colony))	0.1	1.6
Phylum	Nematoda	0.8	2.4
Phylum	Mollusca	22.0	12.0
Class	*Bivalva (Sphaeriidae)*	***22.0***	***12.0***
Phylum	Annelida	11.5	8.1
Sub-Class	*Oligochaeta (Tubificidae, Naididae, Lumbriculidae, etc.)*	***11.3***	*6.9*
Sub-Class	*Hirudinea (Erpobdellidae and Glossiphoniidae)*	*0.2*	*1.2*
Phylum	Arthropoda	65.2	75.8
Class	*Arachnida (Acarina: Hygrobatidae, Torrenticolidae, etc.)*	*3.6*	*3.0*
Sub-Phylum	*Crustacea*	*0.8*	*12.2*
Class	*Branchiopoda (Chydoridae, Sididae, etc.)*	*0.4*	***11.3***
Class	*Maxillopoda (Copepoda)*	*0.3*	*0.3*
Class	*Ostracoda*	*0.0*	*0.1*
Class	*Malacostraca (Amphipoda)*	*0.0*	*0.5*
Sub-Phylum	*Hexapoda*	–	–
Class	*Insecta*	*60.8*	*60.7*
Order	*Odonata (Corduliidae, Gomphidae, etc.)*	*0.3*	*0.1*
Order	*Ephemeroptera (Ephemerellidae, Leptophlebeiidae, etc.)*	***10.2***	*6.3*
Order	*Plecoptera (Leuctridae, Taeniopterygidae, etc.)*	*6.8*	*0.8*
Order	*Megaloptera (Sialidae)*	*0.0*	*0.2*
Order	*Trichoptera (Hydroptilidae, Leptoceridae, Limnephilidae, etc.)*	***16.9***	*3.6*
Order	*Coleoptera (Elmidae)*	*5.7*	*0.3*
Order	*Diptera (Chironomidae, Ceratopogonidae, etc.)*	***20.9***	***49.4***
Other	Other (Plathelminthes, Ectoprocta, Caudata and Cyprinidae)	0.4	0.1
	Total	**100**	**100**

Note: Bolded values correspond to a relative abundance of *>0.5%.*

Diptera are also dominant (relative abundance of 80% to 94%) in lakes sampled for the Matoush Project (Strateco Resources, 2009) and in Lake Bloom near Fermont (Genivar, 2006).

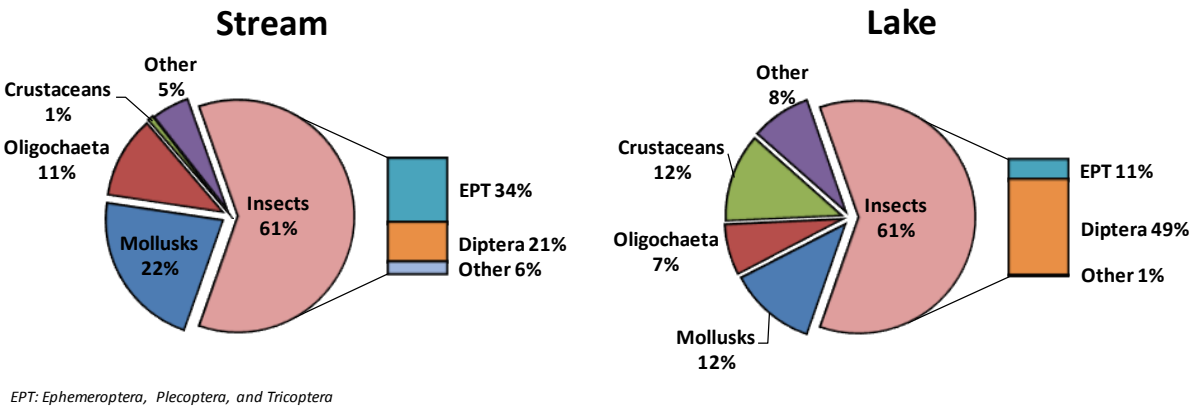


Figure 7.2.1 Benthic Community Structure of Streams and Lakes in the Study Area

For the other environmental indicators, analyses show that benthic communities vary significantly within and among lacustrine and fluvial environments. In streams, the richness, diversity and structure of invertebrate benthic communities differ significantly from one zone to another. Although the density of organisms varies considerably, it does not differ significantly between zones. Lacustrine benthic communities differ significantly among Lake Lagopede's eastern, northeastern and northern bays in terms of taxum richness, community structure and density.

Comparatively speaking, the richness of lake benthic communities in the study area is similar to that of the Opinaca reservoir, located in the Eastmain River watershed (Roche, 2007), and the Lake Bloom Project, located near Fermont (Genivar, 2006). An average of 10 taxa per station were found in Lake Lagopede compared to 13 taxa per station at the Opinaca reservoir and 12 taxa per station in the lakes of the Lake Bloom Project. The average number of taxa per sampling zone is also similar for Lake Lagopede (26 taxa) and the Opinaca reservoir (22 taxa).

The mean density of benthic invertebrates is comparable but slightly higher in Lake Lagopede (6,678 individuals/m^2) than in the Opinaca reservoir (4,815 individuals/m^2), and higher than in the more southern lakes sampled for the Matoush Project (30 to 3,941 organisms/m^2) (Strateco Resources, 2009) and near Fermont (1,739 to 3,000 organisms/m^2) (Genivar, 2006).

In short, the study area's benthic communities show significant differences in species richness, diversity, density and composition by zone, in lakes and streams. The density of macrobenthic organisms also varies greatly between each zone. This high intrinsic variability of benthos' biological characteristics is not unique to the study area and partly reflects the diversity of substrate and flow pattern (lacustrine vs. fluvial environment).

➢ *BENTHOS VALUE*

Benthos plays an important role in the aquatic food chain, notably in recycling organic matter, and constitutes the main food source for many fish and wildlife species (waterfowl, herpetofauna, etc.). Although it is not used directly by the region's inhabitants, benthos invariably helps maintain wildlife communities that are particularly important for the Crees and Jamesians, such as fish and waterfowl.

Benthic organisms integrate short-term (up to a few years) cumulative and synergic effects related to the various physical, biological and chemical disturbances in streams (Moisan and Pelletier, 2008). Consequently, they are good indicators of aquatic ecosystem health.

➢ *MAIN ISSUES*

The main project-related issues where benthic communities are concerned include:

- Increased sediment transport toward the hydrographical network resulting from disturbances in the terrestrial environment, that can potentially modify water quality (increased turbidity and concentration of suspended solids) and lake and stream substrate grain size and quality due to particulate matter sedimentation (e.g. clay and sand);
- Silting of gravel or rocky substrate by eroded particulate matter associated with soil disturbance and entering the hydrographical network;
- Decreased dissolved oxygen concentration near lake and stream beds associated with a higher organic matter load in the hydrographical network;
- Destruction of aquatic habitats due to the project's encroachment on the hydrographical network during construction.

7.2.1.3 Airstrip Area

Benthos sampling was not conducted in the airstrip area, which has only two small lakes that were characterized during fish surveys (see Section 4.3.2.6 of the EBS, Roche 2011). The airstrip alignment selected will not affect the lake located inside the alternative not chosen. Consequently, by controlling erosion at source, the substrate of the lake located about 500 m downstream from the airstrip should not be significantly modified. The surface water characteristics of this lake are similar to those of the stations sampled in the mine area. The same is true for the substrate, which consists of silt-clay and sand.

7.2.2 Construction Phase Impacts

During the construction phase, the main activities likely to affect the study area's benthic communities include:

- Development and preparation work (e.g. backfilling and excavation) on the sites (waste rock and ore stockpiles, processed kimberlite confinement area, and mine camp) and airstrip area;
- Dewatering of lakes and streams in the affected area (including diversion of stream F3298V, north of open pit R-65) and sediment and water management;
- Maintenance and operation of machinery and power generating sets;
- Fuel and hazardous material storage and management;
- Water management of effluent discharge by the domestic wastewater treatment plant.

7.2.2.1 Impact Description and Assessment

The main project-related issues for benthic communities include:

1. **Destruction of aquatic habitats** due to dewatering of two lakes and three ponds (total surface area of 3.72 ha) and streams over a distance of 1,019 m (surface area of 0.63 ha);

2. **Modification of aquatic habitat quality** reflected by:
   a. A temporary increase, mainly during heavy rains, in sediment transport and organic matter input caused by soil disturbance during the work and discharge of dewatering waters of lakes and streams in the affected area;
   b. Organic matter and nutrient input into Lake Lagopede linked to the discharge of treated domestic wastewater;
   c. A decrease in dissolved oxygen concentrations near lake and stream beds caused by an increase of the organic matter load (see points a and b);
   d. Potential water contamination by petroleum products linked to the use and maintenance of machinery and power generating sets.

3. **Development of a stream with surface flow** resulting from the diversion of tributary F3298V, which has a positive impact on benthic communities.

- *LAKE AND STREAM DEWATERING AND SEDIMENT AND WATER MANAGEMENT*

Destruction of aquatic habitats

Dewatering of wetlands and streams located in the project's footprint and of streams located in the subwatersheds of lakes F3302 and F3303 will inevitably destroy aquatic habitats used by benthos.[1] Table 7.2.2 shows the benthic habitats affected and also the proportion of these habitats considered as fish habitats. Wetlands also constitute potential benthic habitats and the total area destroyed covers 6.1 ha (Map 7.2.1). These impacted areas represent only 0.4% of the area occupied by the study area's hydrographical network (1,624 ha).

The waters from dewatering these aquatic environments will be treated by mobile treatment units before being released into Lake Lagopede. This new inflow of water will have a negligible impact on Lake Lagopede's hydrology since it represents only 0.028% of the lake's mean natural water inflow (4.6 m^3/s). Since the water pumped from the lakes and/or diverted from the streams will be treated to meet MDDEP effluent discharge objectives, the quality of the water discharged into Lake Lagopede should not affect its benthic communities.

[1] Aquatic habitats for benthos include all streams and water bodies but exclude streams flowing underground resulting from water percolating into the ground, also called thalwegs.

Table 7.2.2 Summary of Benthic Habitats affected by the Project

Name of stream or water body	Location	Surface area affected			Length affected		
		Total (ha)	Fish habitat		Total (m)	Fish habitat	
			(ha)	Percentage of total surface area affected (%)		(m)	Percentage of total surface area affected
Lake F3302	Open pits R-2 and R-3	2.5	2.5	100	n/a	n/a	n/a
Lake F3303	Open pit R-65	1.2	1.2	100	n/a	n/a	n/a
Pond	Open pit R-65	0.02	0.02	100	n/a	n/a	n/a
	Total	**3.72**	**3.72**	**100**	-	-	-
Wetlands	Open pit R-3 and overburden stockpile	6.1	0	0	n/a	n/a	n/a
	Total	**6.1**	**0**	**0**	-	-	-
Tributary F3298V	North of open pit R-65	0.28	0.28	100	256.3	256.3	100
Tributary F3303V	Open pit R-65	0.09	0.09	100	133.8	0	0
Tributary F3302V	Open pits R-2 and R-3	0.26	0.26	100	290	100	34
North tributary F3301V	PKC area	dna	dna	dna	147	147	100
Tributary F2607M	PKC area	dna	dna	dna	192	0	0
	Total	0.63	0.63	100	1019.1	503.3	**49**
	Grand total	**10.5**	**4.35**	**42**	**1019.1**	**503.3**	**49**

n/a: not applicable
dna: data not available
PKC area: processed kimberlite confinement area

It is very likely that the benthic invertebrate communities of the lakes to be dewatered are similar to the communities of Lake Lagopede, which is dominated by Diptera, crustaceans (zooplankton) and mollusks (Roche, 2011). The substrate of the deep-water zones of lakes F3302 and F3303[2] is the same as the zones of Lake Lagopede sampled for benthos during the EBS. Therefore, its richness in benthic invertebrate species should also be similar, albeit lower than in streams.

About half the total length of the streams to be dewatered and diverted for the project is characterized by substrate dominated by fine particles (sand, clay) and organic matter, while the flow facies is slow-to-moderate. The other half is dominated by rock outcrops, coarse materials (pebbles, cobbles, boulders) and high flows. The streams affected by the project are similar to those found elsewhere in the study area, with variable substrate types and flow facies. The affected area's benthic communities are, therefore, likely to be comparable to those located downstream of the project, i.e. of varying richness, diversity and composition (Roche, 2011).

- *SITE PREPARATION AND DEVELOPMENT*

Modification of aquatic habitat quality

Any construction work involving soil disturbance is likely to cause erosion and increased sediment transport into the hydrographical network downstream the work area. Site preparation and development work will cover an area of 201 ha in the mine area, which represents 2.5% of the Lake Lagopede watershed. If erosion of exposed soil is not controlled at source, sediment inputs of terrigenous origin may generate a site specific, temporary increase in water turbidity and total suspended solid (TSS) concentration in Lake Lagopede, lake F3300, lake F2607 and its tributary (F2607V).

Unless it is controlled, this sediment transport will probably also modify the bottom substrate composition and contribute to silting gravelly or rocky substrates through particulate matter sedimentation. Benthic organisms are likely to be affected, thereby changing the benthic communities' structure and richness. For example, the number of certain taxa, i.e. Ephemeroptera, Trichoptera and Plecoptera, may decline in favour of taxa that are less sensitive to sedimentation, i.e. Diptera. This change in benthic community structure may, ultimately, result in a change in fish food sources and fish habitat use in the affected stream segments.

Depending on the nature of the soil disturbed during the work and their organic matter content, some of the organic matter could also be carried into the aquatic environment, thereby reducing the dissolved oxygen concentration near the bottom of lakes and streams if the amounts are substantial.

[2] Lake F3303's littoral substrate is dominated primarily by boulders, gravel and sand, while the pelagic zone's substrate consists mainly of silt-clay. Lake F3302's littoral substrate is composed primarily of sand, gravel and some boulders, while the pelagic zone's substrate consists mainly of silt-clay.

690 000 m.E

5 856 000 m.N

R-10
R-7
R-1
R-65
R-4
R-8
R-9
R-2
R-3

F3294
F3297
F3295
F3295M
F3297V
F3298
F3298V
F3296
F3296M
F3303
F3303V
F3302
F3302V
F2607M
F3301
F3301V
F2607
F2607V

Dérivation de cours d'eau /
Stream derivation

Étang
Étang
Baie Nord-Est
Lac Lagopède
Baie Sud

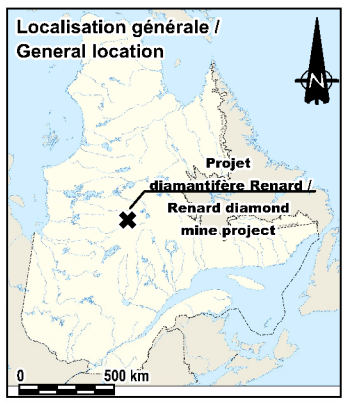
Tributaire Nord, F3301V
Tributaire Sud, F3301V

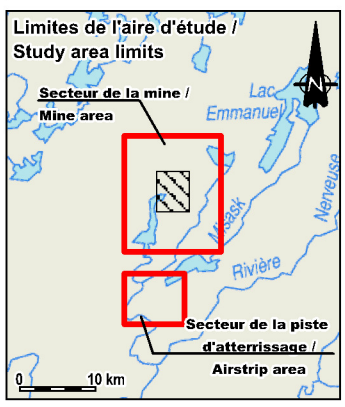
0 250 500 m

Échelle/Scale 1 : 10 000

UTM, zone 18 (NAD83)

Courbe de niveau (intervalle de 50 pieds) /
Contour line (50 feet interval)





R-x Identification du gisement / Deposit identification

R-x Autres ressources minérales / Other mineral resources

Emprise du projet / Project footprint (26/10/2011)

Fosse d'extraction à ciel ouvert / Open pit

F3293 Numéro d'identifiant de lac CEHQ / CEHQ lake ID number

Cours d'eau permanent / Permanent stream

Cours d'eau intermittent à écoulement de surface et souterrain / Intermittent stream with surface and underground flow

Écoulement souterrain / Underground flow

Thalweg

Milieu humide / Wetland (tel qu'identifié par Roche 2011)

Végétation aquatique / Aquatic vegetation

Habitat du poisson / Fish habitat

Non considéré comme habitat du poisson mais considéré comme habitat pour le benthos / Not considered as fish habitat but considered as habitat for benthos

Habitats aquatiques impactés pour le benthos /Benthic aquatic habitats impacted

Cours d'eau impacté

Milieu humide impacté / Impacted wetland

Lac et étang impacté / Impacted lake and pond

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Habitats aquatiques pour le benthos impactés par le projet /

Benthic aquatic habitats impacted by the project

ROCHE

Carte de base : Stornoway, 2010;
CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier : 61470_EIES_BenthosImpact_111221.WOR

Décembre 2011 / December 2011

Carte / Map 7.2.1

- *WORKSITE WATER MANAGEMENT*

Modification of aquatic habitat quality

Water and sediment quality at the treated domestic wastewaters discharge point into Lake Lagopede may also be modified by the treated effluent due mainly to the associated organic matter and nutrient load (nitrogen and phosphorus). Respecting the MDDEP effluent discharge objectives and surface water quality criteria for the protection of aquatic life (at the limit of the mixing zone) will limit this impact. Changes in the lake's water and sediment quality should be restricted to the plume's initial mixing zone. At peak flow (7.6 L/s), the mixing zone will extend over a maximum of 130 m and cover an estimated surface area of 12,873 m^2, which corresponds to 0.06% of Lake Lagopede's surface.

The potential, site specific changes in water quality (increased turbidity and TSS concentrations, possible reduction in dissolved oxygen concentration) related to water management, and also silting of stream and water body substrate downstream of the work area, notably Lake Lagopede, stream F2607V, lake F2607 and lake F3300 located in the southwestern portion of the study area, and lake F3398 (located in the study area's northwestern portion), could affect the structure, density and relative abundance of their benthic communities. This could especially affect taxa sensitive to low dissolved oxygen concentrations, in particular the Ephemera and Trichoptera identified in the streams of the study area (streams F3298V and F3294V), and favour benthic species with a greater tolerance for silting.

Development of a stream with surface flow

In the northeastern portion of the affected area, west of the processed kimberlite confinement area, the diversion of tributary F3298V into a small tributary of lake F3295 will change this underground thalweg into a stream with surface flow. The level of lake F3295 and the hydrology of its outlets will not be significantly affected.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; FUEL AND HAZARDOUS MATERIAL STORAGE AND MANAGEMENT*

The use and maintenance of machinery and temporary power generating sets along with the storage and management of hazardous materials and fuels constitute a potential risk of surface water contamination in the eventuality of accidental spills or leaks of petroleum products or other contaminants. This could affect the benthic invertebrates inhabiting nearby streams and lakes.

7.2.2.2 Mitigation Measures

- *SITE PREPARATION AND DEVELOPMENT*

During the construction phase, numerous mitigation measures will be implemented on the mine site and airstrip area to control erosion at source and limit sediment transport into the hydrographical network.

They include preserving a 30-m strip of riparian vegetation along streams and managing the work areas' runoff, which will be directed to vegetated areas at least 20 m from streams.

A system of drainage ditches will be implemented as soon as the construction phase begins to divert runoff from the mine camp and direct them to a sedimentation pond located near the camp. This pond will be used to capture and hold particulate matter before runoff are being released to Lake Lagopede.

- *DEWATERING OF LAKES AND STREAMS AND SEDIMENT AND WATER MANAGEMENT*

The waters resulting from dewatering lakes F3302 and F3303 and the pond will be treated by mobile treatment units to remove suspended solids before the waters are being released to Lake Lagopede.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; FUEL AND HAZARDOUS MATERIAL STORAGE AND MANAGEMENT*

To minimize the machinery's encroachment on streams, vehicle traffic will be restricted to access roads and work areas. Speed limits will be enforced to limit soil erosion and dust dispersion into the hydrographical network.

Other measures are also planned to prevent the risk of water contamination due to the use and maintenance of machinery and power generating sets. Machinery maintenance, cleaning and fuelling will occur more than 60 m from any water body and a recovery kit will be available in case of accidental leaks or spills.

Fuel and hazardous materials will be stored and managed so as to minimize the risk of leaks or spills. The mitigation measures linked to their storage and management to protect surface waters during the construction phase (Section 6.8.2) will also apply for benthos.

- *WORKSITE WATER MANAGEMENT*

All of the mitigation measures implemented to control erosion at source, limit sediment transport and minimize the deterioration of Lake Lagopede's water quality due to treated mine and domestic effluents are described in detail in Section 6.8.2, which discusses the project's impacts on surface water quality during the construction phase.

7.2.2.3 Residual Impact

During the construction phase, following the implementation of mitigation measures, sediment transport into the hydrographical network linked to site preparation and development and discharge of the waters pumped from lakes F3302 and F3303 will have a negligible impact on the benthic communities downstream of the work area. The sediment transport anticipated will occur mainly during storms and be of low intensity, as well as site specific. Since sediment in Lake Lagopede are primarily fine, there will probably be no perceptible change in the substrate.

The risk of contamination by petroleum products is also minimal due to the above-mentioned measures, which will ensure to contain and recover potential spills rapidly.

A macrobenthic community monitoring plan will be set up for the entire duration of the construction phase to ensure that Lake Lagopede's benthic communities maintain their integrity, notably downstream of the discharge point of the waters pumped from lakes F3302 and F3303 and of treated domestic wastewaters (see Section 11.4.8.1 *Benthos Monitoring Plan*).

Upstream of the affected area, the diversion of tributary F3298V will have a positive effect by developing a stream with surface flow that will create potential habitats for colonization by macrobenthos. This aspect is discussed further in the section on fish habitat compensation measures (Section 7.3.5).

In the airstrip area, once measures to control erosion and sediment transport have been implemented, no residual impact from the work is expected on the lake's benthic communities located approximately 500 m downstream of the airstrip.

The destruction of aquatic habitats in lakes and streams will have a high intensity impact on benthic communities that is long-lasting (permanent destruction) and site specific (restricted to the affected area). Overall, the significance of the impact on benthic communities during the construction phase is considered moderate.

7.2.3 Operation Phase Impacts

During the operation phase, the main sources of impact will be:

- Water management, which will include:
  - mine camp runoff, mine waters from open pits and the underground mine, runoff from the processed kimberlite confinement area, waste rock and overburden stockpiles;
  - treated mine effluent discharge;
  - treated domestic wastewater discharge.
- Use and maintenance of vehicles, machinery and power generating sets;
- Fuel and hazardous material storage and management.

These activities may affect benthic communities by **modifying the quality of aquatic habitats,** more specifically, through:

- Input of contaminants and particulate matter into Lake Lagopede.

7.2.3.1 Impact Description and Assessment

➢ *WATER MANAGEMENT*

Particulate matter and contaminant input

Mine camp runoff (open pits, mine waters, processed kimberlite confinement area, waste rock stockpile, overburden stockpile, etc.) could generate an increase in sediment and organic matter load in Lake Lagopede. However, these waters will be collected and directed to a main sedimentation pond located

in open pit R-65 before being treated by the mine wastewater treatment plant. Their quality will be controlled before they are discharged into Lake Lagopede.

Runoff and exfiltration waters[3] from the processed kimberlite confinement area, waste rock stockpile, overburden stockpile and ore stockpile could potentially contain certain metals that might be transported into lakes located downstream of these sites (lakes F3297, F3298 and F3295 and, ultimately, Lake Lagopede). However, the results of the kinetic leaching tests performed showed that the overburden, ore, waste rock, and processed kimberlite are geochemically inert, meaning they do not acid generator or leachable (Golder, 2011c). The drainage waters from these stockpiles will, nevertheless, be intercepted via a peripheral drainage ditch and then directed to the mine wastewater treatment plant before being released into Lake Lagopede. The characteristics of the mine effluent will meet the criteria of Guideline 019 and the *Metal Mining Effluent Regulations* (MMER). The impact of discharging treated mine effluent on the benthic communities in the study area will, therefore, be site specific and limited to the plume's initial mixing zone.

Nutrient and organic matter input

The treated domestic wastewaters discharged could cause a site specific increase in algal biological activity (periphyton and phytoplankton) near the discharge point in response to the increase in Lake Lagopede's nutrient load. Given that MDDEP effluent discharge objectives will be met, it is unlikely that these inputs will significantly change the lake waters' physico-chemical properties (pH, oxygen), elsewhere than the treated effluent dispersion plume. A local decrease in oxygen concentration near the lake's bottom at the discharge point is also possible due to the decomposition of the organic matter input by the effluent.

These water quality modifications could temporarily affect the benthic communities at the discharge point. The benthic organisms identified in Lake Lagopede sediment, that is, Oligochaeta and certain species of Diptera and mollusks, generally tolerate changes in water quality (see Section 7.2.1.2).

MDDEP domestic effluent discharge objectives and surface water quality criteria for the protection of aquatic life (at the limit of the mixing zone) will, however, be met. Consequently, changes in water quality should be restricted to the effluent mixing zone, which is estimated at 6,161 m^2. The impact of the treated domestic wastewater discharge on the benthic communities will be limited since it will be restricted to the effluent mixing zone, i.e. 38 m to 83 m from the outfall at medium flow (0.0012 m^3/s) and peak flow (0.0047 m^3/s), respectively. A monitoring program will also be set up to ensure that surface water quality criteria for the protection of aquatic life in Lake Lagopede are not exceeded.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; FUEL AND HAZARDOUS MATERIAL STORAGE AND MANAGEMENT*

[3] Exfiltration waters are waters leaking from a saturated soil surface due to the effect of the hydraulic gradient.

Particulate matter and contaminant input

Vehicle maintenance and fuelling constitute a risk for surface water contamination through accidental spills or leaks of petroleum products or other contaminants, which might temporarily affect benthic invertebrates. Diesel fuelling and storage for power generating set operation could also involve spills or leaks of the petroleum products stored in the reservoirs. A large-scale spill or leak that is not contained could contaminate Lake Lagopede's waters and affect its benthos.

7.2.3.2 Mitigation Measures

- *WATER MANAGEMENT*

The implementation of measures to control erosion at source and limit sediment transport will help to restrict additional inputs into Lake Lagopede. The water management plan will ensure that mine camp runoff will be intercepted and directed to sedimentation ponds to remove particulate matter and undergo treatment by the mine wastewater treatment plant. The quality of the treated water will be monitored before it is discharged into Lake Lagopede. These measures are described in detail in Section 6.8.3 (*Surface Water Impacts During the Operation Phase*).

Runoff from areas upstream of the mine site, i.e. west of the processed kimberlite confinement area, will be diverted to one of lake F3295's tributaries to avoid contact with the mine site.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; FUEL AND HAZARDOUS MATERIAL STORAGE AND MANAGEMENT*

To prevent the risk of machinery encroachment on streams, vehicle traffic will be restricted to access roads. Machinery maintenance and fuelling will occur in specially designed areas more than 60 m from any stream. Diesel fuelling and storage activities for power generating set operation will occur in specially designed areas and a recovery kit will be available in case of accidental spills or leaks.

The mitigation measures linked to the storage and management of fuel and hazardous materials to protect surface waters during the construction phase (Section 6.8.2) will also apply to benthos.

7.2.3.3 Residual Impact

During the operation phase, following the implementation of measures to control erosion and restrict sediment transport, the additional sediment and organic matter load in Lake Lagopede generated by mining activities will be relatively limited.

The project's residual impacts on the benthic communities should be limited to a site specific, marginal increase in Lake Lagopede's sediment and organic matter load. Given the measures to prevent and confine accidental petroleum product spills, the risk of aquatic environment contamination by petroleum products is low.

Consequently, the significance of the project's impact on benthic communities during the operation phase is low, given its low intensity, site specific extent and moderate duration.

7.2.4 Closure Phase Impacts

The main sources of impact in the closure phase include:

- Water management by flooding open pits R-2/R-3 and R-65 and ceasing discharge of treated domestic wastewaters and mine effluent into Lake Lagopede;
- Final site rehabilitation and revegetation;
- Dismantling and recovery of facilities;
- Use and maintenance of machinery and road circulation.

7.2.4.1 Impact Description and Assessment

➢ *WATER MANAGEMENT*

Flooding of open pits R-2/R-3 and R-65 will create 22.2 ha of lacustrine habitats that could be suitable for aquatic life. This is the greatest impact on benthos in the closure phase. The lakes created will have a respective surface area of 12.6 ha (open pits R-2/R-3) and 9.6 ha (open pit R-65) and maximum depths of approximately 113 and 161 m, respectively.

Ceasing discharge of treated domestic wastewater and mine effluent during closure will have a positive impact on substrate and benthic community recovery to baseline conditions at the domestic and mine effluent discharge points.

➢ *DISMANTLING AND RECOVERY OF FACILITIES AND FINAL SITE REHABILITATION AND REVEGETATION*

Mine site rehabilitation activities in the closure phase include dismantling buildings and revegetating the sites they occupied. They also include stabilization and final revegetation of the processed kimberlite confinement area and overburden stockpile, as well as revegetation of the surfaces formerly occupied by the waste rock and ore stockpiles. The rehabilitation work will include the use, during the operation phase, of waste rock to fill the underground mine and open pits, which, in the closure phase, will reduce the volume of materials to manage. The overburden will also be used for progressive site revegetation. The soil re-engineering required to restore topography, the stabilizing of slopes and the addition of a layer of overburden and topsoil is likely to generate a temporary increase in erosion, as well as sediment and organic matter transport into Lake Lagopede.

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; FUEL AND HAZARDOUS MATERIAL STORAGE AND MANAGEMENT*

Machinery and vehicle maintenance and refuelling present a risk for surface water contamination due to potential accidental spill or leak of petroleum products or other contaminants. This could affect the benthic invertebrates present if these products are not rapidly contained and recovered.

7.2.4.2 Mitigation Measures

- *WATER MANAGEMENT*

The same measures as those mentioned for surface water quality will be applied during site rehabilitation and closure work.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS, ROAD TRAFFIC; FUEL AND HAZARDOUS MATERIAL STORAGE AND MANAGEMENT*

Vehicle and machinery traffic will be restricted to access roads. Machinery maintenance and fuelling will occur more than 60 m from stream or water bodies and a recovery kit will be available in case of an accidental spill or leak.

The mitigation measures linked to the storage and management of hazardous materials and fuels to protect surface waters in the construction phase (Section 6.8.2) will also apply to benthos.

7.2.4.3 Residual Impact

During the closure phase, a positive impact on benthos is anticipated. The significance of this positive impact on benthic communities is deemed moderate, given its high intensity, site specific extent and long duration.

7.3 Fish

7.3.1 Current Conditions

Fish populations and their habitats were characterized as part of the Renard Project Environmental Baseline Study (EBS) (Roche, 2011) in order to:

- Determine the species composition of the fish present in the study area's hydrographical network;
- Assess species richness and relative abundance;
- Characterize the fish communities present;
- Determine the heavy metal content in the flesh and liver of the following fish species: Lake Trout, Northern Pike and Lake Whitefish;
- Characterize the fish habitat accessible by fish;
- Characterize fish habitat use in lakes and streams likely to be affected by the project;
- Determine the habitat's ecological functions.

The study area's fish habitat and communities were characterized using information taken from:

- Past studies conducted by Roche (2003), Roche (2005) and Stantec (2009);
- Survey data from the environmental and social impact assessment of the extension of Route 167 North to the Otish Mountains (Roche – SNC-Lavalin, 2010);
- Sampling campaigns conducted in September 2010 and spring 2011 as part of the Environmental Baseline Study (EBS) and the Environmental and Social Impact Assessment (Roche, 2011).

All surveys performed in 2010-2011 were taking into account the results of past surveys and the positioning of planned infrastructures. Sampling campaigns were conducted from August 23 to September 10, 2010 and from May 26 to June 9, 2011. Work in late summer 2010 allowed observation of salmonids aggregations in sectors near spawning sites and sampling of young-of-the-year (YOY), thus confirming recruitment of certain species. The main purpose of the complementary sampling campaign of spring 2011 was to assess fish habitat use during the spring spawning period for fish species, which spawn in spring, known to be present in the area (i.e. Northern pike). Between 2003 and 2011, fish habitat was characterized in 26 streams and 28 lakes. Furthermore, experimental fishing was carried out in 29 lakes and 18 streams.

In the Renard Project study area, fish habitat was characterized using biophysical elements (substrate type, flow facies, presence of aquatic vegetation, current velocity, physicochemical measurements, etc.). Stream habitat characterization was performed using the Boudreault (1984) method by delineating uniform stream sections based on visual and underwater camera observations and by collecting substrate samples. Fish habitat characterization also made it possible to assess the potential ecological functions of these habitats, i.e. spawning sites, nurseries, rest, feeding or migration. Other elements were also noted, including the presence of obstacles to the free passage of fish and the presence of pools and shelters in the streams and water bodies surveyed. Some of the streams characterized were not considered fish habitat due to the absence of fish and one or more of the following conditions:

- The stream resulted from diffuse drainage creating water accumulation;
- The stream's flow was diffused in vegetation (Photo 7.3.1);
- It flowed underground (e.g. under boulders or Sphagnum) (Photo 7.3.2);
- There was no surface hydraulic connection with a fish habitat;
- A channel only a few meters long was observed in swamp.

The different fish species recorded in the study area were identified through experimental fishing based on fishing standardization guides (MRNF, 2011; MEF, 1994). Different types of fishing gear were used to obtain a representative profile of the different species and age classes present in the hydrographical network. The detailed methodology and fishing effort are presented in the Environmental Baseline Study (Roche, 2011).

The results of the 2010-2011 fisheries were combined with previous ones to define the biological characteristics of the fish populations found in the area and their use of habitat. The following sections provide a regional profile of fish habitat and fish populations and of the Renard Project study area in order to assess the richness and relative importance of the habitats encountered.

7.3.1.1 Regional Environmental Context

The Renard Project site is located in the James Bay territory, whose hydrographical network is characterized by the presence of Quebec's largest natural lake, Lake Mistassini, and major rivers such as the La Grande, Rupert and Eastmain. The study area straddles the northwestern limit of the Misask

River watershed and the southeastern limit of the Sakami watershed. The Misask River belongs to the Eastmain River watershed and the Sakami River belongs to the La Grande River watershed.

The Misask River watershed is known to be highly diverse in terms of fish habitat due to the presence of the Misask and Nerveuse rivers, lakes Lagopede and Emmanuel and many small streams (Photo 7.3.3). This watershed contains many types of flow facies, substrates, depths, flow velocity and, in places, aquatic vegetation. More specifically, the Misask River watershed contains many streams with riffle flow facies (alternating riffles and pools), whose substrates consist of gravel or cobbles (Roche – SNC-Lavalin, 2010) (Photo 7.3.4). This facies type is under-represented in the other watersheds located between Lake Albanel and the Renard Project site (Albanel-Mistassini, Témiscamie, Takwa, Tichégami and Eastmain). The heterogeneity of the habitats characterized in the Misask River watershed promotes this environment's specific richness. According to surveys performed as part of Route 167 North extension ESIA, the Renard Project EBS and ESIA, 14 fish species were caught in this watershed's streams and water bodies (Table 7.3.1) (Photo 7.3.5). Of these fourteen species, six (Walleye, Northern Pike, Lake Whitefish, Burbot, Brook Trout and Lake Trout) are harvested by Native communities.

Table 7.3.1 List of Species Potentially found in the Renard Project Study Area according to the MRNF and Species whose Presence has been confirmed in the Study Area and the Otish Mountains Area

French name	English name	Scientific name	Study area[1]	Watershed[2]					
				Misask	Eastmain	Tichegami	Takwa	Temiscamie	Albanel-Mistassini
Chabot tacheté	Mottled Sculpin	*Cottus bairdii*							
Chabot visqueux	Slimy Sculpin	*Cottus cognatus*	X	X	X	X	X		X
Cisco de lac	Cisco	*Coregonus artedi*							
Doré jaune	Walleye	*Sander vitreus*		X	X				
Épinoche à neuf épines	Ninespine Stickleback	*Pungitius pungitius*			X				
Fouille-roche zébré	Logperch	*Percina caprodes*							
Grand brochet	Northern Pike	*Esox lucius*	X	X	X		X	X	
Grand corégone	Lake Whitefish	*Coregonus clupeaformis*	X	X	X	X			
Lotte	Burbot	*Lota lota*	X	X	X	X	X	X	
Mené de lac	Lake Chub	*Couesius plumbeus*	X	X	X	X	X		X
Ménomini rond	Round Whitefish	*Prosopium cylindraceum*	X						
Meunier noir	White Sucker	*Catostomus commersonii*	X	X	X	X	X	X	X
Meunier rouge	Longnose Sucker	*Catostomus catostomus*	X	X	X	X	X		
Mulet à cornes	Creek Chub	*Semotilus atromaculatus*	X						
Mulet perlé	Pearl Dace	*Margariscus margarita*	X	X	X				
Naseux des rapides	Longnose Dace	*Rhinichthys cataractae*	X	X	X	X			X
Omble de fontaine	Brook Trout	*Salvelinus fontinalis*	X	X	X	X	X	X	X
Ouitouche	Fallfish	*Semotilus corporalis*	X						
Touladi	Lake Trout	*Salvelinus namaycush*	X	X					
Perchaude[3]	Yellow Perch	*Perca flavescens*		X					
Species richness			**14**	**13**	**12**	**8**	**7**	**4**	**5**

[1] According to the studies conducted by Roche (2003), Roche (2004), Stantec (2009) and Roche (2011)

[2] Source: Consortium Roche - SNC-Lavalin (2010)

[3] Yellow Perch is not listed by the MRNF as a species that is potentially present in the study area. However, Genivar (2009) caught some Yellow Perch in the Misask River watershed.



Photo 7.3.1 Diffuse Flow in Vegetation (2010)



Photo 7.3.2 Flow Under Boulders (2010)



Photo 7.3.3 Nerveuse River (June 20, 2010)



Photo 7.3.4 Riffle Flow Facies of a Stream in the Misask River Watershed (2010)



Photo 7.3.5 Fish Species Found in the Misask River Watershed (2010)

7.3.1.2 Mine Area

Fish habitat characterization and fisheries were performed for streams and water bodies located on the planned mine site in order to determine habitat quality and richness.

- *FISH HABITAT*

Located at the head of its watershed, the Renard Project study area's hydrographical network is characterized by many small streams (mean width < 2 m), whose flow is low-to-intermittent, and by generally shallow lakes (Photo 7.3.6). Lake Lagopede (32302) receives waters from the all the sub-watersheds affected by the mine area (Photo 7.3.7).

The streams are generally characterized by a channel flow facies with substrate consisting of silt and sand. Some small streams have a facies of riffles and pools with substrates of boulders and stones. The mean depth of the streams surveyed is less than 1 m. While little aquatic vegetation is found in these streams, some flow through beds of Sphagnum or overhanging mosses providing shelters (Photo 7.3.8). Other shelters found in streams are overhanging banks, boulders and woody debris. The main habitat functions of these streams are migration route and feeding. In some locations, like the lake F3301 tributary and lake F3298 outlet, a Brook Trout spawning site and fish nursery were confirmed. Schools of mature Lake Chub were found in the outlets of lakes F3294 and F3348 and at the confluence of the outlets of lakes F3293 and Lagopede. The spawning sites locations and the stream's flow facies are illustrated on Map 7.3.1 (in pocket insert in Volume 3).

The majority of the study area's lakes are small (<10 ha) and rather shallow (< 5 m), with the exception of Lake Lagopede (471 ha), which is the study area's largest lake and is characterized by numerous pools up to 20 m deep. Lake substrates generally consist of silt, organic matter, sand and large boulders. Shoreline substrate is primarily composed of sand and sometimes of gravel. Aquatic vegetation is observed mainly near lakeshores and near boulders in shallow waters. In general, the lakes are quite uniform in terms of fish habitat. Their main habitat functions identified are feeding, rest and fish nurseries. Some species' young-of-the-year (Northern Pike, Burbot, Pearl Dace, White Sucker and Brook Trout) were observed or caught near lakeshores (Photo 7.3.9). Potential Northern Pike spawning sites were identified, notably in the southern sector, eastern bay and at confluence of lake F3296 outlet and Lake Lagopede as well as in lake F3295.

Lake Lagopede offers very heterogeneous fish habitat. The presence of many structural elements of fish habitat (pools, sand shoals, isles, many tributaries, aquatic vegetetion, shallow bays, etc.) (Photo 7.3.10) creates considerable diversity in terms of structures and functions (feeding, spawning, fish nursery, etc.). Lake Lagopede's main three northern bays offer fish habitat with similar characteristics. All are characterized by the presence of a tributary, a pool more than 5 m deep, aquatic vegetation and substrate consisting of silt and organic matter in the deeper areas and sand and gravel near the shores. Lake Lagopede has several potential Northern Pike spawning sites. The Cree tallyman

confirmed the presence of a spawning ground further south in Lake Lagopede but did not specify which species uses this site (Roche, 2011).

- *SPECIES ABUNDANCE AND RICHNESS*

Fisheries performed in the study area between 2003 and 2011 lead to the capture of 1,314 specimens from 14 species: Slimy Sculpin, Northern Pike, Lake Whitefish, Burbot, Lake Chub, Round Whitefish, White Sucker, Longnose Sucker, Creek Chub, Pearl Dace, Longnose Dace, Brook Trout, Fallfish and Lake Trout. All are on the MRNF's list of 19 species potentially present in the region (Table 7.3.1). None is a special status species under the *Species at Risk Act or* the *Act respecting threatened or vulnerable species*. Of the 14 fish species caught in the study area, 5 are considered of interest for sport fishing. They are: Lake Whitefish, Northern Pike, Burbot, Brook Trout and Lake Trout. Although Walleye is found in the Misask River watershed, not a single individual from this species was caught in the study area. This may be linked to the presence of a barrier at the Lake Lagopede outlet. Walleye is very popular with the Native people and sport fishers.

Despite the study area's apparent species richness, four species represent more than 90% of all fish caught since 2003. They are: Pearl Dace (44.9%), White Sucker (23.7%), Brook Trout (13.2%) and Lake Chub (9.1%) (Figure 7.3.1 and Table 7.3.2). Fish abundance and fishing yield data are generally expressed in terms of catch per unit effort (CPUE) and biomass per unit effort (BPUE). For gillnet fishing, an effort of 50 net-nights was deployed in the Renard Project study area. Brook Trout was the most abundant sport species in catches, with a fishing yield of 1.8 Brook Trout per net-night. White Sucker (3.9 captures/net-night) and Pearl Dace (2.2 captures/net-night) were the most abundant in catches for all lakes as a whole. For small fish, Pearl Dace (3.6 captures/bait trap-night), White Sucker (0.8 captures/bait trap-night) and Brook Trout (0.3 captures/bait trap-night) were the most abundant species in catches using minnow traps (148 bait-trap-nights) (Photo 7.3.11). In electrofishing catches, Brook Trout was the most abundant species with a CPUE of 5 captures/100 m^2.

For gillnet catches, the two species constituting most of the fish biomass caught were White Sucker (1.117 g/net-night) and Northern Pike (973 g/net-night). For minnow trap catches, Pearl Dace (11.9 g/bait trap-night), Brook Trout (7.6 g/bait trap-night) and White Sucker (4.3 g/bait trap-night) were the species constituting the largest BPUE.



Photo 7.3.6 Lake F2607, Shallow and Typical of the Study Area (September 2010)



Photo 7.3.7 Lake Lagopede (June 2011)



Photo 7.3.8 Stream Flowing Through Sphagnum (September 2010)



Photo 7.3.9 Lake F3298 Shoreline (September 2010)



Photo 7.3.10 Habitat Heterogeneity in Lake Lagopede (September 2010)



Photo 7.3.11 Minnow Trap Fishing in Lake F3302 (September 2010)

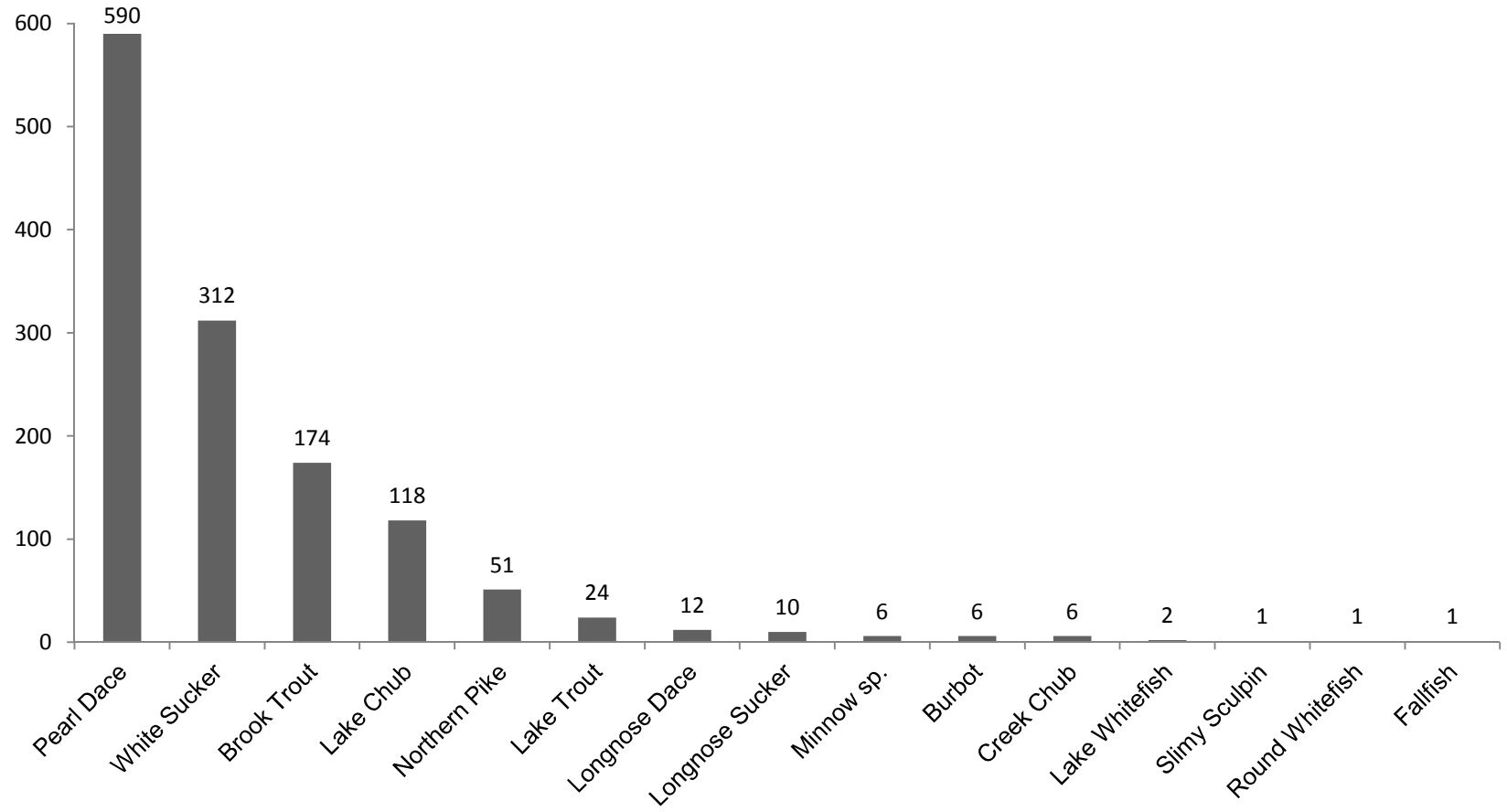


Figure 7.3.1 Relative Abundance of Species Caught in the Study Area (2003-2011)

Table 7.3.2 Relative Abundance of Catches in the Renard Project Study Area

Species	Number of catches						Relative abundance (%)
	Roche, 2003	Roche, 2004	Stantec, 2009	Roche, 2010	Roche, 2011	Study area	
Pearl Dace	0	59	76	441	14	590	44.9
White Sucker	15	5	12	211	69	312	23.7
Brook Trout	0	24	42	71	37	174	13.2
Lake Chub	0	15	0	2	102	119	9.1
Northern Pike	3	2	9	18	19	51	3.9
Lake Trout	0	0	6	5	12	23	1.8
Longnose Dace	0	1	16	0	0	17	1.3
Minnow sp.	1	0	3	2	0	6	0.5
Creek Chub	0	0	6	0	0	6	0.5
Burbot	0	0	0	5	1	6	0.5
Longnose Sucker	0	0	0	0	5	5	0.4
Lake Whitefish	0	0	1	1	0	2	0.2
Slimy Sculpin	0	0	1	0	0	1	0.1
Round Whitefish	0	0	0	0	1	1	0.1
Fallfish	0	0	1	0	0	1	0.1
Total number of catches	**19**	**106**	**173**	**756**	**260**	**1314**	**100**
Relative abundance (%)	**1**	**8**	**13**	**58**	**20**	**100**	

- *HABITAT USE*

Northern Pike, Lake Chub, White Sucker, Pearl Dace and Brook Trout are the most common species found in the area. They are abundant in water bodies and streams of the study area. Apart from Pearl Dace and Creek Chub, all fish species inventoried in the study area were caught in Lake Lagopede or its main tributary (Map 7.3.2 in pocket).

White Sucker were recorded in both Lake Lagopede (32302) and lakes situated at the head of the sub-watershed (i.e. lakes F3312 and F3316).

Northern Pike was caught (or observed) primarily in Lake Lagopede (32302) and in some lakes downstream of the sub-watersheds (F3295, F3296 and F3300). The species is known to be present in slow-flowing streams and bays where aquatic vegetation abounds (Bernatchez and Giroux, 2000). Potential Northern Pike spawning sites and nurseries were identified in Lake Lagopede and lake F3295 (Photo 7.3.12) and visited in spring 2011. However, it was impossible to validate spawning activity. Several mature Pike were observed in Lake Lagopede's bays, whose water temperature was warmer than the rest of the lake. The mean temperature of Lake Lagopede fluctuated around 4^{o}C, while in the eastern bay, the southern sector and the confluence between the lake F3296 outlet and Lake Lagopede, it ranged from 6 to 12^{o}C. The water temperatures measured in May 2011 correspond to the Pike's preferred spawning temperatures, which vary from 4.4 to 11.1^{o}C. Pike juveniles were, however, observed in shallow waters near lakeshores (32302, F3295, F3296 and F3300 in September 2010) near tributaries where aquatic and/or overhanging vegetation was present.

Brook Trout is found in the head streams and lakes of most of the sub-watersheds (F2604, F3298, F3299 and F3301) (Photo 7.3.13). Brook Trout spawning, which occurs in fall in streams with gravel or coarse sand substrates, was confirmed in two streams (lake F3301 tributary and lake F3298 outlet) (Photo 7.3.14).

Lake Trout and Lake Whitefish prefer the cold waters of lakes or large rivers. Few individuals were caught in Lake Lagopede or other lakes outside the mine area (Roche, 2011), generally in pelagic zone of lakes. No spawning sites for these species were confirmed in the study area.

Slimy Sculpin, Round Whitefish, Creek Chub and Fallfish are under-represented in the study area. Slimy Sculpin and Fallfish were caught in Lake Lagopede's main tributary (Photo 7.3.15; Map 7.3.2 in pocket), which flows into Lake Lagopede's northern bay, draining, among others, the waters from two large lakes located upstream of Lake Lagopede (lakes 32300 and 32304-2). Round Whitefish (Lake Lagopede (32302)) and Creek Chub (Lake F3298) were caught in one lake only.

➢ *HEAVY METAL CONCENTRATIONS*

Fish mercury levels are an indicator of this heavy metal's bioaccumulation[4] and biomagnification[5] in the food chain. The values measured in the fish of different lakes throughout Quebec allow the MDDEP, in its *Guide de consommation du poisson de pêche sportive en eau douce,* to make recommendations regarding the number of fish-based meals that can be safely consumed per month. Maximum concentrations of the heavy metals contained in fish destined to be marketed are regulated by the Canadian Food Inspection Agency (CFIA). Maximum concentrations are of 0.5 mg/kg for mercury and 0.5 mg/kg for lead. There are currently no standards governing fish copper, nickel or cadmium levels.

Mercury and heavy metal concentrations were measured in 20 fish caught in Lake Lagopede and belonging to 3 target species (Northern Pike, Lake Whitefish and Lake Trout) for the following reasons:

- Species used by the Cree;
- Species found in Lake Lagopede (32302);
- Species belonging to different food chain levels.

The mean mercury levels measured in small Pike (400 - 550 mm) (0.10 mg/kg) and average-sized Pike (550 - 700 mm) (0.41 mg/kg) are below the Canadian Food Inspection Agency standard for consumption (0.5 mg/kg). The mean level (0.89 mg/kg) measured in large Pike (>700 mm) exceeds the Canadian standard, a fact that does not prevent its consumption. At these concentrations, the MDDEP recommends not consuming this fish more than 4 times a month.

The mean mercury concentration in Pike caught in the study area is similar to levels measured 96 km south of the Renard Project (Strateco, 2009) and lower than mean values for the province of Quebec as a whole (MDDEP, 2011) (0.40; 0.64 and 1.08 mg/kg for small, medium and large Pike respectively).

Lead, copper, nickel and cadmium levels were measured in the livers of the fish caught since these metals bioaccumulate more in the liver than the flesh. The metal concentrations observed in the liver of the fish caught in Lake Lagopede are relatively low, reflecting the low levels of heavy metals found in the study area's aquatic environment (Roche, 2011).

➢ *ISSUES TO CONSIDER*

Construction and implementation of the mine and its related infrastructures will inevitably alter or destroy fish habitat in this area. Dewatering two lakes (F3302 and F3303) and five streams, two of which are considered fish habitat (outlet of lakes F3298 and F3302), will cause permanent fish habitat losses. Dewatering the lakes and diverting the streams will also change the hydrological regime of certain streams and modify fish habitat conditions. Clearing and excavation are likely to cause limited and temporary increases in sediment transport in the hydrographical network that could alter fish habitat

[4] Bioaccumulation: An organism's ability to absorb and concentrate certain chemical substances in all or part of its body.
[5] Biomagnification: Process by which the levels of certain substances grow at each stage in the food web (food chain).

quality. Finally, discharging mine and domestic effluent into Lake Lagopede could potentially modify local water quality.

Of the species found in the study area, Brook Trout is the most likely to be affected by the project. This species is very common in the study area's hydrographical network and is known to be very sensitive to changes in water and habitat quality. Lake Trout is also very sensitive to water temperature increases, seeking temperatures under 10°C (Scott and Crossman, 1974). However, this species is not very abundant in the study area.

- *AIRSTRIP AREA*

The site selected for airstrip construction is an area where little fish habitat is present. The alignment chosen runs 500 m south of a small lake (F3291), which drains into lake F3290 located 1,310 m downstream (Map 7.3.1 in insert pocket in Volume 3). Lake F3290 constitutes a fish habitat, where presence of Northern Pike was confirmed (Roche, 2011) (Photo 7.3.16). The lake F3291 outlet, where no fish were caught, offers fish habitat over approximately 180 m near lake F3290. Then, the stream becomes intermittent. Lake F3291 is not considered fish habitat since there is no surface hydraulic connection with a fish habitat and no fish were caught in it.



Photo 7.3.12 Potential Northern Pike Spawning Site in lake F3295 (2010)

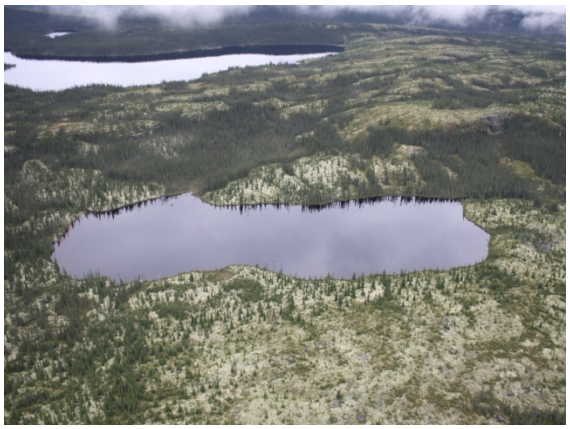


Photo 7.3.13 Typical Brook Trout Habitat (lake F2604) (2010)



Photo 7.3.14 Lake F3301 Tributary (2010)



Photo 7.3.15 River Flowing into Lake Lagopede's Northern Bay (2010)



Photo 7.3.16 Lake F3290 and its Tributary (2010)

7.3.2 Construction Phase Impacts

7.3.2.1 Detailed Impact Description

During the construction phase, the project components most likely to affect fish and fish habitat are:

- Site preparation and development;
- Lake and stream dewatering and water and sediment management;
- Site water management;
- Water supply;
- Use and maintenance of machinery and power generating sets; road circulation;
- Hazardous materials and fuel storage and management;
- Manpower and procurement.

The resulting impacts that might affect fish and fish habitat are:

- **Permanent destruction of 41,617 m² of fish habitat** due primarily to dewatering 36,992 m² of water bodies and 4,625 m² of streams,[6] site preparation and development and stream crossing of mining roads;
- **Alteration of fish habitat quality** in streams and water bodies during site preparation and development, discharge of waters from site pumping and drainage, discharge of treated domestic effluent into Lake Lagopede, machinery traffic during site preparation and water supply;
- **Temporary disruption of fish** due to use of explosives and road traffic;
- **Increased fishing pressure** on fish populations due to workers' presence if fishing is not controlled.

➢ *SITE PREPARATION AND DEVELOPMENT, LAKE AND STREAM DEWATERING AND WATER AND SEDIMENT MANAGEMENT*

Destruction of Fish Habitat

Several project components will cause fish habitat losses by dewatering two water bodies and five streams, diverting 762.5 m of streams and installing stream crossings of mining roads. Construction will cause temporary fish habitat losses (e.g. temporary flow diversion while culverts are being installed) and permanent ones (e.g. dewatering lakes F3302 and F3303).

Permanent losses

While significant optimization work has been done to substantially reduce the mine's footprint, infrastructure construction will require permanent encroachment on fish habitat. The main construction activities generating such losses are shown in Table 7.3.3.

[6] In these streams, the bed is much narrower than the natural high water mark. The habitat lost at bankfull discharge is approximately 405 m².

Stream diversion and dewatering

Developing and operating open pit R-65 requires dewatering a 260-m section of the lake F3298 outlet, which constitutes a fish habitat. This section alternates between channel and riffle flow facies (Photo 7.3.17). This stream's main habitat function is feeding. In its downstream section, a Brook Trout spawning site and nursery was identified and will be dewatered. This stream will be diverted into lake F3295 using natural drainage ditches (thalwegs) as much as possible. The bed of the stream that will be diverted will be developed into a fish habitat as far as lake F3295. Almost 930 m of the stream's bed will developed this way, resulting in a net fish habitat gain of about 670 m (linear).

The lake F3302 outlet is a channel flowing partly underground and partly on the surface (Photo 7.3.18). A small section of about 110 m (linear) from the lake is a fish feeding ground. From that point, the stream flows mostly underground, thus it is not considered as a fish habitat. Two other streams will be dewatered by diverting their drainage. These are the northern tributary of the lake F3301 outlet and lake F2607's secondary tributary. However, these are not considered fish habitat, given their intermittent flow that runs mostly underground (Photos 7.3.19 and 7.3.20).

Dewatering lakes F3302 and F3303

Site preparation and development for the use of open pits R-2/R-3 and R-65 involves dewatering lakes F3302 and F3303. Lake F3302 is shallow (3.3 m) and covers about 25,000 m^2 (Photo 7.3.21). The only fish species recorded in this lake is Pearl Dace. Lake F3303 has a maximum depth of 3.8 m and covers approximately 12,000 m^2 (Photo 7.3.22). It supports populations of Pearl Dace, White Sucker and Brook Trout. Since no tributaries feed this lake, its Brook Trout production is limited. Mitigation measures will be implemented to recover and relocate the two lakes' fish (see Section 7.3.2.2).

Table 7.3.3 Summary of Permanent Fish Habitat Losses for each Stream and Water Body affected by the Project

Name of stream or water body	Flow facies	Habitat function	Fish species caught	Types of infrastructure or activity	Percentage of fish habitat loss (%)	Fish habitat loss (m^2)
Lake F3302	-	Feeding, nursery and spawning	Pearl Dace	Dewatering to dig open pits R-2/R-3	100	25 030
Lake F3303	-	Feeding, nursery and spawning	White Sucker Pearl Dace Brook Trout	Dewatering to dig open pit R-65	100	11 962
Pond (near lake F3303)	-	Not considered a habitat	None	Dewatering to dig open pit R-65	–	0
Lake F3298 outlet	Channel, riffle and underground flow	Feeding, nursery and spawning	Brook Trout	Stream diversion and dewatering to dig open pit R-65	70	3 535 [1]
Lake F3298 tributary	Undergound flow	Not considered a habitat	None	Processed kimberlite confinement area	–	0
Lake F3302 outlet	Channel, riffle and underground flow	Considered a fish habitat for the first 110 m downstream of the lake	Pearl Dace	Dewatering to dig open pits R-2/R-3	100	1 090 [2]
Lake F3303 outlet	Channel alternating between surface and underground flow	Not considered a habitat	None	Dewatering to dig open pit R-65	–	0
Tributary north of lake F3301 outlet	Undergound flow	Not considered a habitat	None	Dewatered; Processed kimberlite confinement area	–	0
Lake F2607 secondary tributary	Underground flow	Not considered a habitat	None	Dewatered; Processed kimberlite confinement area	–	0
TOTAL						**41 617**

[1] This brook's downstream section has a floodplain where some of the brook's secondary branches are submerged only in the spring. The brook bed at bankfull discharge is much narrower. Habitat loss at bankfull discharge is approximately 255 m².

[2] A section of this stream is a somewhat diffuse channel in a floodplain. The stream bed is much narrower than the natural highwater mark. Habitat loss at bankfull discharge is approximately 150 m².



Photo 7.3.17 Section of Lake F3298 Outlet to be Dewatered (September 2010)



Photo 7.3.18 Lake F3302 Outlet (May 2011)



Photo 7.3.19 Northern Tributary of Lake F3301 Outlet – Underground Flow (September 2010)



Photo 7.3.20 Lake F2607's Secondary Tributary – Accumulation of Surface Water Near the Deposit R3 Drilling Area (May 2011)



Photo 7.3.21 Lake F3303 to be Dewatered (September 2010)



Photo 7.3.22 Lake F3302 to be Dewatered (September 2010)

Temporary losses

Temporary fish habitat losses will occur when stream crossings of mining roads are built. Generally, culvert installation requires temporary stream diversion and, as a result, may cause temporary fish habitat losses. Once the work has been completed, the temporary structures will be completely dismantled, materials will be recovered and the water's original flow will be restored.

Stream crossings of mining roads

While some mine roads will be built on the mine site, these will cause any additional fish habitat loss. In fact, prior diversion of certain streams and dewatering of lakes F3302 and F3303 will involve no stream crossing. However, culverts may be built to cross the new drainage ditches. No additional losses are calculated for mine road culverts because these losses have already been taken into account in stream diversion and dewatering.

Alteration of fish habitat quality

Activities linked to site preparation and development (clearing and backfill/excavation) are likely to diminish fish habitat quality near work areas unless soil erosion and sediment transport are controlled. The main potential habitat quality alterations are:

- An increase in TSS concentrations in the water, due to sediment transport and deposit in fish habitat;
- A potential water temperature increase in small streams due to riverbank clearing and inflow of warmer, more turbid runoffs;
- Possible growth of periphyton and algae in small streams due to potentially greater inputs of organic matter and phosphorus.

Increased TSS concentrations in runoffs, streams and water bodies near the worksite are anticipated. During site preparation and development, large soil surfaces will be exposed to erosion. Despite erosion and sediment transport control measures, during storms, an increase in TSS concentrations may be observed in streams and lakes located near the worksite. Given the low naturally-occurring TSS concentrations in these streams, frequent and higher concentrations in TSS could potentially occur and affect fish and fish habitat if not controlled. An increase in total suspended solids in the water column may have physiological effects (e.g. damage to gills, etc.) and behavioural effects (e.g. decreased predation success, avoidance of turbid areas, change in prey abundance and diversity, etc.) and affect fish habitat (e.g. suspended solid deposits on spawning substrate, increased water temperature, etc.) (Bash *et al*., 2001). Increased TSS coupled with riverbank clearing could temporarily increase water temperature. Species seeking cold and clear waters (Brook Trout) might avoid the affected habitats.

Fish Disruption

During construction, the use of explosives near streams could cause vibrations and sound waves likely to temporarily disturb fish. Fish may well move to other similar habitats nearby to avoid the disrupted

areas. This avoidance effect can be observed in fish exposed to high sound pressure (Popper and Hastings, 2009). Avoidance can vary among species from during noise exposure only to until a few days thereafter. Lake Lagopede's northeastern bay, lakes F2607, F3295, F3296, F3298 and F3301 and the outlets of lakes F3296, F3298 and F3301 are the areas most sensitive to these impacts.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; HAZARDOUS MATERIALS AND FUEL STORAGE AND MANAGEMENT*

Alteration of Fish Habitat Quality

Machinery circulation and use on the worksite, storage and management of hazardous materials and fuels constitute potential risks for accidental petroleum products leaks or spills and, as a result, for impacting fish habitat if not contained. These petroleum products could leak into the waterways and adversely affect fish species if concentrations exceed water quality aquatic life criteria (CALC = 0.01 mg/l and AALC = 0.11 mg/l).

- *SITE WATER MANAGEMENT*

Discharge of drainage and/or pumping waters during the construction phase is likely to cause a site specific and temporary increase in turbidity and TSS concentrations in the aquatic environment. The input of waters from dewatering and open pit pumping may affect fish and fish habitat. To prevent and/or limit these impacts, construction worksite waters will be collected and treated by mobile treatment units before being sent to sedimentation ponds in order to meet MDDEP effluent discharge objectives.

Water management during construction is likely to cause changes in water quality. Given the low levels of phosphorus and organic matter in the receiving environment, the growth of periphyton and algae in small streams may augment proportionally to greater inputs of these components. The main sources of phosphorus and organic matter anticipated are related to:

- Soil erosion and sediment transport during site preparation and development (clearing, excavation and levelling);
- Discharge of treated domestic effluent;
- Discharge of the site's drainage waters;
- Inflows of residual ammonia that could occur if explosives are improperly managed.

The final treated domestic effluent discharge point was chosen to take advantage of the environmental features promoting effluent dispersion and minimizing impacts on fish and fish habitat as described in the analysis of alternatives (Section 3.2.2.4). Discharge of the treated domestic effluent may modify water quality inside the dispersion plume in Lake Lagopede. Given the low concentrations of phosphorus, nitrogen and BOD_5 measured in Lake Lagopede, particular attention must be paid to controlling nutrient and organic matter inputs. Phosphorus inputs will be controlled by applying a coagulant before the treated waters are discharged into Lake Lagopede. The wastewater treatment

system's BOD_5 elimination capacity is excellent. Due to the low alkalinity levels observed in the study area (<10 mg of $CaCO_3$/l), lake waters are sensitive to acidification (Roche, 2011). Rapidly lowering pH to less than 5 could cause developmental or mortality problems in sensitive species like Lake Trout and Brook Trout (Dupont, 2004). This is why the pH will be adjusted if need be before discharging the treated effluent into Lake Lagopede. The treated domestic effluent modeling results show that a dilution factor of 1:100 will be reached 52 to 130 m from the outfall discharge point, depending on whether conditions are those of estimated mean flow or peak flow. At the plume's edges, contaminant concentrations will be of the same range as those currently measured in the lake. The avoidance effect is the main impact on fish associated with the discharge of treated effluent. Certain so-called specialist species, like Lake Trout, may avoid the immediate discharge zone and the dispersion plume.

Periphyton growth on substrate might also increase in the work area, given that some streams will be more exposed to sunlight. This may harm litophil species, like Brook Trout, which spawn on rocky or gravelly substrates.

- *WATER SUPPLY*

The water intake site was chosen in keeping with Fisheries and Oceans Canada recommendations (1995). Given the small volume of water pumped from Lake Lagopede during the construction phase (mean daily flow of 173 m^3/d), its large volume (21 Mm^3) and its hydraulic residence time (53 days), water withdrawal will not significantly modify the lake's water level (< 5 mm) or the fish habitat.

- *MANPOWER AND PROCUREMENT*

Increased Fishing Pressure on Fish Populations

During the construction phase, many hundreds of workers will be on the project site. Some may want to fish in their free time. To prevent this impact, on-site fishing by workers and contractors will be prohibited contractually.

7.3.2.2 Mitigation Measures

The mitigation measures advocated will protect the fish habitat of species of interest to be protected during spawning, incubation and fry-rearing. Brook Trout, Lake Trout and Lake Whitefish generally spawn between September and November (Bernatchez and Giroulx, 2000). Certain fish species found in the study area, notably Northern Pike, spawn in the spring generally in May (Scott and Crossman, 1974). A fisheries timing window will be applied to work to be carried out in the aquatic environment. Stream diversion, small lake dewatering and culvert installation will be performed outside the Brook Trout spawning period, i.e. September 1 to November 1. Outfalls will be installed in Lake Lagopede between May 30 and August 31. However, when justifiable, it is possible to get an exemption from the authorities to carry out one-time work.

➢ *LAKE AND STREAM DEWATERING AND WATER AND SEDIMENT MANAGEMENT*

Dewatering of the small lakes F3302 and F3303 will cause permanent fish habitat losses. However, certain specific measures can be applied to reduce impact on fish, namely:

- Lower the lake level slowly so that fish concentrate in the deepest pool of the lake;
- Catch all fish using seine nets or trapnets;
- Relocate fish into a nearby water body in which the same fish populations are found.

When specific stream sections are diverted (e.g. outlet of lake F3298 to lake F3295), different measures will be taken to minimize the impact on fish:

- If diversion is necessary, minimize the length of the section to be diverted;
- Avoid performing work in fisheries timing windows periods;
- Reconfigure the stream by reproducing its original characteristics (natural banks with indigenous plant species, particle grain size, identical slope and length);
- Reshape bank slope (if need be) to ensure stability;
- Plan for a preferential flow section (thalweg) in the stream's substrate and ensure fish passage;
- Ensure that diversion structures do not obstruct fish passage or shrink fish habitat width by more than one-third (measured from the highwater mark);
- Choose adequate substrate for the stream bed (natural granular substrate) to ensure optimal flow;
- Limit riprap on riverbanks up to the natural highwater mark and plant a riparian buffer strip from the edge of the riprap bank using recognized vegetation engineering techniques favouring shrub and overhanging grasses.

➢ *SITE PREPARATION AND DEVELOPMENT AND SITE WATER MANAGEMENT*

To minimize the input of fine soil particles, organic matter and woody debris into streams and water bodies during clearing activities, the following measures will be implemented:

- Permanently dispose of materials or debris from clearing and cutting level with the ground (trees, stumps, shrubs, branches, brush, deadwood and other plant debris) no less than 60 m from a lakeshore or riverbank, floodplain, marsh, swamp or bog;
- Do not dump any debris into the aquatic environment; remove any debris that enters immediately;
- Maintain plant cover over a 30-m buffer strip bordering a stream;
- If cutting is absolutely necessary less than 20 m from a stream, trees will be cut manually and woody debris will be disposed of outside the natural highwater mark. This measure will make it possible to direct trees so that they fall outside streams and water bodies and so that soils are kept intact by protecting them from machinery traffic;
- Runoff will be directed into temporary sedimentation ponds while awaiting construction of the sedimentation pond located on the open pit R-65 site;
- Perform work during low flow periods and respect fisheries timing windows;
- Always control erosion at the source and slow down the flow rate of runoff to reduce their erosive power;
- Promote ground infiltration of runoff from the work area;
- Avoid any fine particle transport into the aquatic environment beyond the work area;
- Limit land clearing to a strict minimum, that is, only at the specific location of the work area;

- Do not perform any earthwork or excavation near streams during flooding or heavy rains;
- Prohibit machinery fording in streams;
- Promote riverside slope stabilization as soon as possible using recognized vegetation engineering techniques.

Stream crossing - mining roads

To minimize encroachment on fish habitat and ensure free fish passage at stream crossing sites, culverts will be installed in keeping with the recommendations of the *Guide des bonnes pratiques pour la conception et l'installation de ponceaux de moins de 25 m* (DFO, 2010). Stream slope, minimum structure width (little restriction compared to full flow width), countersunk percentage and stream bed reconstitution are the main elements considered in choosing the type of structure used to limit fish habitat losses.

The working methods used will allow negative impacts on fish and fish habitat to be attenuated by reducing the volume of fine particles suspended in runoff and streams. More specifically, the following measures will be applied for temporary structures and during culvert installation:

Temporary structures

- Ensure free water flow at all times to maintain fish habitat functions downstream of the work area. Take the measures required to avoid and limit impacts (e.g. flooding, exposure, erosion, sediment transport, etc.) upstream and downstream of the work area;
- Design the temporary stream diversion (if required) to resist flooding that might occur during the work period, stabilize adequately to prevent erosion and sediment transport downstream and upstream and maintain the free passage of fish.

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; FUEL AND HAZARDOUS MATERIALS STORAGE AND MANAGEMENT*

The following measures will be applied to reduce the impacts of maintaining and operating machinery and power generating sets and storing hazardous materials and fuels on aquatic life:

- Machinery and truck traffic will be restricted to access road and work areas;
- Machinery maintenance, cleaning, fuelling, and mechanical checks will be carried out more than 60 m from any stream, lake or other body of water ;
- Machinery, trucks and generating sets will be inspected before entering the worksite and regularly thereafter to ensure that they are in good working order and have no fuel or oil leaks;
- Hazardous materials will be managed in keeping with the Regulation respecting hazardous materials (R.S.Q., c. Q-2, r. 15.2), Transportation of Dangerous Substances Regulation (R.R.Q., c. C-24.2, a. 622) and Regulation respecting biomedical waste (R.R.Q., c. Q-2, r. 12, par. 1 to 8). Petroleum equipment and products are managed in keeping with the Act respecting petroleum products and equipment (R.S.Q., c. P-29.1) and the Petroleum Products Regulations (R.R.Q., c. P-30.1, r.1);
- Hazardous materials and petroleum products storage areas will be equipped with a confinement platform of sufficient capacity to contain accidental leaks and spills;
- An emergency recovery kit for petroleum products and hazardous materials will be on the worksite and accessible to relevant areas at all times;

- Any accidental spill will be reported immediately to the person in charge of applying the project's emergency response plan, which will have been developed and approved prior to the work. The affected area will be contained immediately and cleaned without delay;
- The developer and contractors will have to ensure that all equipment is in good condition to avoid fuel, oil or grease leaks. No cleaning equipment will be authorized near or in the aquatic environment.

➢ *WATER SUPPLY*

When the water supply intake is designed and developed, certain measures will be considered to protect fish, notably approach velocity (velocity of water that runs through the grating or velocity of water perpendicular to the grating), grating openings and intake installation site (DFO, 1995). The following specific measures will be considered to reduce the water intake's impact on fish:

- Grating openings can be round, square, rectangular or combinations thereof, but will have no projections that could injure fish;
- Materials used will be corrosion and UV ray-resistant: brass, bronze, aluminum, monel, galvanized or stainless steel and plastics;
- Guide openings and joints will be smaller than the criteria for structures needed to prevent fish passage;
- Gratings will be positioned at least 300 mm from the lake bottom to prevent drawing in sediments or benthic organisms;
- A support structure will be fitted onto grating panels to prevent them from sagging or collapsing.

➢ *WATER MANAGEMENT OF WORKSITE*

Mitigation measures related to water management on the worksite during the construction phase are presented in Section 6.8.2.2 on water quality.

7.3.2.3 Residual Impact Assessment

During the construction phase, after mitigation measures have been implemented, the intensity of the residual impact on fish proves moderate since the habitats disrupted or destroyed by the construction work are primarily feeding and resting areas. The extent of the impact will be site-specific, since it will be restricted to the streams and water bodies affected by the project. Fish habitat disruption will be of short duration (limited to the work period) with regard to altering water quality and of long duration in terms of permanent fish habitat losses in the study area. In short, the significance of the residual impact on fish during the construction phase will be moderate.

All of these measures will allow impacts on fish to be minimized. Fish habitat compensation measures will be developed to offset these residual losses in keeping with the requirements of the *Fisheries Act*.

7.3.3 Operation Phase Impacts

7.3.3.1 Detailed Impact Description

During the operation phase, the project components most likely to generate impacts on fish and fish habitat are:

- Site water management;
- Pit development;
- Extraction, handling and ore storage;
- Use and maintenance of machinery and power generating sets and road circulation;
- Water supply;
- Manpower and procurement.

The resulting impacts that might affect fish and fish habitat are:

- **Alteration of fish habitat quality** in streams and lakes during drainage and infiltration of water from the processed kimberlite confinement area and overburden stockpile, discharge of treated mine and domestic effluent and traffic on access roads;
- **Modification of habitat use** by fish in the streams and lakes whose hydrological regime will have been modified by water table drawdown around open pits and by mine site water management;
- **Temporary disruption of fish** due to use of explosives and road circulation;
- **Increased fishing pressure** on sport fish populations due to workers' presence if fishing is not controlled.

➢ *SITE WATER MANAGEMENT*

Alteration of fish habitat quality

Drainage and runoff from the processed kimberlite confinement area, waste rock stockpile, overburden and ore stockpiles, discharge of treated mine and domestic effluents and traffic on mining roads have the potential to modify the quality of nearby lakes and streams. The changes in water quality that could potentially occur and alter fish habitat quality are: an increase in TSS, change in metal concentrations, change in pH and increase in nutrients or organic matter in the water or sediment.

Runoffs and water infiltrating from the processed kimberlite confinement area (Photo 7.3.23) could potentially carry contaminants into lakes F3297 and F3298 (Photos 7.3.24 and 7.3.25). The results of kinetic leaching tests showed that the rock is geochemically inert, meaning it is unlikely to generate acid or leach contaminants in concentrations that could harm aquatic life. Furthermore, the infiltration rates estimated in the processed kimberlite confinement area are 0.9 l/m^2/day compared to 1.2 l/m^2/day for water infiltrating into the overburden. These values are far below the threshold established in Guideline 019 (i.e. 3.3 l/m^2/day). The risk of the fish habitat being contaminated by subsurface seepage is also virtually inexistent. Finally, the surface waters in these two specific areas will be intercepted by a series of drainage ditches and then pumped into a sedimentation pond located in open pit R-65, monitored, treated and discharged into Lake Lagopede.

The final treated effluent discharge point was chosen to take advantage of environmental features promoting its dispersion and minimizing impacts on fish and fish habitat as described in the analysis of alternatives (Section 3.2.2.4). Treated mine and domestic effluent discharge may modify water quality in the Lake Lagopede dispersion plume (Photos 7.3.26 and 7.3.27). The results of treated mine effluent plume dispersion modeling (Appendix 3.10.1) show that, under severe low-water conditions, the initial treated effluent concentration would reach a dilution factor of 1:10 at 750 m from the outfall discharge point (Figure 3.10.7) and 300 m during fall mixing (see Section 3.10.5.2 and Figure 3.10.8). In the northern basin, at the plume's edge, concentrations of the different contaminants will be within the range measured in the environment in the Environmental Baseline Study (Roche, 2011), with the exception of total phosphorus, whose concentration at the plume edge may be slightly higher (0.01 mg P/l) than in the lake (95th percentile = 0.007 mg P/l). In Lake Lagopede's northern basin, phosphorus inputs from mine effluent could translate into a temporary (around August), site specific increase in the total phosphorus concentration corresponding to that of an oligo-mesotrophic lake (typically between 0.007-0.013 mg/l of total phosphorus; MDDEP, 2007). Depending on the proportion of this total phosphorus that is bioavailable in the form of orthophosphates, these inputs could possibly contribute to a limited, temporary increase in the productivity of this sector of Lake Lagopede and in its fisheries potential. Given the lakes's hydraulic residence time, which is 53 days, and the temperature drop that generally occurs in September, this effect will be short-lived, possibly limited to August. To validate the impact assessment, a water quality monitoring program targeting Lake Lagopede and its effluents is envisaged (see Chapter 11).

During the operation phase, domestic effluent discharges are lower than those anticipated during the construction phase. Therefore, the initial dilution limits and 1:100 dilution will be achieved closer to the discharge point. The 1:100 dilution limit will be reached approximately 38 m downstream of the discharge point at mean flow and potentially 83 m at hourly peak flow (Figure 3.10.5).

The plume will not rise to the surface in the 1:100 mixing zone but will remain in the water column at a depth of 4 to 6 m. The mine and domestic effluent plumes will not overlap (Environnement Illimité, 2011).

The main impact on fish associated with effluent discharge is the avoidance effect. Certain, so-called specialist species, like Lake Trout, are likely to avoid the plume's initial mixing zone.

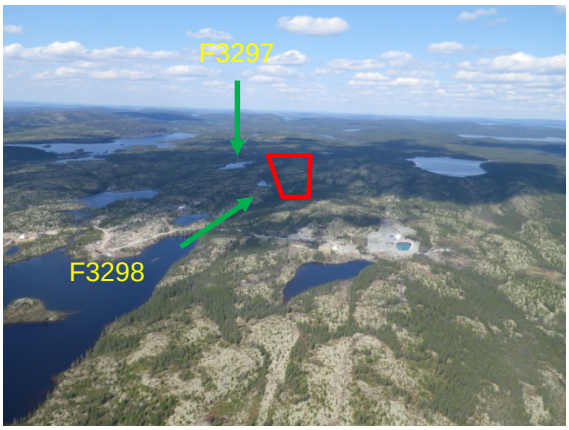


Photo 7.3.23 Area Envisaged for Processed Kimberlite Confinement (June 2011)



Photo 7.3.24 Lake F3298 Bordering the Processed Kimberlite Confinement Area (September 2010)



Photo 7.3.25 Lake F3297 Bordering the Processed Kimberlite Confinement Area (September 2010)



Photo 7.3.26 Treated Domestic Effluent Discharge Site in Lake Lagopede (June 2011)



Photo 7.3.27 Treated Mine Effluent Discharge Site in Lake Lagopede (June 2011)

Alteration of fish habitat use

The hydrological regime of certain streams will change following stream diversions and implementation of the water management plan required to prevent alteration of the quality of Lake Lagopede's water due to the mine's operation. This change in the hydrological regime could decrease surface water inflow into certain streams and water bodies. The drainage ditches envisaged in the water management plan will gather some of the surface runoff upstream of lakes F2607, F3295, F3296 and F3298, thereby reducing the daily water inflows into these lakes. To quantify the impact of the water management plan, the percentage of daily flow reduction was estimated using the surface area of the sub-watershed to be drained over the surface area of sub-watersheds specific to each water body. The reduction in the surface area of the sub-watersheds supplying lakes F2607, F3295, F3296 and F3298 is 26.5%, 8.2%, 7.8% and 69.9% respectively. A reduction in daily surface flows into these lakes might decrease the water level and outflow from the lakes affected, especially during low flow periods. To ensure that the minimum flows fish need to survive are met year-round in the outlets of the lakes affected, the stream ecological flows were estimated as of 0.5 QMA (half of annual flow) for each of these lakes (Belzile *et al.*, 1997). The ecological instream flow estimated using 0.5 QMA is conservative, since it encompasses all of the flows a given species requires year-round. For example, the ecological instream flow required for the salmonid's egg incubation period corresponds to 0.25 QMA, which is lower than the flow shown here (Belzile *et al.*, 1997). The ecological instream flows will be respected in all streams (Table 7.3.4).

Table 7.3.4 Estimated Reduction of Flows supplying Lakes F2607, F3295, F3296, F3298 and F3301 resulting from the Water Management Plan's Implementation

Lake	Lake's initial drained mean daily flow (m^3/d)	Reduction in lake's initial drained mean daily flow (%)	Daily mean outflow (m^3/d)*	Ecological instream flow year-round 0.5 QMA (m^3/d)
F2607	9,167	26.5	6,638	1,799
F3295	5,589	8.2	5,073	1,066
F3296	5,750	7.8	5,295	1,099
F3298	578	69.9	163	97
F3301	4,246	0	4,184	798

*Note: The final flow reflects lake evapotranspiration.

To avoid losing fish habitat in lake F3298 (the most affected) and respect the ecological instream flow in the lake F3298 outlet (presence of Brook Trout), a hydraulic structure (weir with notch or other) will be built at the lake outlet. If this mitigation measure is insufficient to maintain an acceptable water level in the lake and its outlet, an infiltration well will be set up upstream of lake F3298, in the drainage ditch surrounding the kimberlite confinement area (PKC). This infiltration well will allow a portion of the surface waters to be recovered and directed to lake F3298 instead of the open pit R-65. The infiltration well's technical feasibility study will be conducted, if need be, during the project's detailed engineering phase.

The absence of a tributary supplying lake F3298, which is a sub-watershed head lake, suggests that the lake is supplied by groundwater. The bedrock's low permeability does not promote water infiltration from the surface deposits into the bedrock. Consequently, a significant portion of the surface waters supplying the lakes seems to originate primarily from groundwater resurgences from the deposits (Itasca, 2011). The water table's drawdown immediately around the open pit mines threatens to alter the hydrological regime of the lakes and streams nearby. The reduction in certain lakes' water levels could potentially modify fish habitat use. For example, accessibility to certain shoreline areas favourable to feeding might be restricted. Simulation results showed that groundwater levels could be lowered from a dozen meters to a maximum of approximately 500 m near the open pit mines' walls. The propagation line corresponding to a 1 m drawdown is limited mainly to the mine site, i.e. 1 km from the open pit mines. The lakes and streams located nearby will be dewatered before the open pits are developed. Four lakes large enough to be modeled (F2607, F3295, F3298 and F3301) are located in the propagation line corresponding to a 1 m drawdown. Simulation results show that the decrease in resurgences would be negligible for lakes F3295 and F3298. For lake F3301, the reduction would be about 40 m^3/d of the base flow and for lake F2607, 60 m^3/d (Itasca, 2011). These decreases correspond to approximately 0.01% of the daily flow for lakes F3301 and F2607 and to less than 2% for lake F3298, which indicates that the impact of the water table's drawdown on fish habitat will be negligible (see Section 6.6.3 for further details on modeling groundwater drawdown).

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

Machinery circulating on mining roads could cause an increase in sediment transport into the waterways near the worksite. If sediment transport is not controlled at the source, the rise in TSS could have site-specific impacts on fish and fish habitat, including change in food-seeking behaviour, deposit of particles on spawning substrate and, in extreme cases, damage to the gills (Bash *et al*., 2001). As a result, several at-source erosion and sediment transport control measures will be implemented and an integrated water management plan has been developed (see Section 6.8.2 and Section 6.8.3 on water quality).

- *WATER SUPPLY*

The water supply intake located in Lake Lagopede (32302) could generate a drop in the lake's water level, thereby altering fish habitat use. Given the low flow rate pumped in the lake (106 m^3/d during the operation phase), its large volume (21 Mm^3), and its hydraulic residence time (53 days), there will be no significant change in the lake's level (< 5 mm under extreme conditions) and, consequently, in fish habitat use.

The presence of a water intake could have a short-term effect on habitat use and cause fish to avoid this area. This is why the site selected for the water intake's installation was chosen in keeping with DFO recommendations (1995).

- *PIT DEVELOPMENT; EXTRACTION, HANDLING AND ORE STORAGE*

Fish disruption

Drilling and blasting for open pit operation and machinery traffic near streams may cause vibrations and sound waves that could disrupt fish. Lake Lagopede's northeastern bay, lakes F2607, F3295, F3296, F3298 and F3301 and the outlet of lakes F3296, F3298 and F3301 are most likely to be affected. Fish usually move to other similar habitats located nearby to avoid the areas affected by vibrations. Fish exposed to high sound pressures may engage in avoidance behaviour for periods of time that vary by species (Popper and Hastings, 2009). In extreme cases, the internal organs (e.g. swim bladder, kidneys, liver, spleen, etc.) may be damaged and the eggs and larvae destroyed. These effects are seen only in cases of surges exceeding 100 kPa (Wright, 1982). The damages' scope depends on the type of explosive, its size, firing plan, detonation method, distance from the detonation point, water depth, fish species, size and life cycle. Use of explosives in or near fish habitat can also physically or chemically alter the latter. For example, sedimentation resulting from the use of explosives can cover spawning sites (DFO, 1998). The effects of vibrations and sound waves from blasting will be located near the open pits. The fish of lakes F3302 and F3303 and their outlets will not be impacted since these lakes and streams located near the open pits will be dewatered beforehand. To prevent any impact on fish in the water bodies and streams on the periphery of the open pits (Lake Lagopede's northeastern bay, lakes F2607, F3295, F3296, F3298 and F3301 and the outlet of lakes F3296, F3298 and F3301), the mitigation measures discussed in Section 7.3.3.2 will be implemented.

- *MANPOWER AND PROCUREMENT*

Increased fishing pressure

The Renard Project is located in the James Bay territory on Category III lands. The rules governing fishing are the same as for the rest of Quebec, except for Lake Whitefish, a species strictly reserved for Native people. Increased fishing pressure is foreseeable since the Renard Project expects to employ about 450 employees annually while the mine is in operation (a 20-year period). Some of these workers may want to go fishing in the little free time they have outside working hours. To prevent this impact, fishing will be prohibited on-site by contractual clauses governing workers and contractors.

7.3.3.2 Mitigation Measures

- *SITE WATER MANAGEMENT*

Water management-related mitigation measures are discussed in the section on water quality (Section 6.8). Among other things, a drainage system and integrated water management plan are envisaged to prevent and limit impacts on fish habitat (see Section 6.8.2 and 6.8.3).

For fish habitat more specifically, the following measure is envisaged:

- Build a hydraulic structure (weir with notch or other) at the lake F3298 outlet to maintain the lake's water level and respect lake F3298 outlet's ecological instream flow.

➢ *PIT DEVELOPMENT; EXTRACTION, HANDLING AND ORE STORAGE*

To minimize this work's impact on fish disruption and fish habitat use, the following measures will be implemented (DFO, 1998):

- The contractor must comply with guidelines governing the use of explosives in or near Canadian fisheries waters;
- It is prohibited to use ammonium nitrate or fuel oil in or near fisheries waters due to the production of toxic by-products (i.e. ammonium hydroxide).

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

To limit vibrations and dust emissions that could affect fish and fish habitat, the following measures will be implemented:

- Vehicles will have to travel slowly (30 km/h speed limit on-site and 70 km/h on secondary roads);
- Unauthorized machinery traffic will be prohibited outside work areas;
- Vehicles shall not travel less than 30 m from a stream unless there is a specific reason;
- If dust control agents are used, they must be MDDEP-compliant or MDDEP-approved.

➢ *WATER SUPPLY*

The operation phase water supply mitigation measures are the same as those for the construction phase.

7.3.3.3 Residual Impact Assessment

During the operation phase, the intensity of the residual impact on fish is low since the main habitat destruction will already have occurred during the construction phase. The extent of the impact will be local, since it will be limited to the streams and water bodies in the study area. Fish habitat disturbances will be of moderate duration with regard to water quality modification restricted to the operation phase. In short, the significance of the residual impact on fish will be moderate.

7.3.4 Closure Phase Impacts

7.3.4.1 Detailed Impact Description

In the closure phase, site water management is the project component most likely to have an impact on fish and fish habitat:

- **Gain in fish habitat –** 220,000 m^2 resulting mainly from flooding open pits R-65 and R-2/R-3;
- **Alteration of fish habitat quality** – after discharge of domestic and mine effluents into Lake Lagopede ceases.

➢ *WATER MANAGEMENT*

Gain in fish habitat

As far as possible, when mining operations end, surface drainage will be re-established at pre-project-like conditions. Open pits R-2/R-3 and R-65 will cease to be drained and will gradually become “lakes”. More than 220,000 m² of fish habitat will be developed by flooding R-65 and R-2/R-3. The lake F3298 outlet, which will have been diverted to lake F3295, will be diverted anew to open pit R-65 to accelerate filling. A hydraulic surface connection will be developed between this new lake and Lake Lagopede’s northeastern bay to ensure the free passage of fish between the two water bodies. An hydraulic connection will also be established between open pit R-2/R-3 and the site’s drainage system to ensure pit filling. Once open pit R-2/R-3 has been filled, an hydraulic connection will be set up with the natural environment, probably Lake Lagopede. It will take about 6 years for the system to return to a state of equilibrium (Itasca, 2011). The lakes created in the pits will be large and their average depth deeper than all of the study area’s lakes. They will be suitable to species valued by the Cree (Brook Trout, Lake Trout, Lake Whitefish and Burbot).

Alteration of fish habitat quality

After mining activities have ceased, no more domestic or mine effluents will be discharged into Lake Lagopede. Therefore, the physical and chemical characteristics of the water and sediment at the two discharge points should return to initial baseline conditions.

The draining of runoff from the processed kimberlite confinement area will continue to flow into the hydrographical network after the mine’ closure. However, the area’s stabilization and revegetation will provide additional water retention and filtration capacity, permitting a gradual return to the initial baseline quality measured. The results of Itasca’s modelling (2011) seem to show that only low concentrations of contaminants in the waters seeping through areas where mining activities’ materials are stored will be found in the resurgence points. The results of geochemical tests and modelling suggest concentrations in the order of magnitude of the naturally-occurring background noise.

7.3.4.2 Mitigation Measures

➢ *WATER MANAGEMENT*

While open pits R-65 and R-2/R-3 are flooded, various measures will be applied to minimize the impacts on fish:

- The pits will be filled gradually to avoid particle suspension;
- Hydraulic connections will be developed with the natural environment to ensure free fish passage.

7.3.4.3 Residual Impact Assessment

During the closure phase, the intensity of the residual impact on fish and fish habitat is positive and moderate since there will be a gain in the latter. The impact's extent will be site-specific, since it will be restricted to the two open pits and nearby streams. The duration will be long, the fish habitat gain will be permanent since filling the pits is an integral part of the closure plan. In short, the significance of the residual impact on aquatic life in the closure phase will be moderate and positive since it constitutes a major gain in fish habitat.

7.3.5 Fish Habitat Compensation Measures

Certain project components will permanently destroy fish habitat. To meet the requirements of the *Fisheries Act,* which stipulates zero net fish habitat loss, a preliminary fish habitat compensation program has been developed. This program specifies the type of intervention proposed (development of spawning sites, creation of shelters and feeding grounds), target species, sites envisaged, etc.

Various avenues have been proposed to offset the fish habitat losses incurred through the project. This compensation program will have to be analyzed and discussed with the parties in question to meet governmental requirements and the objectives of the *Fisheries Act*.

7.3.5.1 Species Targeted by Compensation Measures

The main fish species targeted by the compensation measures are those that use the habitats destroyed by the project and that represent an important fish resource for the Cree, Fisheries and Oceans Canada (DFO) and the Ministère des Ressources Naturelles et de la Faune du Québec (Quebec Ministry of Natural Resources and Wildlife) (MRNF), notably Brook Trout (*Salvelinus fontinalis*) and Lake Trout (*Salvelinus namaycush*).

Given the receiving environment's pristine nature and current conditions, compensation measures are relatively limited on the outskirts of the project. However, certain habitats that are under-represented in the sector could be targeted by measures to enhance their productivity. In the study area, Brook Trout populations are limited to small sub-watershed head waters or stream sections. Furthermore, in some cases, free fish passage is limited by the presence of underground or diffuse flows. The development proposed will target primarily Brook Trout spawning habitats. Since Lake Trout is not strongly represented in the study area's lakes, spawning habitat development for this species will be implemented in Lake Lagopede.

7.3.5.2 Compensation Sites Envisaged

To define compensation options, many sites were visited in the Renard Project study area, notably all Lake Lagopede tributaries. The main sites proposed for compensation measures are shown on Map 7.3.3.

7.3.5.3 Measures Proposed

The measures proposed, target species, function of the habitat developed and potential habitat gain are illustrated in Table 7.3.5. A detailed description of each measure is given below.

Table 7.3.5 Description of Compensation Measures proposed to Offset Fish Habitat Losses generated by the Project

Compensation site	Location (MTU zone 18)	Measures proposed	Target species	Habitat function	Habitat (m^2)
Lake Lagopede	687616 5854093	Lake spawning site	Lake Trout	Spawning	300
Lake Lagopede	687917 5855050	Lake spawning site	Lake Trout	Spawning	200
Lake F3294 outlet	687930 5856508	Gravel box	Brook Trout	Spawning	50
Lake F3294 outlet	687907 5856271	Gravel box	Brook Trout	Spawning	150
Lake F3294 outlet	687921 5856203	Gravel box	Brook Trout	Spawning	50
Lake F2604 outlet	689838 5857329	Weir (n=5)	Brook Trout	Spawning	100
Lake F2604 outlet	689805 5857284	Cleaning	Brook Trout	Migration	150
Lake F3293 outlet	687174 5855933	Sills n=5)	Brook Trout	Spawning	100
Lake F3301 outlet	689695 5854762	Sills (n=5)	Brook Trout	Spawning	100
TOTAL					**1,200**
Unnamed stream #1	693003 5854945	Sills (n=5)	Brook Trout	Spawning	100
Unnamed stream #1	693005 5854833	Cleaning	Brook Trout	Migration	200
Unnamed stream #2	692309 5852881	Sills (n=5)	Brook Trout	Spawning	100
TOTAL					**400**
Open pit R-65	689010 5855740	Watering	Lake Trout, Northern Pike, Burbot and Lake Whitefish	Feeding	96,000
Open pits R-2-R-3	689344 5855123	Watering	Brook Trout	Feeding	126,000
TOTAL					**222,000**
GRAND TOTAL					**223,600**

- *DEVELOPMENT OF SPAWNING SITES*

Lake Lagopede

During the surveys, two potential Lake Trout spawning sites development were identified in the northern portion of Lake Lagopede (Photos 7.3.28 and 7.3.29). The southernmost site offers Lake Trout suitable spawning conditions. Both sites consist of two rocky shoals, composed mainly of boulders and cobbles, located near a deep pool (up to 15 m) (Photo 7.3.30). The water depth over these shoals varies from 0.5 m to 3 m. Their slopes towards the deeper areas are quite abrupt. The surface area of these potential spawning sites is approximately 2,500 m^2 and 1,000 m^2 respectively. Sites with similar characteristics were also observed in the southern portion of Lake Lagopede.

The development proposed involves placing stones 5 cm to 30 cm in diameter around the shoals to increase the Lake Trout spawning site surface area. The gains in Lake Trout spawning habitat could correspond to about 500 m^2.

Lake F3294 outlet

Although no Brook Trout were caught during the fish survey in Lake Lagopede, the species is found in some of its tributaries, notably the lake F3294 outlet, which is the lake's main tributary. This stream is fast-flowing, more than 10 m^3/s at high water compared to less than 1 m^3/s for other streams typical of the study area. Consequently, its substrate is generally composed of boulders and cobbles. The scarcity of gravel in this stream may limit Brook Trout spawning activity. One Brook Trout fry was seen here in spring 2011.

Based on observations for this stream, three potential sites were targeted for Brook Trout spawning habitat development. The chosen sites are small secondary channels (Photos 7.3.31, 7.3.32 and 7.3.33) where the current slows down and gravel is present (Photo 7.3.34). The development will be gravel boxes, which require creating riprap keys upstream and downstream of the secondary channels and placing gravel between them. These riprap keys will reduce flow velocity and avoid gravel loss in the gravel boxes. The implementation of these three gravel boxes will create approximately 200 m^2 of Brook Trout spawning habitat.



Photo 7.3.28 Location of Rocky Shoal #1 in Lake Lagopede (2011)



Photo 7.3.29 Location of Rocky Shoal #2 in Lake Lagopede (2011)



Photo 7.3.30 Substrate Observed at Foot of Shoal #1 in Lake Lagopede (2011)



Photo 7.3.31 Potential Location of Gravel Box #1 Situated in Lake's F3294 Outlet (2011)



Photo 7.3.32 Potential Location of Gravel Box #2 Situated in Lake's F3294 Outlet (2011)



Photo 7.3.33 Potential Location of Gravel box #3 Situated in Lake's F3294 Outlet (2011)

Secteur de la mine / Mine area

Exutoire du lac F2604

Exutoire du lac F3294

Exutoire du lac F3293

R-65

R-2

R-3

Exutoire du lac F3301

Ruisseau sans nom 1

Ruisseau sans nom 2

Lac Lagopède

1

2

5 860 000 mN

5 855 000 mN

5 850 000 mN

685000 mE

690 000 mE

695 000 mE

0 1 2 km

Échelle / Scale 1 : 50 000

UTM, zone 18 (NAD83)

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

Secteur de la piste d'atterrissage / Airstrip Area

LEET

Bancs d'emprunts potentiels / Potential borrow pits

5 847 500 mN

5 845 500 mN

0 1500 m

UTM, zone 18 (NAD83)

Échelle / Scale: 1: 70 000

Courbe de niveau (intervalle de 50 pieds) / Contour line (50 feet interval)

685 000 mE

687 500 mE

690 000 mE

Limites de l'aire d'étude / Study area limits

Secteur de la mine

Mine area

Lac Emmanuel

Rivière Nenveuse

Secteur de la piste d'atterrissage

Airstrip area

0 10 km

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

- Mise en eau des fosses / Open pit rewatering
- Emprise du projet / Project footprint (26/10/2011)
- Frayère potentielle à aménager / Potential trout spawning site
- Cours d'eau potentiel pour la compensation / Potential stream for compensation
- Cours d'eau visités pour la compensation / Potential stream visited for compensation

Localisation des sites potentiels à aménager dans le cadre du projet de compensation / Potential site for fish habitat compensation project

ROCHE

Carte de base / Base Map : Stornoway, 2010; CanVec, 1: 50 000, 33A16-33A09, RNCan, 2010
Fichier / File : 61470_EIES_Compensation_111221.WOR

Décembre 2011 / December 2011

Carte / Map 7.3.3

Lake F3301 Outlet

The lake F3301 outlet connects lake F2607 to lake F3301 (Photo 7.3.35). While both of these lakes support a Brook Trout population, they offer few good quality habitats mainly due to the fact that they are not very deep. The stream connecting these lakes flows over about 400 m; its flow facies consists of riffle and channel. Various sectors were identified to develop rock weirs (Photo 7.3.36), creating a small retention pool where the gravel will be placed. At least five weirs could be developed in this stream, resulting in a gain of about 100 m^2 of Brook Trout spawning habitat.

Lake F2604 Outlet

The lake F2604 outlet flows over some 570 m and connects lakes F2604 and F3297. This stream is characterized by alternating riffle and deep channel (± 1 m) flow facies whose substrate consists of cobbles, gravel, sand, organic matter and boulders. Brook Trout is present in both lakes and in the stream.

Various potential sites were identified to set up rock weir in the riffle sections (Photo 7.3.37). Adding gravel in the retention pools created by the weirs will generate a Brook Trout spawning habitat gain of about 100 m^2.

Lake F3293 Outlet

The lake F3293 outlet flows over some 400 m into Lake Lagopede's western bay, with alternating riffle and channel flow facies (Photos 7.3.38 and 7.3.39). Brook Trout were caught here in 2009 (Stantec) and observed in 2011 (Roche) feeding in a section of the stream flowing in a channel facies. The presence of gravel, cobbles and pebbles in riffle facies indicates spawning potential in the stream.

Creating rock weirs in the lake F3293 outlet would slow current velocity in some sectors. Adding gravel to the weirs would increase this stream's Brook Trout spawning potential.

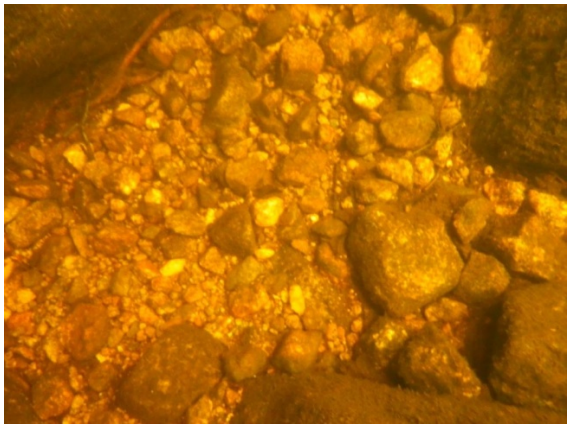


Photo 7.3.34 Substrate Observed in Different Potential Gravel Box Sites (June 2011)



Photo 7.3.35 Location of Lake F3301 Outlet (June 2011)



Photo 7.3.36 Riffle Flow Facies in the Lake F3301 Outlet (June 2011)



Photo 7.3.37 Site for Setting up a Rock Weir in the Lake F2604 Outlet (June 2011)



Photo 7.3.38 Riffle Flow Facies in the Lake F3293 Outlet (May 2011)



Photo 7.3.39 Channel Flow Facies in the Lake F3293 Outlet (June 2011)

Unnamed streams #1 (MTU zone 18, 693005 5854833) and #2 (MTU zone 18, 692309 5852881)

Other streams in the study area with development potential are unnamed streams #1 and #2, which flow into one of the Misask River's main tributaries. Both have riffle and channel flow facies (Photos 7.3.40 and 7.3.41). Their dominant substrate consists of gravel, cobbles, sand and organic matter.

Developing rock weir in these two streams would create roughly 100 m^2 of Brook Trout spawning habitat per stream. However, they can be accessed by helicopter only, thereby considerably increasing the related development costs.

- *STREAM CLEANING*

Certain streams to be developed, notably the lake F2604 outlet and unnamed stream #1, flow diffusely and underground over several meters in their downstream section, just before their confluence with a lake or another stream (Photos 7.3.42 and 7.3.43). These sections limit fish passage upstream where quality habitats with development potential have been identified. Cleaning and creating a well-defined channel in these sections would create a migration habitat and facilitate fish movement to these good quality habitats.

7.3.5.4 Habitat Gains and Losses – Balance Sheet

Overall, the fish habitat losses related to the Renard Project represent about 41,617 m² (4,625 m² in streams and 36,992 m² in lakes). The fish habitat gains anticipated through the developments suggested and by flooding the open pits when operations cease represent 310,600 m² (1,100 m² in streams, 500 m² in lakes and 222,000 m² in the pits).

The project-generated fish habitat losses result primarily from dewatering lakes F3302, F3303 and lake F3298 and F3302 outlets. The absence of species of interest in lake F3302 and the poor quality habitats found in these two lakes reduce the impact's intensity in this area. The two streams offer habitats of average quality. The developments identified under the compensation measures will create more than 1,000 m^2 in diverse habitats. Fish habitat use (spawning) and the species (Brook Trout and Lake Trout) targeted by the developments suggest that the compensation measures will benefit the environment. Once the pits have been flooded in the closure phase, habitat gains far exceed (222,000 m²) habitat losses. In addition to a significant gain in fish habitat, all of the species targeted by watering the pits are valued by the Cree (Northern Pike, Lake Whitefish, Burbot, Brook Trout and Lake Trout).



Photo 7.3.40 Upstream Section of Unnamed Stream #1 (2011)



Photo 7.3.41 Aerial View of Unnamed Stream #2 (2011)



Photo 7.3.42 Downstream Section of the Lake F2604 Outlet (2011)



Photo 7.3.43 Section of Diffused Flow of Unnamed Stream #1 (2011)

7.4 Vegetation and Wetlands

7.4.1 Current Conditions

The biological environment's valued components were assessed as part of the Renard Diamond Project's Environmental Baseline Study (Roche, 2011). Among other elements, this study aimed to generate detailed maps of the study area's forest stands and wetlands.

To begin with, the existing literature was reviewed to determine whether surveys of the area had been previously performed. The *Ministère des Ressources Naturelles et de la Faune* (MRNF) was contacted to verify whether the study area enclosed any exceptional forest ecosystems (EFE). Aerial photographs taken in 2004 (scale 1:3,000) were interpreted to identify and define the types of forests (coniferous, mixed, deciduous) and wetlands (peatland, marsh, swamp, etc.) found in the area. The survey and delineation of wetlands was performed according to the MDDEP's guide "*Identification et délimitation des écosystèmes aquatiques, riverains et humides"* (2006). A particular attention was paid to the study area's sensitive and scarce habitats. The photo-interpretation was validated in the field through 96 checkpoints (vegetation survey stations; Map 7.4.1 in Volume 3).

Field surveys were carried out between August 3 and 12, 2010.

The survey methods and information sources used for this purpose are described in details in the background report produced by Roche (2011).

7.4.1.1 Regional Environmental Conditions

In Quebec, the James Bay territory stretches from approximately the 49th to the 55th parallel North latitude and covers more than 400,000 km^2. This vast, rugged territory is characterized by a harsh, cold sub-Arctic climate that limits the growing season. Winter begins in late October and ends in early May.

The region's forests consist primarily of Black Spruce, Jack Pine, Tamarack and Trembling Aspen stands. Tree diameters are a mere 10 to 15 cm, which does not allow commercial harvesting in the northern sector where the Renard Project is located. Here and there, burns are present, the vestiges of fires lit by lightning during long summer droughts. These burned areas are covered with Lichen, essentially of the genus *Cladonia*. Some deciduous species grow in the rare sunny locations protected from the wind.

For the most part, the James Bay territory is located within the boreal vegetation zone, continuous boreal forest and taiga subzones, more specifically the Spruce-Moss and Spruce-Lichen bioclimatic domains (MRNF, 2003).

The taiga subzone, composed of the Spruce-Lichen bioclimatic domain, is highly representative of Nord-du-Québec, in addition to being one of the most common domains in North America. The Renard Project is located in the taiga subzone, which represents 29% of the Nord-du-Québec region's forest cover which is dominated by Black Spruce. It differs from the Spruce-Moss domain in its sparse forest

cover. This zone is also characterized by vast fire-ravaged tracts. Spruce-Lichen forests stretch virtually from the 52th to the 55th parallel.

The James Bay territory's forest dynamics reflect major disturbances, mainly fire—the northern boreal forest's leading disturbance (Commission de la Baie-James, 2010). In the northern James Bay territory, where the Renard Project is located, the lack of a firefighting program means that the fire cycle is relatively short, i.e. 50 to 115 years. Consequently, open Spruce forests and Jack Pine forests with Cup Moss are the two main stands observed here. Jack Pine is generally most common in locations with high fire recurrence and on well-drained sites (Le Goff & Sirois, 2004). Black Spruce may or may not be present after fire and constitutes the leading forest stand in the absence of fire. Three fires disturbed the Renard Project study area between 1935 and 1970. The first occurred in the VGR71 station area around 1935 (± 5 years); the second, around 1970, in the VGR87 station area; and the third, in 1979, in the VGR45 station (Map 7.4.1 in Volume 3). The post-fire regenerating areas were taken into account for young stands.

These forest dynamics are also determined by the underlying surficial deposits. For example, glacial silt-sand deposits (fine deposits) are essentially covered by stands dominated by Black Spruce. Coarser sand-and-gravel deposits are dominated by Jack Pine, a fact that could be partly explained by a shorter fire cycle. Organic deposits are covered by Black Spruce. Certain environments, like peatlands, are less conducive to short-term fire recurrence. The low impact of fire in these environments also explains the preservation of Tamarack in peatlands.

The plant communities observed during the surveys can be grouped into two types: forest stands, which occupy about 96% of the study area (i.e. 10,108.6 ha), and wetlands, covering just over 2% of the area (266.6 ha). Table 7.4.1 illustrates the relative dimensions (in terms of surface area) of each plant community observed in the mine and airstrip areas. The relative scarcity of wetlands in the study area is not representative of the regional situation. Based on the distribution map produced by the National Wetlands Working Group (Environment Canada, 1986), wetlands cover from 6 to 25% of the landscape, thereby constituting an environmental component that is well-represented regionally. The forest stands consist of six plant communities: Black Spruce-Lichen, Black Spruce-Sphagnum, Black Spruce-Moss, Jack Pine-Lichen, mixed forest and deciduous forest. The wetlands are characterized by bogs (open or forested), riparian fens, patterned fens[7] and swamps. Finally, some sites present an absence of vegetation. They are barren, dry areas generally characterized by boulder fields or rock outcrops. The study area has few dry barrens (1.7%, approx. 185 ha).

[7] Patterned fen: A peatland whose surface appears wrinkled due to a network of alternating ridges (strings) and hollows (flarks),running perpendicularly to the slope. In fens, the ridges or strings are generally smaller, barely a few dozen centimeters higher than the hollows. In bogs, the ridges are called hummocks, due to their unique shape and size, which is sometimes higher and wider than the strings.

Black Spruce-Lichen forests are by far the study area's most represented plant community (Map 7.4.1 in Volume 3). Covering close to 7,945 ha, Black Spruce-Lichen stands occupy over 75% of the study area's land and are mainly observed on dry, well-drained sites.

- *"SPECIAL STATUS" PLANT SPECIES*

Consultation of the information provided by the *Centre de Données sur le Patrimoine Naturel du Québec* (Quebec Natural Heritage Data Centre) (CDPNQ) allowed us to determine that no plant species that is designated "threatened", "vulnerable" or "likely to be designated threatened or vulnerable" has been reported in the study area (Appendix 7.4.1).

According to Blondeau (2004), a species found in the Otish Mountains sector can be considered "likely to be designated threatened or vulnerable" in Quebec according to the list published under section 9 of the *Act respecting threatened or vulnerable species* (R.S.Q., c. E-12.01, s. 9). It is the *Agroseris aurantiaca*, which colonizes mainly prairie grasslands in subalpine environments. This habitat is not well represented in the study area and only a handful of vascular plants that are companion species to it were observed. It was not identified in the study area during vegetation survey performed in August 2010 despite the fact that particular efforts aimed to detect its presence.

- *TRADITIONAL USE OF PLANTS*

According to the information supplied by members of the Cree communities of Mistissini, Nemaska, Wemindji, Eastmain and Waskaganish in 2002 and 2003 for the Eastmain-1A impact study, which was supplemented by data from the literature (Assiniwi 1972, 1988; Fleurbec, 1987), there are apparently about fifty vascular plants for which traditional uses (medicinal, food, etc.) are known in the James Bay territory. These plants have been divided into three groups: trees, shrubs and herbaceous plants (Table 7.4.2).

On the whole, these plants are used for many purposes, notably food, tool fabrication, shelter and traditional medicine.

Among the traditional-used plant species likely to be found in the study area, 24 were observed during surveys (Table 7.4.2). Some are in the northern limit of their range: Eastern White Cedar (*Thuya occidentalis*), Chive (*Allium schoenoprasum*), Common Mint (*Mentha canadensis*), Cow Parsnip (*Heracleum lanatum*) and Common Cattail (*Typha latifolia*). The latter were not seen during the plant survey.

Table 7.4.1 Relative Size and Clearing Areas of Plant Communities in the Study Area and on Mine Property

Plant community	Airstrip area		Mine area				Study area		
	Existing conditions	Total affected during construction phase (ha)	Existing conditions	Total affected during construction phase (ha)	Total affected during operation phase (ha)	Total affected in mine area (ha)	Existing conditions	Total affected by project (ha)	
	Initial stand / wetland size (ha)		Initial stand / wetland size (ha)				Initial stand / wetland size (ha)		
Forest stands									
Black Spruce-Lichen (old)	395.50	0.00	837.20	0.00	0.00	0.00	1,232.70	0.00	
Black Spruce-Lichen (young)	1,197.30	25.95	5,514.80	146.10	22.70	168.80	6,712.10	194.75	
Black Spruce-Sphagnum (old)	49.20	0.00	349.00	38.40	1.70	40.10	398.20	40.10	
Black Spruce-Sphagnum (young)	0.00	0.00	70.20	2.24	3.00	5.24	70.20	5.24	
Black Spruce-Moss (old)	55.00	4.60	1,159.30	0.40	0.00	0.40	1,214.30	5.00	
Black Spruce-Moss (young)	0.00	0.00	89.00	0.00	0.00	0.00	89.00	0.00	
Jack Pine-Lichen (old)	294.00	35.86	0.60	0.00	0.00	0.00	294.60	35.86	
Jack Pine-Lichen (young)	0.00	0.00	11.00	0.00	0.00	0.00	11.00	0.00	
Mixed predominantly hardwood forest (old)	0.00	0.00	2.20	0.00	0.00	0.00	2.20	0.00	
Mixed predominantly coniferous forest (old)	0.00	0.00	78.10	0.00	0.00	0.00	78.10	0.00	
Mixed predominantly coniferous forest (young)	0.00	0.00	6.10	0.00	0.00	0.00	6.10	0.00	
Hardwood forest (young)	0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.00	
Subtotal	1,991.00	**66.41**	8,117.60	187.14	27.40	**214.54**	10,108.60	**280.95**	
Wetlands									
Open bog	42.40	0.00	54.10	3.09	0.60	3.69	96.50	3.69	
Forested bog	43.60	0.00	20.90	0.00	0.00	0.00	64.50	0.00	
Riparian fen	5.20	0.00	62.80	1.72	0.60	2.32	68.00	2.32	
Patterned fen	0.00	0.00	7.20	0.00	0.00	0.00	7.20	0.00	
Swamp	0.80	0.00	29.60	0.00	0.00	0.00	30.40	0.00	
Subtotal	92.00	**0.00**	174.60	4.81	1.20	**6.01**	266.60	**6.01**	
Barrens									
Dry barrens	113.40	14.90	67.80	3.50	0.00	3.50	181.20	18.40	
Anthropic dry barrens	0.00	0.00	3.60	1.90	0.00	1.90	3.60	1.90	
Subtotal	113.40	**14.90**	71.40	5.40	0.00	**5.40**	184.80	**20.30**	
LAND TOTAL	2,196.40	**81.31**	8,363.60	197.35	28.60	**225.95**	10,560.00	**307.26**	
REHABILITATION PLAN									
Surface area revegetated actively		22.90				97.90		120.80	39%
Surface area revegetated naturally		58.41				51.28		109.69	36%
Surface area not revegetated (open pits)	-	0.00	-			22.17	-	22.17	7%
Surface area not revegetated		0.00				54.60		54.60	18%
TOTAL SURFACE AREA REVEGETATED		**81.31**				**149.18**		**230.49**	**75%**

Table 7.4.2 Traditionally Used Plants Likely to be Found in the Study Area

Tree and shrub species	Herbaceous species
• White Birch (*Betula papyrifera*)* • Sweet Blueberry (*Vaccinium angustifolium*)* • White Spruce (*Picea glauca*) • Alpine Bilberry (*Vaccinium uliginosum*)* • Black Spruce (*Picea mariana*)* • Bog Rosemary (*Andromeda glaucophylla*) * • Tamarack (*Larix laricina*) * • Green Alder (*Alnus crispa*) * • Balsam Poplar (*Populus balsamifera*) • Leatherleaf (*Chamaedaphne calyculata*) * • Trembling Aspen (*Populus tremuloides*) • Pin Cherry (*Prunus pennsylvanica*) * • Jack Pine (*Pinus banksiana*) * • Choke Cherry (*Prunus virginiana*) • Eastern White Cedar (*Thuja occidentalis*) • Creeping Snowberry (*Gaultheria hispidula*) *	• Red-osier Dogwood (*Cornus stolonifera*) * • Chive (*Allium schoenoprasum*) • Skunk Currant (*Ribes glandulosum*) * • Wild Sarsaparilla (*Aralia nudicaulis*) • Swamp Black Currant (*Ribes lacustris*) • Purple Avens (*Geum rivale*) • Canada Gooseberry (*Ribes hirtellum*) • Cow Parsnip (*Heracleum lanatum*) • Bog Laurel (*Kalmia polifolia*) * • Bunchberry (*Cornus canadensis*) * • Lambkill (*Kalmia angustifolia*) * • Strawberry (*Fragaria virginiana*) • Labrador Tea (*Ledum groenlandicum*) * • Stiff Club-Moss (*Lycopodium annotinum*) * • Cranberry (*Oxycoccus microcarpus*) • Common Mint (*Mentha arvensis*) • Long-beaked Willow (*Salix bebbiana*) * • Buckbean (*Menyanthes trifoliata*) * • Shining Willow (*Salix lucida*) • Meadow Rue (*Thalictrum pubescens*) • Balsam Willow (*Salix pyrifolia*) • Red Raspberry (*Rubus idaeus*) * • Bush Willow (*Salix humilis*) • Dwarf Raspberry (*Rubus pubescens*) * • Bog Willow (*Salix pedicellaris*) * • Purple Pitcher-Plant (*Sarracenia purpurea*) * • Common Cattail (*Typha latifolia*)

* Species found in the study area.

7.4.1.2 Mine Area

➢ *FOREST STANDS*

Black Spruce-Lichen forests (Photo 7.4.1; Table 7.4.1) which occupy vast surfaces in Nord-du-Québec and dominate the taiga, cover approximately 8,120 ha (78%) of the mine area. These forests are very sparse and Black Spruce cover is generally less than 25%. Reproduction occurs essentially by compact layering around the mother tree.

In these stands, Lichens (*Cladina mitis*, *C. stellaris* and *C. rangiferina*) cover at least 40% of the ground, accompanied by *Pleurozium schreberi* in the shade of spruce or shrubs. Among them, *Betula glandulosa* is quite common and Heaths (Ericaceae) are abundant (*Vaccinium* spp.*, Ledum groenlandicum, Kalmia angustifolia* and *Chamaedaphne calyculata)*. Black Spruce-Lichen stands develop especially north of the 52th parallel, a region characterized by a colder, drier climate preventing development of a closed forest. They ensure the transition to the low tundra formation. Black Spruce-

Lichen stands grow slowly because soil and climate conditions are especially harsh. After a disturbance, reconstruction of Black Spruce stands is very slow and not always certain.

Black Spruce-Lichen forests colonize virtually all types of environments, except damp and very damp sites. They were observed on hilltops, slopes and flat, well-drained land.

The second most common forest stand, in terms of surface area, is the Black Spruce-Moss (1,250 ha; Photo 7.4.2; Table 7.4.1), which constitutes a more open forest occupying the entire northern portion of the Spruce-Moss bioclimatic domain. These stands provide the transition between closed coniferous forests and the taiga, which is definitely open. Black Spruce-Moss stands are dominated by three layers: 1) an open, sparse tree layer, in which we find practically only Black Spruce; 2) a dense, shrub layer of Heaths; 3) a virtually continuous muscinal layer largely dominated by *Pleurozium schreberi*. Of the Heaths, which cover at least 40%, *Ledum groenlandicum* is the most abundant, but *Kalmia angustifolia, Cassandra calyculata, Vaccinium angustifolium* and *Vaccinium myrtilloides* are also observed. In century-old stands, the layer of organic matter covering the soil begins to thicken and falling trees allow the light to enter, promoting the growth of Heaths (Cauboue, 2007).

The Black Spruce-Moss stands surveyed in the study area all reflect the above-mentioned typical pattern. The dominant plant species include *Rubus chamaemorus* and *Empetrum nigrum* (in addition to the species described above). These forest stands present no particular spatial pattern in the study area. However, they seem to be more abundant in the area east of Lake Lagopede.

The study area's third largest forest stand is Black Spruce-Sphagnum (419 ha; Photo 7.4.3; Table 7.4.1), which can be found just about everywhere with limited drainage conditions (poor to very poor) and very slow organic matter decomposition. It is more or less open. The tree layer is occupied by Black Spruce with some Tamarack. Heaths are abundant, covering at least 40% (divided between *Ledum groenlandicum, Kalmia angustifolia, Kalmia polifolia, Chamaedaphne calyculata and Andromeda glaucophylla)*. The soil is organic, saturated with water and covered with Sphagnum. These stands are observed on flat land and in closed, damp hollows; they are growing very slowly and are not highly productive (Cauboue, 2007).

In the Renard Project study area, Black Spruce-Sphagnum stands are observed primarily in hollows, near lakes and streams, generally adjacent to peaty environments. In addition to Black Spruce, Tamarack and Balsam Fir are present in the tree layer.

The following forest stands were also observed in the mine area: Jack Pine-Lichen, deciduous, and mixed stands (dominated either by deciduous trees or conifers). Altogether, those represent only 1% of the terrestrial environment of the study area. Barrens were also observed. The lower abundance of these stands is a direct consequence of the harsher climate conditions prevailing at the study area's latitude. It is quite scarce to see deciduous stands other than White Birch's and Trembling Aspen's at this latitude, the latter being essentially limited to slopes facing south. Still, these species and the stands

they compose become very common and quite abundant as moving south. Given this extensive cover, these species and their related forests stands do not represent a particular interest on behalf of conservation purposes.

As for the presence of exceptional forest ecosystems in the study area, field observations corroborated the information supplied by the MRNF to the effect that no such ecosystem is present in the study area.

- *WETLANDS*

Wetlands were divided into four main categories: bogs (open or forested), riparian fens, patterned fens and swamps. The small surface areas covered by wetlands in the mine area (174.6 ha, or 2% of the mine area; Table 7.4.1) are essentially represented by bogs, riparian fens and swamps.

Bogs are characterized by the fact that the mineral elements needed for vegetation growth come exclusively from rain falls, decomposing plants and humification. Since rainwater supplies few minerals, the vegetation present in these peatlands, which is dominated by Sphagnum, is acidophilic and deprived of vascular species (Payette and Rochefort, 2001).

Bog vegetation is generally less diversified than fen vegetation and includes very few vascular plants. In a comprehensive analysis of the plant species found in 65 northeastern American bogs, Glaser (1992, taken from Payette and Rochefort, 2001) counted only 81 vascular species. The poorest bogs (less than 20 vascular species) are those that are continental in range and covered by forests, west of Quebec. The peatlands observed in the study area belong to this category. Those of the Atlantic maritime regions are richer, with 32 to 50 vascular species.

Fens contain diversified vegetation which grows in damp conditions where groundwater level is high. These peatlands are located in hollows or on slopes where water flows freely and carries dissolved mineral elements from adjacent mineral sites. More often, fen vegetation is dominated by a grass cover, notably Sedges (Cyperaceae) and Bryophytes (e.g. brown mosses of the Amblystegiaceae family), shrubs and trees. When the pH is high, Sphagnum is rare or absent (Payette and Rochefort, 2001).

The study area's fens are riparian. They have no apparent structure on the surface and are common along boreal streams and lakes (Payette and Rochefort, 2001).

Swamps are dominated by woody vegetation, trees and shrubs, growing on mineral or organic soils subject to seasonal flooding or characterized by a high water table and a circulation of dissolved mineral-enriched water. Swamps are either isolated or opened onto a lake or a stream (MDDEP, 2006). This type of wetland represents a small proportion of the totality of wetlands surveyed in the study area.



Photo 7.4.1 Black Spruce-Lichen forest



Photo 7.4.2 Black Spruce-Moss forest



Photo 7.4.3 Black Spruce-Sphagnum forest

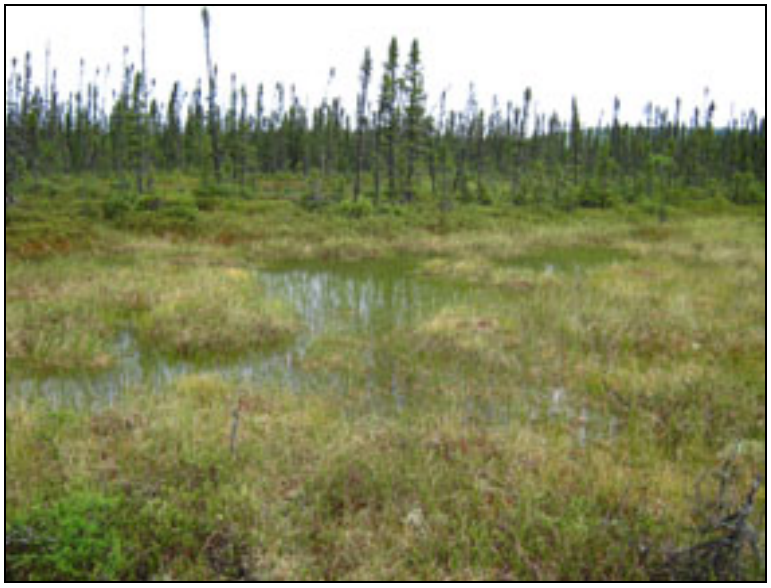


Photo 7.4.4 Bog



Photo 7.4.5 Riparian fen



Photo 7.4.6 Swamp

Finally, patterned fens are peatlands whose surface appears wrinkled due to a network of alternating narrow ridges (strings) and hollows (flarks), running perpendicularly to the slope. In fens, ridges are generally smaller, barely a few dozen centimeters higher than the hollows. Among patterned fens, and generally speaking, fens appear wrinkled (with vegetated hollows) or stringed, whereas bogs are concentric, excentric or reticulate (Payette and Rochefort, 2001). All of the study area's patterned fens were wrinkled or stringed.

7.4.1.3 Airstrip Area

- *FOREST STANDS*

The main forest stands identified in the airstrip area were Black Spruce-Lichen (58.5%) and Jack Pine-Lichen (10.8%; Table 7.4.1). Black Spruce-Moss and Black Spruce-Sphagnum stands and numerous dry barrens (boulder fields, etc.) were also observed.

- *WETLANDS*

In regard to wetlands, an extensive forested bog is located in the northwest corner of the study area (Map 7.4.1 in pocket). Bogs represent most of the wetlands identified in this area, i.e. 86 of the 92 ha covered by this type of ecosystem (Table 7.4.1). A few small fens and one swamp were also found.

7.4.2 Construction Phase Impacts

7.4.2.1 Impact Description and Assessment

Figure 5.1.1 identifies the potential impacts resulting from the interaction between project components and valued components of the receiving environment, during the construction phase. The major potential impacts identified for this phase are described below.

- *SITE PREPARATION AND DEVELOPMENT*

As illustrated in Table 7.4.1, work related to site preparation and development for mine construction (clearing, excavation, earthwork, storage areas, open pits, etc.) will cause habitat losses that could represent a total of 197 ha of terrestrial environments and wetlands. The vast majority of this area, about 74%, is occupied by Black Spruce-Lichen stands.

By calculating the ratio between the area occupied by a given affected type of stand and its initial state (current conditions), it is possible to define more precisely the potential impact engendered by the construction of the Renard Project. In the mine area, it appears that the Black Spruce-Sphagnum forests will be more affected because, over the approximate 419 ha these currently occupy, 40 ha (or just fewer than 10%) will be destroyed during the construction phase. In comparison, although approximately 146 ha of Black Spruce-Lichen stands will be cleared during construction, this represents only slightly more than 2% of their current cover in the study area. Among the wetlands identified in the

mine area, the highest impact will be felt by open bogs, where just fewer than 6% of their initial surface area will be affected. Otherwise, the implementation of the water management plan will not affect the wetlands located close to the mine since the water inflow into these environments will not be modified.

In the airstrip area, close to 12% of the surface area presently covered by Jack Pine-Lichen stands (36 ha) will be destroyed when the airstrip will be built and when the surrounding areas will be cleared for security purposes. However, no wetland will be destroyed or drained by airstrip construction.

Site preparation and development activities will reduce the size of these habitats in the study area (Table 7.4.1). Given the abundance of the forest stands identified and the fact that they occur on a common basis in both of the mine and the airstrip areas, the losses incurred will have no significant impact on species richness either locally or regionally. The regional landscape is relatively uniform and the stands identified in the study area are ubiquitous. Plant diversity varies little from site to site and the project's impact on this diversity will not be far-reaching, given the different stands' abundance on a regional scale.

In summary, just fewer than 3% of the terrestrial environments located in the study area will be affected. No area classified as exceptional forest ecosystem by the MRNF or having any significant interest for conservation purposes will be affected by the activities related to the project.

7.4.2.2 Mitigation Measures

Nevertheless, numerous environmental measures were implemented along with the design of the project, in order to avoid or minimize potential impacts on forests and wetlands vegetation:

- Reduce facilities and infrastructures' footprint as part of the project design phase to minimize land and wetland habitat losses;
- Preserve forest stands and prevent wetland fragmentation;
- Whenever possible, maintain a riparian buffer strip of at least 30 m;
- Minimize the number of sub-watersheds affected so as to prevent impacts on the wetland natural hydrological regime.

Furthermore, the following environmental measures will be implemented during the construction phase:

- Minimize work area stripping, clearing, excavation, backfilling and levelling to a strict minimum in order to respect the natural topography and prevent erosion;
- Prohibit disposing of wood debris or natural waste materials in flooding areas or wetlands, e.g., swamps and peatlands, even in such areas that are not within the working areas' boundaries;
- Work areas limits will be clearly established and identified. No encroachment will be allowed outside these areas. No traffic will be tolerated outside defined accesses, crossings or work areas;
- Minimize and control the risk of forest fires during construction;
- Remove the topsoil (organic portion) and reserve for progressive revegetation work;
- The overburden removed during mine site preparation will be set aside and stored for subsequent rehabilitation work.

7.4.2.3 Residual Impacts

During the construction phase, and following the implementation of the mitigation measures, the intensity of the project's residual impact on vegetation and wetlands is deemed low. In fact, the integrity of the receiving environment (abundance, distribution) will not be significantly affected because of the general abundance of the local forest stands throughout the region. Residual impact spatial extent is considered site specific since it is restricted to the mine and airstrip areas. Otherwise, duration is considered moderate because the impacts will extend from the construction phase to the mine site's rehabilitation and closure phases completion. Some areas of the mine will be cleared permanently, creating an extensive impact. Once the mine will be closed, the only areas that will not be revegetated are the slopes of the processed kimberlite confinement area, the overburden stockpile and the open pits to be flooded (overall area of 83.2 ha, i.e. 27% of the impacted area). The flat surfaces of the processed kimberlite confinement area and overburden will be revegetated. In the long-term, species colonizing the flat surfaces will propagate naturally over the steep areas so that the mine site will present a complete vegetation cover after closure. The open pits to be filled with water represent the only long-term vegetation loss. The pit's surface area covers less than 10% of the impact zone and under 0.3% of the study area. The residual impact of the mine and airstrip's construction on terrestrial environments and wetlands is, therefore, deemed low.

7.4.3 Operation Phase Impacts

7.4.3.1 Impact Description and Assessment

Figure 5.1.1 presents the potential impacts arising from the interactions between the project components and the valued components of the receiving environment, during the construction. The project's main potential impacts during this phase are described below.

- *PIT DEVELOPMENT*

In the operation phase, open pit development will require clearing of 28.6 ha of forests stands, primarily colonized by Black Spruce-Lichen stands (Table 7.4.1). Only 1.2 ha of wetlands will be destroyed during this phase and no wetland located near the mine site will be dewatered for pit development. The intrinsic characteristics of both riparian swamps and peatlands (the major type of wetlands found) protect them from the potential impacts of local groundwater table drawdown since their water supply is not related to it. Riparian swamps are fed by streams they border and whose flow will be maintained (see Section 6.7 Hydrological Regime). Bogs are located on impervious deposits consisting mainly of clay, which promote their formation. This impermeability controls surface water / groundwater exchanges into these ecosystems, so these bogs are primarily supplied by rainwater (Payette and Rochefort, 2001).

During the operation phase, the magnitude of dust emission foreseen (see Section 6.3) are estimated at 2.2 g/m²/month in the area most affected by operations, i.e. less than 300 m away from the processed

kimberlite confinement area. This magnitude is not high enough to significantly affect plants physiology (growth rate, photosynthesis) within, or outside those areas. To harm plant growth and photosynthesis, the amount of dust emitted must be high enough to obstruct most of a plant's leaves and be sustained over a long-lasting period. These conditions will definitely not occur on the site.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

Supplies and equipment transport toward the Renard Project site could potentially introduce seeds of invasive plant species. Exotic introduced species could also root in rights-of-way and road ditches. Hardwoods (Birch and Poplar) could also take advantage of the recently cleared areas and colonize the mine area. Some shrubs, like Willow and Mountain Serviceberry, could also benefit from the right-of-way maintenance. The potential changes caused by the arrival of these species are not expected to be as significant as those observed in southern Quebec for the Common Reed (Phragmites) or the Water Chestnut, for example. These alterations would fairly be limited to the migration of some species already found in the Spruce-Moss bioclimatic domain up to the northern limit of their distribution range, thereby constituting an arrival of a few new relatively scarce species rather than a large-scale invasion by a single species. Further on, the quite harsh climate conditions prevailing in the Renard Project area significantly restrains the growth potential of the vast majority of invasive species found in Quebec.

- *PROGRESSIVE SITE REHABILITATION*

Rehabilitation involves the restoration of disturbed lands in a way to recreate, as far as possible, their initial features. This activity will be initiated during mine operation (progressive rehabilitation) and will be continued after mine closure. The impact associated with it is, therefore, deemed positive.

The progressive rehabilitation performed throughout the operation phase aims to optimize conditions for implementation of self-sustaining vegetation (choice of species, need for fertilizer, etc.). Revegetation is planned as two stages. First, hydroseeding will be carried out. The selected plant species will be adapted to northern conditions and will be non-invasive. A mixture, such as the "northern mountain mix," which consists exclusively of grasses, will be used. Second, Black Spruce seedlings will be planted at a density of 2,000 plants per hectare. Part of the overburden will be used to progressively revegetate the site, including the ore, waste rock and processed kimberlite storage areas. Further details about the methods and the indigenous species to be employed during site rehabilitation and revegetation phase are provided in Section 3.18 of the impact assessment and in Appendix 3.18.1 of the Restoration Plan. The areas targeted in the final rehabilitation of the site are detailed in Table 7.4.1.

Agronomic monitoring will be initiated when the progressive rehabilitation phase will start (i.e. revegetation while the mine is operational) and will be continued over the closure phase. This monitoring is described in Section 11.4.9.

7.4.3.2 Mitigation Measures

- *PIT DEVELOPMENT*

  - Limit stripping, clearing, excavation, backfilling and leveling to a strict minimum in the work area in order to respect the natural topography and prevent erosion;
  - Prohibit disposal of wood debris or natural waste materials in flooded areas or wetlands, i.e. swamps and peatlands, even outside areas directly affected by work.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SET; ROAD CIRCULATION*

  - Work area boundaries will be clearly defined and identified. No encroachment will be allowed outside these areas. No traffic will be tolerated outside accesses, crossings or work areas;
  - Plan contractually agreed measures with contractors to ensure that worksite machinery and equipment are adequately cleaned to limit propagation of exotic and invasive plant species.

7.4.3.3 Enhancement Measures

- *PROGRESSIVE SITE REHABILITATION*

Rapidly stabilize and revegetate areas that have been temporarily disturbed by construction with indigenous species and revegetate abandoned areas after activities.

7.4.3.4 Residual Impacts

During the operation phase and after mitigation measures will been implemented, the intensity of the project's residual impact on vegetation and wetlands will be low, its spatial extent site limited and its duration, moderate. The site's progressive rehabilitation will have a positive impact on the receiving environment. The open pits will be filled with water and therefore will not be revegetated (for a total of 28.6 ha, i.e. 9% of the impacted area). The significance of the residual impact associated to the mine and airstrip operation on vegetation and wetlands is therefore, considered as low.

7.4.4 Closure Phase Impacts

7.4.4.1 Impact Description and Assessment

- *FINAL SITE REHABILITATION AND REVEGETATION*

Rehabilitation involves restoring disturbed land to recreate its initial features as far as possible. This activity will be initiated during mine operations (progressive restoration) and after mine closure. The impact associated to this phase is therefore, deemed positive.

As soon as the construction activities will come to an end, the cleared areas that are no longer required for the operation phase will be revegetated. Most of the areas impacted will be revegetated throughout two stages. First, hydroseeding will be carried out. The selected plant species will be adapted to northern conditions and will be non-invasive. A mixture, such as the "northern mountain mix," which consists exclusively of grasses, will be used. Second, Black Spruce will be planted at a density of 2,000 seedlings per hectare. Part of the overburden will be used to progressively revegetate the site,

including the ore, waste rock and processed kimberlite storage areas. Further details about the methods and the indigenous species to be employed during the site rehabilitation and revegetation phase are provided in Section 3.18 of the impact assessment and in Appendix 3.18.1 of the Restoration Plan. The areas slated for final rehabilitation are detailed in Table 7.4.1.

Agronomic monitoring will be initiated when the progressive rehabilitation phase will start (i.e. revegetation while the mine is operational) and will be continued over the closure phase. This monitoring is described in Section 11.4.9.

- *WATER MANAGEMENT*

Following the closure of the mine, the affected hydrographical network will be restored so that small riparian wetlands, such as those that initially occurred before to the mine's construction, will naturally be formed where land topography is favourable (hollows, impervious soils).

7.4.4.2 Residual Impacts

Site revegetation after mine and airstrip closure will have a positive impact on the receiving environment, allowing 230.5 ha (or 75% of the area impacted), to return to baseline conditions. Areas that will not be revegetated (essentially steep areas) will be gradually colonized by local species and seeded, therefore recovering to their original situation. In the long-term, only the open pits to be watered upon mine closure will not be revegetated (7% of the project impact zone and less than 0.2% of the study area).

7.5 Reptiles and Amphibians

7.5.1 Current Conditions

The scientific literature does not report specific data for the Foxtrot Property's area concerning reptile and amphibian communities. However, information was obtained from the following studies on behalf of boreal areas located in a surrounding range of 30 km to more than 200 km away from the Renard Project area, namely:

- Albanel-Témiscamie-Otish Park Project Status Report (Gagnon, 2011);
- James Bay wildlife portrait (CRRNTBJ, 2010a);
- Route 167 North extension impact assessment (Roche – SNC-Lavalin, 2010) and baseline survey data (Genivar, 2009);
- Matoush Uranium Project impact assessment (Strateco Resources Inc., 2009).

Discussions with Cree users of the study area also provided information on the subject.

In order to determine the reptiles and amphibians species composition within the Renard Project study area, surveys were carried out as part of the Renard Project Environmental Baseline Study (EBS) (Roche, 2011), from June 24th to July 1st, 2010, then from June 1st to June 10th, 2011. Stations were selected in order to document potentially impacted areas and aimed to represent the diversity of

habitats. Control areas bordering externally the mine site limits were also selected. Overall, 63 stations, located in lakes, peatlands, streams and wetlands, were surveyed in the mine area, while 9 stations were surveyed in the airstrip area.

Due to the territory's wide range and logistical constraints, an active search method was carried on. During fieldwork, a particular attention was paid at all times to breeding calls. Night listening was carried out on June 28, 2010 and June 1, 6, 7 and 8, 2011. A detailed description of the survey protocol can be found in the EBS (Roche, 2011).

First, this section describes the reptile and amphibian species that might be found in the study area, based on the information currently available for the James Bay territory and adjacent areas. Then, species currently identified in the Renard Project study area are presented, along with their overall biological characteristics. Finally, the issues of the Renard Project related to these species are described.

7.5.1.1 Regional Environmental Conditions

Quebec is home to six urodela species (Salamanders, Mud Puppies and Newts), eleven anuran species (Frogs, Toads and Tree Frogs), nine Turtle species and eight Snake species. The Renard Project study area is located above 52° north latitude, at an altitude of more than 450 m, and north of annual daily mean temperature 2.5°C isotherm (the Lake Mistassini region being south of this isotherm). At this latitude, the number of reptile and amphibian species is limited by northern climatic conditions. For example, according to the James Bay wildlife portrait, nine amphibian species and one reptile species could potentially be found east of the James Bay territory (CRRNTBJ, 2010a). A survey performed during the feasibility study of the Route 167 North extension identified four anuran species, three of which are found about 10 km south of Camp Lagopede (Genivar, 2009). More recent surveys confirm the presence of seven amphibian species and one reptile species in between the future highway's km 0 (Témiscamie) and km 211 (30 km south of Camp Lagopede) (Roche – SNC-Lavalin, 2010; Roche 2011; Fortin *et al.,* 2012). The presence of three species of urodela, six species of anurans and one species of Snake has been confirmed in the Albanel-Témiscamie-Otish national park project area (Gagnon, 2011). Based on Native knowledge, no Turtle or Snake species have been observed in the Renard Project study area to date (Matthew and Nathaniel Swallow, pers. comm., 2010). In fact, no species of Turtle has ever been observed at such northern latitudes (Bider and Matte, 1994; Roche – SNC-Lavalin, 2010; Fortin *et al.,* 2012). The only species of Snake that could potentially be found in the study area is the Common Garter Snake, which has been observed northwest of James Bay, in the La Grande reservoir area and also south of Lake Mistassini (Bider and Matte, 1994; Roche – SNC-Lavalin, 2010; Fortin *et al.,* 2012).

Five species of anuran are potentially present in the study area. The American Toad (*Anaxyrus americanus*), Spring Peeper (*Pseudacris crucifer*), Wood Frog (*Lithobates sylvaticus*) and Mink Frog (*Lithobates septentrionalis*) have all been identified in the La Grande River area and even further north

(Bleakney, 1958; Bider and Matte, 1994; Fortin, 2007; Ouellet *et al.,* 2009). The Northern Leopard Frog (*Rana pipiens*) has been observed in the Robert-Bourassa reservoir and in the Eastmain River area. However, it does not appear to be common north of Lake Mistassini (Bider and Matte, 1994; Roche-SNC-Lavalin, 2010; Roche, 2011).

Finally, three species of urodela may inhabit the study area. The Northern Two-lined Salamander (*Eurycea bislineata*) was identified in the Eastmain and Laforge-1 reservoirs area (Fortin, 2006). Sightings of the Blue-Spotted Salamander (*Ambystoma laterale*) were reported in the La Grande and Robert-Bourassa reservoirs area and in Lake Mistassini neighbouring (Fortin, 2007). Occurrences of this species were also reported further north than the Foxtrot Property, further east and as far as Labrador (Petranka, 1998). It was identified in the Témiscamie area in the Route167 North extension impact assessment (Roche – SNC-Lavalin, 2010). The northernmost sighting of the Yellow Salamander (*Ambystoma maculata*) documented in Quebec was northeast of Mistissini, near Lake Mistassini (Fortin, 2007). However, this distribution range was found to be almost 100 km further north of the Route 167 as shown by the Route 167 North extension impact assessment (Roche – SNC-Lavalin, 2010; Fortin *et al.,* 2012).

The James Bay territory encompasses many wetlands offering quality habitats for the few amphibian and reptile species found in the area (CRRNTBJ, 2010a). According to the diverse areas, these wetlands cover a surface area of less than 5%, to up to 65% of the James Bay territory. The Renard Project study area is located in a James Bay area which includes a small proportion of wetlands (less than 5% of the surface area) (CRRNTBJ, 2010a). Consequently, it is possible to presume that amphibian and reptile populations would be less abundant in the project area than elsewhere in the James Bay territory. The study area's aquatic habitats and wetlands include lakes, ponds, pools (flarks), streams, swamps, bogs, fens and patterned fens (Roche, 2011). The hydrographical network and wetlands cover 18% and 2% of the Renard Project study area, respectively.

7.5.1.2 Mine Area

Within the mine infrastructures area, the habitats surveyed for amphibians and reptiles included lakes, pools (flarks), ponds, peatlands, swamps and permanent flow streams. Five amphibian species at different development stages (larvae, tadpoles, juveniles and adults) were observed, including four anuran species (American Toad, Wood Frog, Mink Frog and Spring Peeper) and one urodela species (Northern Two-lined Salamander). The four anuran species were encountered in 51 of the 63 stations surveyed in the mine area. These, are considered common and are rather generalists for their habitats or diet. Their North American range is extensive, from the temperate to the subarctic zone. The American Toad was observed in 38 stations, the Wood Frog in 23, the Mink Frog in 22 and the Spring Peeper in 22.

The Northern Two-lined Salamander was found in 10 stations in the mine area, including streams and lakeshores. It was also caught at the lake F3303 outlet with a Surber net during September 2010

benthos survey (Roche, 2011). Quebec's most common stream Salamander, it is the species most tolerant of water quality deterioration. It may also use terrestrial forest habitats during a part of the year (Petranka, 1998). While no "special status" species were recorded in the survey, according to provincial or federal lists, these northern populations have adapted to harsh climatic conditions, making them distinct from the province's southern populations.

The species found on the site uses different types of aquatic habitats depending on the stage, biological function and season (Table 7.5.1).

The Wood Frog and American Toad prefer shallower, temporarily flooded environments for breeding (flarks). After hatching and passed the tadpole stages, they become terrestrial, so they spend most of the year on land. The Spring Peeper uses a variety of wetlands for breeding while it hibernates on land.

The Mink Frog is more aquatic, using permanently flooded environments for breeding since the tadpole stage can last more than two years. It hibernates in stream or lake bottoms. Generally, these species are not associated with specific vegetation types (Duellman, 1999) and, at this latitude, may use opened or forested environments. The Northern Two-lined Salamander prefers sections of streams and lakeshore containing wood debris and rocks under which they can hide. Females lay their eggs under submerged rocks (Petranka, 1998) and larvae are aquatic. During the summer, the adults may move to terrestrial environment up to several dozens of meters away from aquatic environment (Petranka, 1998).

Table 7.5.1 List of Amphibian Species Observed and/or Heard in the Renard Project Study Area in 2010-2011

Species (Common Name)	Scientific Name	Main Habitat
AMPHIBIANS		
Anurans		
American Toad	*Anaxyrus americanus*	Forests and open environments; breeds in temporary and permanent aquatic environments; hibernates on land
Wood Frog	*Lithobates sylvaticus*	Forests; breeds in temporary aquatic environments; hibernates on land
Mink Frog	*Lithobates septentrionalis*	Permanent aquatic environments; hibernates in water
Spring Peeper	*Pseudacris crucifer*	Forests and open environments; breeds in temporary and permanent aquatic environments; hibernates on land
Urodelae		
Northern Two-lined Salamander	*Eurycea bislineata*	Forest surrounded lakes and streams; spends winter underwater

All of these species are carnivorous, feeding on insects (larvae, adults), small fish and even tadpoles. The tadpoles absorb microorganisms by filtering water and feed on the surrounding vegetation (Stebbins and Cohen, 1995).

Dispersal distance on land may be of several hundred meters for the Wood Frog (Lannoo, 2005), generally less than 100 m for the Spring Peeper (Werner *et al.*, 2009) and 23 to 480 m for the American Toad (Semlitsch and Bodie, 2003). These distances vary with habitat quality (hiding options, food abundance, and intermediary wet areas) and development stage. Juveniles are generally more mobile than adults, the latter being more loyal to their breeding site.

The absence of Forest Salamander sightings, especially the Blue-Spotted Salamander, is noteworthy because this species is generally observed at higher latitudes as far east as Labrador and as far as west James Bay (Petranka, 1998).

The main issues related to the mine infrastructures area in regards to reptiles and amphibians populations are: changes to the hydrological regime, barriers to moving, contaminants, diseases and noise. These issues are described in details in the following sections.

7.5.1.3 Airstrip Area

The area directly affected by the projected airstrip construction includes a quite small proportion of wetlands and aquatic environments. In fact, it is covered primarily by young Jack Pine-Lichen and Black Spruce-Lichen stands, linked to a dry barren and an old Black Spruce-Moss stand. A few lakes, a small stream and several small bogs are as well found in the area (Roche, 2011). Over the nine stations surveyed for the reptile and amphibian population study, four different species of amphibian were identified: Wood Frog (6 stations), American Toad (3 stations), Spring Peeper (3 stations) and Mink Frog (2 stations).

The main issues raised by the construction of the airstrip for reptiles and amphibians living in the surrounding environment are barriers to moving, contaminants, diseases and noise.

7.5.2 Construction Phase Impacts

Different biotic and abiotic factors can affect amphibian habitat quality (Green, 1997; Sparling *et al.,* 2000; Semlitsch, 2003; Lannoo, 2005). In the Renard Project study area, the following factors have been identified as potential project-related issues for reptiles and amphibians communities:

- Hydrological regime: The Mink Frog, for example, needs permanent aquatic environments for tadpole growth and hibernation. A drop in an aquatic environment's water level, or its dewatering could lead a community to leave the site and kill any tadpoles present;
- Barriers to moving: The presence of a physical barrier limiting movement could cause a population decline in a given site. Natural population variation can no longer be offset since the migration of individuals is null;
- Water acidification: During the development stage, eggs and larvae are sensitive to water acidity. A pH value below a certain level (generally below 5), may cause developmental trouble and even mortality. These effects may vary according to species and population;
- Contaminants: The presence of specific contaminants in water can affect egg and larval development more or less severely, according to concentrations. Contaminants can be introduced into aquatic environments and wetlands by water runoff or in association with dust;

- Noise: Loud, continuous noise sources can affect anuran breeding by interfering with their calls in nearby sites;
- Diseases: Naturally present or introduced diseases may take advantage of individuals' depressed immune system (stress) to spread. Isolated populations are at higher risk due to the absence of migration of new individuals (recruitment).

These factors can act in synergy and lead to a decline acceleration or to a tolerance thresholds decrease. The impact assessment therefore considers these factors into account for the different project phases.

7.5.2.1 Mine Area

The main project components constituting sources of impact during the construction phase, in descending order of importance, are:

- Site preparation and development;
- Dewatering of lakes and streams, and sediment and water management;
- Water management on worksites;
- Use and maintenance of machinery and power generating sets; road circulation;
- Construction of mine facilities.

➢ *SITE PREPARATION AND DEVELOPMENT*

Within the mine area, site preparation and development, will lead to aquatic habitat losses (lakes F3303 and F3302 (Photo 7.5.1), and their related streams, bogs and peatlands) as well as terrestrial habitat losses due to clearing, stripping, excavation, earthwork, infrastructure development and overburden storage. Clearing required for site's preparation will be mainly performed during the construction phase (total of 197.35 ha, including 187.14 ha of forest environments, 3.09 ha of open bogs, 1.72 ha of open fens and 5.40 ha of barrens). The area selected for the ore stockpile presents no major stream but rather small-sized streams and wetlands (bogs, small peatlands) that Wood Frog favours for breeding (Photo 7.5.2). The hydrology of peripheral areas (e.g. lake F2607) will also be affected, given the modifications to topography and loss of a headstream and its watershed. Similar conditions occur in the processed kimberlite confinement area and the overburden stockpile area, which include no major water bodies but small streams and wetlands. The modification of topography and the loss of streams and their watershed will also alter the hydrology of adjacent aquatic environments such as lake F3301 to the east, and lake F3298 to the



Photo 7.5.1 South Bay of F3302 Lake, where the Mink Frog has been observed (*Lithobates septentrionalis*), and will be dewatered (Open Pit R-2)

northwest. All of these areas, combined with those managed for mining operations, will constitute a zone that will be inhospitable for amphibians, along with a barrier of 1 km wide by 4 km long.

In addition to net habitat losses, the secondary mine roads will also constitute physical barriers restricting animal movement to a varying level according to species. Roads will fragment terrestrial habitats and could isolate small wetlands and bring their natural population to decline. Natural population fluctuations could no longer be offset since the migration of new individuals could be stopped. Wetlands located near the site's limits (e.g. lake F3301) may also be affected due to the changes in topography, water inflow (modified hydrology), noise and dust.



Photo 7.5.2 Peatland with Flarks, an Environment used by the Wood Frog (*Lithobates sylvaticus*) for Breeding that will be Backfilled (North of Open Pit R-3)

➢ *DEWATERING OF LAKES AND STREAMS AND SEDIMENT AND WATER MANAGEMENT*

This project component will cause losses of aquatic (lakes F3303 and F3302 and their related streams) and terrestrial habitats. It involves gradual dewatering of two small lakes and their associated streams, pumping of waters into mobile water treatment units and management of the bottom sediments extracted from lakes F3303 and F3302. These activities will create local inadequate environments for the amphibian survival, especially the Mink Frog, which needs permanent aquatic environments, and the Northern Two-lined Salamander, because of the loss of streams.

➢ *WATER MANAGEMENT*

Implementation of the water management plan will result in the diversion of some streams located upstream of the mine infrastructures, notably the outlet of lake F3298 diverted into lake F3295 and the loss of certain streams or stream sections (headstreams of lakes F3301 and F2607, outlet of lake F3302, outlet of lake F3303 and its mouth in Lake Lagopede). The development of a stream during diversion into lake F3295, will partly offset the loss of the outlet of lake F3298. These interventions will cause aquatic habitat losses, generate less suitable environments for amphibian survival and modify hydrology at the site's limits where amphibian populations will have to adapt, particularly for breeding.

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

Road traffic is a cause of mortality for species that cross roads (Forman *et al*., 2003). Springtime is the first critical period for anurans, as the adults travel to their breeding sites. The American Toad, Wood Frog and Spring Peeper are land-based most of the year (notably for hibernation). However, when comes spring, they gather in wetlands to breed. The adults' dispersal period after breeding is another

critical period. Finally, the dispersal of the newly metamorphosed young onto land leads them to cross roads. Road traffic is also a source of noise that can disturb anurans at breeding time, interfering with their calls. Finally, road traffic is a source of atmospheric emissions (dust and contaminants associated to exhaust fumes) and contamination (i.e. hydraulic and motor oil and petroleum product leakage).

- *CONSTRUCTION OF MINE FACILITIES*

Within the mine area, since mine facilities will be built on terrains that have already been developed, most of the environmental impact has already occurred. However, this phase could affect the environment located at the site's periphery, namely by induction of noise (loud and continuous sound sources can affect anuran breeding by interfering with their calls) and dust emissions.

7.5.2.2 Airstrip Area

Site preparation and development in the airstrip area will cause losses of 81.31 ha of terrestrial habitats (66.41 ha of forests and 14.9 ha of dry barrens) but will not affect neither wetlands nor aquatic environments. The airstrip area includes primarily an esker which is not especially favourable for amphibian habitat. The airstrip will represent a barrier to animal movement between the wetlands located either sides of it.

7.5.2.3 Construction Phase Mitigation Measures

- *SITE PREPARATION AND DEVELOPMENT*

  - Limit stripping, clearing, excavation, backfilling and leveling on worksites to a strict minimum so as to respect the natural topography and prevent erosion;
  - Limit wetland clearing to a strict minimum and minimize facilities' footprint;
  - Rapidly stabilize and revegetate areas temporarily disturbed by construction, especially if subjected to erosion;
  - Comply fully with ministerial guidelines concerning culverts; favour large diameters to limit stream reduction and ensure that light enters (a long, narrow culvert may constitute a barrier for amphibians); maintain the presence of substrate on the culvert bottom to provide shelter for the amphibian crossing (especially the Northern Two-Lined Salamander);
  - Preserve a riparian buffer strip of at least 30 m wide along streams and water bodies (screen, filter for contaminants generated by road and storage areas, ecological corridor and wildlife habitat) and up to 60 m wide for debris and organic matter storage areas, hazardous products storage sites and fuelling areas;
  - Limit habitat fragmentation in order to maintain natural migration corridors and ensure a link between wetlands where anurans gather for breeding. These environments also constitute larval development sites (source habitats), from which juveniles later disperse. It is important to maintain a mosaic of inter-related wetlands allowing populations to react to natural water-level fluctuations (Ouellet et al., 2005; Ouellet and Leheurteux, 2007);
  - Wherever required, install sediment barriers (steep slope with insufficient vegetation) along wetlands. These barriers can retain soil particles (control stream and wetland turbidity) as well as contaminants related to vehicles (petroleum products, oils and greases);
  - Confine machinery and workers passageways into work areas.

- *DEWATERING OF LAKES AND STREAMS AND SEDIMENT AND WATER MANAGEMENT*

  - When lakes F3303 and F3302 will be dewatered, inhabiting fish will be caught and then relocated to Lake Lagopede. Use of seine nets or other fishing gear will also allow simultaneous capture and relocation of amphibians potentially present in these lakes;
  - The waters pumped out of lakes F3303 and F3302 will be treated by mobile water treatment units and undergo quality control before being released into Lake Lagopede;
  - The sediment excavated will be dried on a drying bed and subsequently stored with the overburden for later use in the progressive rehabilitation program.

- *WATER MANAGEMENT*

  - Limit machinery circulation while the outlet of F3298 will be diverted to reduce impact on peripheral terrestrial habitats;
  - Apply erosion control measures and rapidly stabilize the banks of the diverted streams (gentle slope, revegetation).

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

  - Limit machinery and workers passageways to work areas;
  - Build bridges to cross streams for main access roads; preferably use half-moon-shaped culverts with wide bases and flat bottoms with substrate to maintain the stream bed;
  - Preserve a riparian buffer strip of at least 30 m wide along streams and water bodies (screen, filter for contaminants generated by road and storage areas, ecological corridor and wildlife habitat) and up to 60 m wide for debris and organic matter storage areas, hazardous products storage sites and fuelling areas.
  - Limit the use of abrasives along streams (runoff to streams);
  - Establish a systematic vehicle and machinery maintenance program to avoid oil spills (hydraulic, motor) that could leak from roads and work areas, into wetlands;
  - Attenuate sources of atmospheric emissions (e.g. dust);
  - Use noise abatement measures: set up appropriate soundproofing devices on machinery motor exhaust pipes and compressor components.

- *CONSTRUCTION OF MINE FACILITIES*

  - Attenuate sources of atmospheric emissions (e.g. dust);
  - Use noise reduction measures: install fan mufflers and set up appropriate soundproofing devices on motor exhaust pipes and compressor components.
  - Limit the use of abrasives along streams (runoff to streams);
  - Ensure a systematic vehicle and machinery maintenance program to limit oil losses (hydraulics, motors) that could leach from roads and work areas into wetlands.

- *AIRSTRIP AREA*

Impacts on amphibians will affect mainly the natural environments bordering the airstrip. Mitigation measures are similar to those for mine site preparation and development work, primarily:

  - Limit stripping, clearing, excavation, backfilling and leveling on worksites to a strict minimum so as to respect the natural topography and prevent erosion;
  - Limit facilities' footprint to a strict minimum;
  - Attenuate sources of atmospheric emissions (e.g. dust);

- Use noise abatement measures: install appropriate soundproofing devices on machinery motor exhaust pipes and compressor components;
- Limit machinery and workers passageways to work areas.

7.5.2.4 Construction Phase Residual Impacts

Because amphibians, with their limited mobility and permeable skin, require both terrestrial and aquatic habitats during their life cycle, they are more vulnerable to environmental impacts than other animal communities that may move more easily to unaffected peripheral habitats. By contextualizing the amphibian impact assessment within the 127-km^2 study area, the Renard Project construction phase will constitute a negative impact of moderate intensity since it will modify amphibian abundance and distribution in the project's footprint, but without altering their integrity within the study area's boundaries. The spatial extent of the impact is considered site specific, since it will be restrained to the mine and airstrip areas and to certain peripheral environments whose hydrological parameters might be altered. The duration is deemed long, given that the wetland loss will be felt over more than 25 years. In fact, it might take several years for the newly rehabilitated habitats to return to an optimal state which will favour the re-establishment of populations (the larger proportion will be created during the closure phase). The significance of the residual impact on amphibians is, thus, deemed moderate.

7.5.3 Operation Phase Impacts

The main project components that constitute impact sources during the operation phase, in decreasing order of importance, are:

- Management of materials generated by mining operations and progressive site rehabilitation;
- Pit development;
- Ore mining, handling and storage;
- Use and maintenance of machinery and power generating sets; road circulation;
- Airstrip operation.

7.5.3.1 Mine Area

➢ *MANAGEMENT OF MATERIALS GENERATED BY MINE OPERATIONS*

Management of materials generated by mining operations includes transportation to the stockpiling sites. Impacts will be related essentially to noise (interference with anuran breeding), potential contaminant transport (hydrocarbons, oils) by runoffs flowing into peripheral wetlands and dust emission. Gradual alteration of topography and hydrology, especially on a wide portion of the processed kimberlite confinement area, could have more specific repercussions in the natural environments bordering the site boundaries.

➢ *PROGRESSIVE SITE REHABILITATION*

The progressive rehabilitation (flat surfaces covered with a layer of overburden, a layer of topsoil and then revegetated) of the processed kimberlite confinement area's berms and of areas that are no longer

used (bulk material storage area, unused borrow pits) throughout the operation phase will mitigate the impact of habitat losses and promote amphibian repopulation, particularly when all activities will come to an end.

- *PIT DEVELOPMENT*

The open pits will be developed, for the most part, in areas that were already cleared and affected. Thus, the main impact on these environments had already occurred. However, clearing and stripping of areas associated to open pits R-2/R-3 and R-65 will take place in the operation phase. The additional areas disturbed totalize 28.6 ha, including 0.6 ha of riparian fens and 0.6 ha of open bogs. Peatlands are amphibian's preferred breeding sites, and are especially important to the Wood Frog. This phase could also affect environments on the site's periphery through noise (loud, continuous sound sources may affect anuran breeding by interfering with their calls), dust emissions and potential contaminant runoff, especially from open pit R-65, since the other two are enclosed in the mine site and surrounded by terrains that will already have been cleared and prepared.

- *ORE MINING, HANDLING AND STORAGE*

The ore will be mined (open pits, mine shaft), transhipped and transported toward the stockpile area. Since the stockpile area will have been cleared during the construction phase, the impact will be mainly associated to noise (interference with anuran breeding), potential contaminant transport (hydrocarbons, oils) via runoff toward peripheral wetlands (lake F2607) and dust emission.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The impacts are similar to those of the construction phase, namely: barrier effect, source of road-related mortality, noise disturbance and risk of contamination through dust and contaminants carried by runoff waters. However, they will be smaller in extent on the mine site since it will already have been altered and will probably support fewer amphibians. The impact could be felt more specifically in the natural environments at the site's edges.

7.5.3.2 Airstrip Area

The impact sources related to airstrip operation will be air traffic, road traffic and machinery circulation for airstrip maintenance, aircrafts and helicopters loading/unloading as well as power generating sets. The airstrip's impacts will be essentially related to noise (interference with anuran breeding), potential contaminant transport (hydrocarbons, oils, glycol) via runoff toward into peripheral wetlands and dust emission.

7.5.3.3 Mitigation Measures

- *MANAGEMENT OF MATERIALS GENERATED BY MINE OPERATIONS*

  - Limit machinery circulation to work areas;
  - Ensure a systematic vehicle and machinery maintenance program to limit oil losses (hydraulic, motor) that could leach from roads and storage areas and reach wetlands.
  - Provide topographic profiles to minimize erosion.

- *PROGRESSIVE SITE REHABILITATION*

  - Ensure progressive revegetation of the processed kimberlite confinement area, borrow pits and areas with no activity so that these new environments are suitable for amphibians (cover density, presence of prey) and promote their repopulation.

- *PIT DEVELOPMENT*

  - Limit dust emissions;
  - Confine machinery circulation into work areas;
  - Provide a systematic vehicle and machinery maintenance program to avoid oil losses (hydraulic, motor) that could leach from roads and storage areas, into wetlands;
  - Preserve a riparian buffer strip of at least 30 m wide along streams and water bodies (screen, filter for contaminants originating from road and storage areas, ecological corridor and wildlife habitat) and up to 60 m wide for debris and organic matter storage areas, hazardous products storage sites and fuelling areas;
  - Plan topographic profiles in order to minimize erosion.

- *ORE MINING, PROCESSING AND STORAGE*

  - Limit wetland backfilling and deposit's footprint to a strict minimum;
  - Preserve a riparian buffer strip of at least 30 m wide and up to 60 m wide (screen, filter for contaminants leaking from deposits) along wetlands adjoining stockpile area.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

  - Use noise abatement measures: install appropriate sound-proofing devices on motor exhaust pipes;
  - Attenuate sources of atmospheric emissions (dust);
  - Limit the use of abrasives along culverts (runoff into streams);
  - Ensure a systematic vehicle and machinery maintenance program to limit oil losses (hydraulic, motor) running off from roads and storage areas, and could reach wetlands.

- *AIRSTRIP OPERATION*

  - Maintain a riparian buffer strip of at least 30 m wide for wetlands adjacent to the airstrip (screen, filters contaminants from airstrip and facilities);
  - Whenever possible, limit the use of abrasives near wetlands;
  - Use noise abatement measures (e.g. install sound-proofing devices on compressor components);
  - Provide a systematic vehicle and machinery maintenance program to limit oil losses (hydraulic, motor) that could reach wetlands;
  - Attenuate atmospheric emissions at source (dust).

7.5.3.4 Operation Phase Residual Impacts

For the most part, the natural environments will already have been affected, during the first stage of the construction phase (site preparation and development), with the exception of the open pits to be developed during the operation phase. Due to habitat alterations and intense activity, the mine area will be improper for amphibians during operations. Operation phase mining activities will have a negative impact of moderate intensity. The progressive rehabilitation of terrestrial habitats will mitigate this impact and promote repopulation by amphibians, especially when activities (e.g. road traffic) will have ceased. The spatial extent includes the mine site, specifically the hill formed by the processed kimberlite confinement area, and its effects on peripheral environment (noise, dust, topography, hydrology, barrier effect). Consequently, it is considered site specific. The duration is deemed moderate since it extends over the mine operation phase. The significance of the residual impact on amphibians is thus considered moderate.

7.5.4 Closure Phase Impacts

7.5.4.1 Mine Area

- *FINAL SITE REHABILITATION AND REVEGETATION*

The site's final rehabilitation will involve dismantling of facilities, removing all remaining hazardous materials off the site, stabilizing, covering and revegetating altered surfaces. Most of the terrains modified during the construction and operation phases will be covered with a layer of overburden and a layer of topsoil for revegetation by hydroseeding and seedling planting. The landscape's topography will partly revert to its original state because all waste rock will be returned to the open pits, if not used for underground backfilling. Revegetation will lead to more appropriate environments for amphibian's habitat (i.e. feeding, sheltering and better hibernating potential).

- *WATER MANAGEMENT*

As far as possible, surface runoff will be returned to baseline conditions. Water management will include the restoration of a stream diverted to fill R-65 open pit, flooding R-2/R-3 and R-65 open pits and create a hydrological link between the newly-created lakes and the hydrographical network. These lakes could constitute permanent aquatic environments of interest to hibernation of the the Mink Frog, and for tadpoles, which need more than two years to metamorphose. The American Toad and Spring Peeper also use these environments for breeding. The planning of shallower, semi-permanent aquatic environments should also be considered as they will constitute Wood Frog's preferred breeding sites. A mosaic of different types of wetlands will promote repopulation of the mine site and improve species survival (Ouellet *et al*., 2005; Ouellet and Leheurteux, 2007), notably by removing the barrier effect created by the altered area.

7.5.4.2 Airstrip Area

- *FINAL SITE REHABILITATION AND REVEGETATION*

In the airstrip area, buildings will be dismantled, and the airstrip scarified, then revegetated, making the terrestrial environment more favourable to amphibian habitat (better potential for food, refuges and hibernation). Restoring the terrestrial habitats will eliminate the barrier effect and allow amphibians' migration either side of the airstrip.

7.5.4.3 Mitigation Measures

- *FINAL SITE REHABILITATION AND REVEGETATION*
    - Carry out restoration work as soon as possible to create new environments appropriate for amphibians (forest cover density, presence of prey) and promote their repopulation.
- *WATER MANAGEMENT*
    - When restoring the surface hydrographical network, check the possibilities for developing permanent wetlands, especially for Mink Frog breeding, growth and hibernation; breeding sites, feeding ground, refuges and aquatic shelters for amphibians;
    - As far as possible, try to induce a mosaic of various types of wetlands (on mine and stockpile areas) in order to eliminate the barrier effect and recreate, as much as possible, the previous aquatic habitat diversity pattern.

7.5.4.4 Residual Impacts

Site rehabilitation will have a positive, moderate-intensity impact on amphibians since both terrestrial and aquatic habitats, the two environmental components required for their life cycle, will be ultimately restored. The spatial extent is considered site specific because restoring these environments will re-establish habitats and migration corridors between the mine site and its periphery. The duration is considered long as it will extend beyond the mine operation phase. The significance of the residual impact on amphibians is, thus, deemed moderate.

7.6 Waterfowl and Other Waterbirds

The objectives of the waterfowl surveys conducted in the context of the Environmental Baseline Study (EBS) were:

- To identify Anatidae (Geese and Ducks) and other waterbirds (Gaviidae and Laridae) that breed in the study area;
- To document study area use by breeding waterfowl and assess their abundance;
- To identify other rare bird species or "special status species" observed during the study and document their use of the environment.

7.6.1 Current Conditions

Little is known about waterfowl and waterbird populations in the Renard Project study area. The James Bay wildlife profile (CRRNTBJ, 2010a) provides an overall description of wildlife in the region, and the

results of the survey conducted as part of the Route 167 North extension impact assessment are presented in Roche – SNC-Lavalin report (2010).

Waterfowl surveys were conducted on May 30-31, 2011 under observation conditions deemed excellent. The survey period was set to coincide with the phase of the Anatidae breeding cycle that stretches, in the spring, from the onset of laying to brooding. The survey was carried out by a helicopter using the method developed by the Canadian Wildlife Service (CWS) (Bordage and Plante, 1997). The area covered by the 2011 waterfowl surveys is shown on EBS Map 6.2. (Roche, 2011). The methods and detailed waterfowl survey findings are shown in Section 6.2 of the EBS report (Roche, 2011).

In addition to the 2011 aerial survey, the water bodies in the immediate mine infrastructures area were visited two or three times each during the forest-dwelling bird survey (June 19-24, 2010) in order to determine whether waterfowl were present.

7.6.1.1 Regional Environmental Conditions

As their name suggests, waterfowl and waterbirds are associated with streams, water bodies and wetlands. Within the James Bay region, wetland abundance varies spatially, their relative importance ranging from more than 65% in the west (Waskaganish area) to less than 5% in the northeast (CRRNTBJ, 2010a). The Renard Diamond Project is located in the latter, which is poorer in wetlands. In fact, wetlands only cover 2% of the study area. These wetlands are represented by bogs (open and wooded), riparian fens, swamps and patterned fens. Streams and water bodies account for 18% of the study area (Roche, 2011).

Just over twenty waterfowl species (Geese and Ducks), three Gaviidae species (Loons) and six Laridae species (Gulls and Terns) are found in the James Bay region in summer (CRRNTBJ, 2010a). During the helicopter surveys of waterfowl and other waterbirds conducted along the Route 167 North extension, between Mistissini and Camp Lagopede, thirteen species of waterfowl[8] were identified along with two species of Gaviidae (Common Loon and Red-throated Loon) (Roche – SNC-Lavalin, 2010). According to the same study, four Laridae species (Bonaparte's Gull, Herring Gull, Arctic Tern and Common Tern) were observed in the proposed route's study area.

In comparison, waterfowl surveys in the Renard Project study area (surface area equivalent to 88% of Route 167 North extension study area and 0.02% of the James Bay region) identified nine species of Anatidae, one species of Gaviidae and two species of Laridae (Table 7.6.1). The phenological index[9] shows that the 2011 aerial survey carried out as part of the Renard Project, was carried out at the appropriate period for most species (see Section 6.2.2.4 of the EBS). However, it is likely that breeding populations of Red-breasted Merganser and Surf Scoter were somewhat overestimated. These species

[8] Canada Goose, Wood Duck, American Black Duck, Mallard, Green-winged Teal, Ring-necked Duck, Surf Scoter, Black Scoter, Bufflehead, Common Goldeneye, Hooded Merganser, Common Merganser and Red-breasted Merganser.

[9] The phenological index is a tool used to determine whether the spring waterfowl surveys were conducted at the appropriate time (Bordage and Plante, 1997). The index corresponds to the ratio of the number of matched males to the number of males that are single or in a group unaccompanied by females.

are among the last to reach their breeding ground in the spring (Gauthier and Aubry, 1995). All of the species observed, except the Tern, breed in the study area (varying degrees of certainty). The two Anatidae that were confirmed breeders here are American Black Duck and Canada Goose. Green-winged Teal, Common Merganser, Hooded Merganser and Surf Scoter also breed with no doubt in the study area, since these species are common at the latitude of Camp Lagopede (Gauthier and Aubry, 1995). The Common Goldeneye and Red-breasted Merganser probably also breed in the study area but, in general, these species are not very abundant at this latitude. The Common Goldeneye is more abundant in the south and the Red-breasted Merganser to the north. Finally, a Herring Gull nest was found, thereby confirming that this Laridae species breeds in the study area.

In spring 2011, 99 Anatidae breeding pairs were estimated for the study area at a population density of 19.1 breeding pairs/25 km^2 (Table 7.6.2). This density was higher in the airstrip area than the mine area. A total of 9 species were observed, 3 of which, Surf Scoter, American Black Duck and Hooded Merganser—constitute 60% of the breeding population (Table 7.6.2). The three species of Merganser composed more than one-third of the breeding population. Canada Goose accounted for only 8% and Green-winged Teal, a mere 3%.

The density of breeding Anatidae observed (19.1 breeding pairs/25 km^2 at 52.8° latitude; Table 7.6.2) compares very favourably with the density estimated for control plots in the environmental studies conducted for the Eastmain-1-A generating station and the Rupert diversion project in 2002 at the 52^{th} parallel, namely 21.0 breeding pairs/25 km^2 (n = 16 plots; Tecsult Environnement inc., 2004). However, it is higher than the density estimated in a control zone for the Sainte-Marguerite River 3 hydroelectric project on the North Shore at the 52^{nd} parallel, from 1997 to 2002, namely 8.9 to 12.3 breeding pairs/25 km^2 (Morneau, 2003). Finally, it is significantly lower than the density observed on the lake plateau near the Laforge 1 reservoir (35.8 breeding pairs/25 km^2; 54^{th} parallel; n = 8; Morneau, 1998) and the Caniapiscau reservoir (30.1 breeding pairs/25 km^2; 54.5^{th} parallel; n = 10; Morneau, 1999).

Common Loon density was 2.9 breeding pairs/25 km^2 in the study area (Table 7.6.2). Mean Common Loon population density is generally between 0.8 and 2.0 breeding pairs/25 km^2 for Quebec as a whole (Morneau, 2008).

The study area density can thus be considered relatively high. It compares to that estimated for the control plots in the environmental studies conducted for the Eastmain-1-A generating station and the Rupert diversion project in 2002 at the 52^{nd} parallel, namely 3.0 breeding pairs/25 km^2 (n = 16 plots; Tecsult Environnement inc., 2004).

Table 7.6.1 English, Latin, French and Cree Names of Species of Anatidae and other Waterbirds Observed in the Renard Project Study Area in 2010 and 2011 and their Breeding Status

English name	Latin name	French name	Cree name[1]	Year observed	Breeding evidence (code)[2]	Breeding status (level of certainty)
Anatidae						
Canada Goose	*Branta canadensis*	Bernache du Canada	*Nisk, kâ cinwâkwaywet-nisk*	2010-2011	NF	Confirmed
Green-winged Teal	*Anas crecca*	Sarcelle d'hiver	*cîscipis*	2011	P	Probable
Greater or Lesser Scaup	*Aythya marila* or *A. affinis*	Petit ou Grand Fuligule	*ayakascikutesip*	2011	H	Possible
American Black Duck	*Anas rubripes*	Canard noir	*sîsîp*[3]	2010-2011	JE	Confirmed
Surf Scoter	*Melanitta perspicillata*	Macreuse à front blanc	*akwâhikan*	2011	P	Probable
Common Goldeneye	*Bucephala clangula*	Garrot à œil d'or	*misikusk, pihkuhkusip*	2011	H	Possible
Hooded Merganser	*Lophodytes cucullatus*	Harle couronné	*cînikutesip*	2011	P	Probable
Common Merganser	*Mergus merganser*	Grand Harle	*mistasik*	2010-2011	P	Probable
Red-breasted Merganser	*Mergus serrator*	Harle huppé	*usik, asik*	2011	P	Probable
Gaviidae						
Common Loon	*Gavia immer*	Plongeon huard	*mwâk*	2010-2011	P	Probable
Laridae						
Herring Gull	*Larus argentatus*	Goéland argenté	*ciyâsk*[4]	2010-2011	NO	Confirmed
(Common) Tern sp.	*Sterna* sp. *(hirundo)*	Sterne sp. (pierregarin)	*apisi-ciyâskuss*	2010	X	Observed

[1]The Cree names were taken from: Cree Research and Development Institute and Kevin Brousseau. 2010. The Cree Research and Development Institute's Trilingual Lexicon of the Fauna and Flora of Eeyou Istchee. Cree Research and Development Institute. 107 pages.

[2] See Appendix 7.6.1 for the signification of these codes.

[3] Generic term used for all dark dabbling ducks, such as the American Black Duck, Mallard and Gadwall.

[4] Generic term used for gulls.

Table 7.6.2 Abundance of Anatidae and Other Waterbird Species Observed During the May 30-31 Survey in the Renard Project Study Area

Species	Mine area										Airstrip area		Study area	
	Plot 1		Plot 2		Plot 3		Plot 4		Mine site total		Plot 5			
	Individuals[1]	Breeding pairs [2]	Individuals	Breeding pairs	Individuals	Breeding pairs	Individuals	Breeding pairs	Individuals	Breeding pairs	Individuals	Breeding pairs	Individuals	Breeding pairs
Anatidae														
Canada Goose	1	1	4	3	2	1	5	3	12	8	4	0	16	8
Green-winged Teal	0	0	0	0	1	1	0	0	1	1	4	2	5	3
American Black Duck	6	4.5	1	1	2	1.5	1	1	10	8	13	10.5	23	18.5
Scaup (Greater or Lesser)	0	0	0	0	0	0	0	0	0	0	2	2	2	2
Surf Scoter	13	8	7	5	4	2	13	4	37	19	15	6	52	25
Common Goldeneye	0	0	4	4	1	1	0	0	5	5	3	2	8	7
Hooded Merganser	12	2	14	4	4	4	4	3	34	13	7	3	41	16
Common Merganser	6	3	3	2	3	1	1	1	13	7	0	0	13	7
Red-breasted Merganser	2	1	2	1	6	3	1	1	11	6	2	1	13	7
Scoter (undetermined)	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Merganser (undetermined)	0	0	3	3	0	0	3	1	6	4	3	1	9	5
Total Anatidae	**41**	**19.5**	**38**	**23**	**23**	**14.5**	**28**	**14**	**130**	**71**	**53**	**27.5**	**183**	**98.5**
Density (Anatidae/25 km^2)	**41.2**	**19.6**	**38.2**	**23.1**	**22.0**	**13.9**	**26.8**	**13.4**	**31.9**	**17.4**	**49.1**	**25.5**	**35.5**	**19.1**
Gaviidae														
Common Loon	3	2	2	1	10	5	3	2	18	10	7	5	25	15
Density (Gaviidae/25 km^2)	**3.0**	**2.0**	**2.0**	**1.0**	**9.6**	**4.8**	**2.9**	**1.9**	**4.4**	**2.5**	**6.5**	**4.6**	**4.8**	**2.9**
Laridae														
Herring Gull	0	0	0	0	0	0	1	1	1	1	0	0	1	1
Density (Laridae/25 km^2)	**0**	**0**	**0**	**0**	**0**	**0**	**1.0**	**1.0**	**0.2**	**0.2**	**0**	**0**	**0.2**	**0.2**

[1] Individuals: Total number of birds observed.

[2] Breeding pairs: The number of breeding pairs is based on determining indicated breeding pairs which involves combinations of birds of both sexes (Appendix 7.6.2). For further details, see Section 6.2.2.4 of the EBS (Roche, 2011).

Notes: Size of plots surveyed (total 129 km^2):
Plots 1 and 2: 24.9 km^2 each
Plots 3 and 4: 26.1 km^2 each
Plot 5: 27 km^2

7.6.1.2 Mine Area

- *ANATIDAE*

Overall, 130 Anatidae individuals (corresponding to 71 breeding pairs) were observed in the mine area (Table 7.6.2). The population density of breeding Anatidae was estimated at 17.4 breeding pairs/25 km^2 in this area (total of 102 km^2). Surf Scoter and Hooded Merganser showed the highest breeding populations with 19 and 13 breeding pairs respectively. They were followed by Canada Goose and American Black Duck, which both showed 8 breeding couples. Together, the three Merganser species accounted for 42% of the breeding population surveyed in the mine area.

In the immediate proposed mining infrastructure area, two surveys were performed to better estimate frequency of use by Anatidae. In the first survey, two male American Black Ducks and one male Common Goldeneye were identified on lake F3302. The next day, two male American Black Ducks were observed on this same lake and a third, of undetermined gender, was seen on lake F2607 where no bird had previously been sighted.

In 2010, a Common Merganser pair was observed on Lake Lagopede. An American Black Duck brood was seen in Lake Lagopede's North Bay (Baie Nord) on June 20, 2010.

- *OTHER WATERBIRDS*

Eighteen Common Loons (Photo 7.6.1), corresponding to 10 breeding pairs, were counted in the mine area, 4 of them on Lake Lagopede. The density of breeding common loons was estimated at 2.5 breeding pairs/25 km^2.

A single Herring Gull was identified in the study area during the May 2011 surveys. It was brooding on a nest located on a rock. The density of Laridae is low in the sector (0.2 breeding pairs/25 km^2).



Photo 7.6.1 Common Loon pair on Lake Lagopede, May 31, 2011

7.6.1.3 Airstrip area

- *ANATIDAE*

In the airstrip area, a total of 53 Anatidae (corresponding to 27.5 breeding pairs) were recorded for a breeding population density of 25.5 breeding pairs/25 km^2. This is higher than the mine area (17.4 breeding pairs/25 km^2). The most abundant species is American Black Duck, which represented 38% of the breeding population. Surf Scoter ranks second with 6 indicated breeding pairs (22% of the population). No Common Merganser was observed in the area, and no Canada Goose breeding pairs were identified.

➢ *OTHER WATERBIRDS*

Common Loon density was estimated at 4.6 breeding pairs/25 km^2 in the airstrip area, which is higher than in the mine area (2.5 breeding pairs/25 km^2).

7.6.2 Construction Phase Impacts

7.6.2.1 Impact Description

During the construction phase, the project components likely to affect Anatidae and other waterbirds are:

- Dewatering of lakes F3302 and F3303;
- Site preparation and development near water bodies that could disturb these birds;
- Water management of worksite, i.e. use of motorboats to install and maintain outfalls and the presence of the domestic wastewater treatment station's aerated lagoons;
- Manpower and procurement, through increased access to Lake Lagopede for the Cree and their boats.

The impact sources refer only to the mine area since none were identified for the airstrip area. There are few water bodies near airstrip facilities and waterfowl and other waterbirds are not abundant in them. Further, flight frequency will be low so the risk of collision between planes and waterfowl will be very unlikely.

➢ *DEWATERING OF LAKES F3302 AND F3303*

Only one (lake F3302) of the two small lakes to be dewatered during construction was visited by two male American Black Ducks, probably representing two breeding pairs whose females were brooding nearby. The birds affected will move to other breeding grounds (Table 7.6.3). In a best-case scenario, these pairs' nests and duckling rearing areas are located near or on other water bodies, outside the area disturbed by the work. In a worst-case scenario, the habitat loss could result in an equivalent population decline. The male Common Goldeneye observed on lake F3302 was considered to be in moult migration. In fact, it was not seen again the next day. Further, 7 of the 8 individuals of this species counted were males, what supports this hypothesis, since it was too early, at this latitude, for the females to be brooding already. These males probably came from breeding grounds located further south, far from the study area where, in all likelihood, their females had already begun brooding. As a result, there is no impact on this species.

Table 7.6.3 Estimated Number of Waterfowl and Waterbird Pairs Affected by the Project

English name	Construction phase			Operation phase		
	Number of pairs affected		Type of impact[1]	Number of pairs affected		Type of impact[1]
	Mine area	Airstrip area		Mine area	Airstrip area	
Anatidae						
Canada Goose	0	0	0	0	0	0
Green-winged Teal	0	0	0	0	0	0
American Black Duck	2 lost + 1 disturbed	0	–	0	0	0
Surf Scoter	0	0	0	0	0	0
Common Goldeneye	0	0	0	0	0	0
Hooded Merganser	0	0	0	0	0	0
Common Merganser	0	0	0	0	0	0
Red-breasted Merganser	1	0	–	0	0	0
Total Anatidae	4	0	–	0	0	0
Gaviidae						
Common Loon	1	0	–	1	0	–
Laridae						
Herring Gull	0	0	0	0	0	0
(Common) Tern sp.	0	0	0	0	0	0

[1] *Type of impact: 0: zero impact*
–: low negative impact; a small proportion of pairs will be affected
+: positive impact; probable project-related population increase

The two American Black Duck breeding pairs that will lose their habitat represent 2.0% of the study area's waterfowl breeding pair population. The loss of the small lake (F3302) is permanent, although the pit that will surround the dewatered lakes will be filled with water in the post-closure phase. It will be too deep for this species, which generally feeds in less than 1 m of water. In a worst-case scenario, that is, if the two pairs do not find suitable habitats nearby, the abundance of American Black Duck in the study area may decline very slightly.

- *SITE PREPARATION AND DEVELOPMENT*

Site preparation and development near water bodies could also disturb breeding pairs of various species in the vicinity. This is true, among other things, for an American Black Duck pair observed in 2011 on a neighbouring lake (F2607). A Red-breasted Merganser pair was also observed in the east bay of Lake Lagopede bay. A Common Loon pair was recorded on Lake Lagopede, in the bay adjacent to the future domestic wastewater treatment station (Table 7.6.3).

The American Black Duck and Red-breasted Merganser pairs each represent 1.0% of the waterfowl breeding pair population observed in the study area.

- *WATER MANAGEMENT OF WORKSITE*

The Common Loon pair could be disturbed by activities requiring the use of small craft (wastewater discharge outfall construction and maintenance). The species is so highly sensitive to watercraft-induced disturbances (Masse, 2000) that, if a nest was nearby, breeding might abort some years, despite the restricted boat use envisaged. This Common Loon pair represents 6.7% of the species'

breeding pairs estimated for the study area in 2011. Despite this, no change in abundance or species distribution is expected.

Development of the domestic wastewater treatment station's aerated lagoons will affect ducks positively. These small bodies of water do not freeze and can host the first migratory species arriving in the spring when neighbouring lakes are still frozen. In addition, breeding ducks could use them for reproduction, a phenomenon that has been observed elsewhere (Guénette, 2011). The species most likely to benefit from these water bodies are American Black Duck and Green-winged Teal. However, we cannot predict how many pairs will settle there. The presence of the aerated lagoons could partly offset the impact of dewatering lake F3302.

- *MANPOWER AND PROCUREMENT*

Implementation of the Renard Project will facilitate the Crees' access to Lake Lagopede, making it easier for them to transport their boats there for hunting and fishing purposes. Increased use of watercraft could further disturb the Common Loon pair and abort breeding some years. However, setting up a safety zone around the mine will limit boating traffic to mine staff responsible for maintaining the treated domestic wastewater and mining effluent discharge outfalls in Lake Lagopede and mitigate this impact.

7.6.2.2 Mitigation Measures

- *DEWATERING OF LAKES F3302 AND F3303*

The only mitigation measure possible to partly offset the loss of the small lake (F3302) is to begin pumping after the breeding season (mid-August) to allow American Black Duck to breed there another year. Consequently, pumping will be done in winter, preferably.

To offset the possible loss of two American Black Duck breeding pairs, nesting boxes (4) for Common Goldeneye will be installed around Lake Lagopede and the small lakes near the mine infrastructures. While the two species differ, this measure will allow the number of waterfowl breeding pairs in the mine area to be maintained. This compensation measure has proved very effective in Quebec boreal forest hydropower projects, notably the Peribonka reservoir (Sénéchal and Morneau, 2011). Nesting boxes last about ten years and require annual maintenance to remain effective.

- *WATER MANAGEMENT OF WORKSITE; MANPOWER AND PROCUREMENT*

Finally, so as not disturb the Common Loon, small crafts users will be advised to avoid the sheltered bays that constitute this species' potential breeding and brood rearing sites in spring and summer (at least until August).

7.6.2.3 Residual Impacts

In the construction phase, once the mitigation measures have been implemented, the impact's intensity is considered low. Spatially, it is deemed site specific since it will be restricted to a small area. The duration is long, given that it will continue into the post-closure phase (loss of American Black Duck habitat). Consequently, the impact is low for this component.

7.6.3 Operation Phase Impacts

7.6.3.1 Impact Description

During the operation phase, the project components likely to affect waterfowl and other waterbirds are:

- Water management, more specifically, the use of small crafts to maintain the treated effluent outfalls and monitor water quality, and the presence of the domestic wastewater treatment station's aerated lagoons;
- Work force and procurement, through increased access to Lake Lagopede for the Crees and their small crafts.

As mentioned for the construction phase, no impact source has been identified for the airstrip area.

Development of the domestic wastewater treatment station's aerated lagoons will affect ducks positively. These small water bodies do not freeze and can host the first migratory species arriving in the spring when neighbouring lakes are still frozen. In addition, breeding ducks could use them for reproduction, a phenomenon that has been observed elsewhere (Guénette, 2011). The species most likely to benefit from these waters are American Black Duck and Green-winged Teal. However, we cannot predict how many pairs will settle there.

The periodic use of small crafts to maintain the treated effluent outfalls and monitor water quality in Lake Lagopede in spring and summer may disturb Common Loon breeding on the lake (Table 7.6.3). No change in abundance or distribution is expected.

7.6.3.2 Mitigation Measures

Small crafts users will be advised to avoid the sheltered bays that constitute potential Common Loon breeding and brood rearing sites in spring and summer (at least until August).

7.6.3.3 Residual Impacts

In the operation phase, once the mitigation measures have been applied, the impact's intensity is considered low. Spatially, it is deemed site specific and the duration is moderate, thereby translating into a low impact.

7.6.4 Closure Phase Impacts

7.6.4.1 Impact Description

In the closure phase, the potential sources of impact on Anatidae and other waterbird species include water management and final site rehabilitation and revegetation in the mine and airstrip areas.

- *WATER MANAGEMENT*

Within the mine area, flooding of open pits R-2/R-3 and R-65 will create two lakes of 12.6 ha and 9.6 ha respectively that could be used by Anatidae. However, they will not be very suitable for feeding due to their great depth. Consequently, it is unlikely that they will shelter broods of these birds. However, they could be used as rest areas, particularly in late fall when neighbouring water bodies are frozen. In fact, their depth and shape will delay the development of ice cover.

As indicated above, in the construction and operation phases, ducks could use the domestic wastewater treatment station's aerated lagoons for brood rearing and during migration. Backfilling the aerated lagoons would have a negative effect on them.

- *FINAL SITE REHABILITATION AND REVEGETATION*

Initial seeding of herbaceous plants should favour Canada Goose feeding, especially during fall migration, in both the mine and airstrip areas. This positive impact will be ongoing as long as the seeded areas resemble a meadow. Shrub growth would make the habitat unsuitable for Canada Goose.

7.6.4.2 Mitigation Measures

Among the plant species to seed, precedence will be given to those preferred by Canada Goose.

7.6.4.3 Residual Impacts

In the closure phase, impact intensity is deemed low since impacts will not significantly alter the component's abundance or distribution in the study area. The extent is site specific and the duration, long, resulting in an impact whose significance is considered low and deemed positive for this component.

7.7 Raptors

The goals of the raptor survey were:

- To count the diurnal cliff-nesting raptors (nocturnal and forest-dwelling raptors are discussed in Section 7.8);
- To identify rare raptor species or special status species observed during the study and document their use of the study area.

7.7.1 Current Conditions

Little is known about the Renard Project area's raptor populations. The James Bay wildlife profile (CRRNTBJ, 2010a) lists the raptor species found in this vast region. Surveys carried out for the Route 167 North extension impact study (Roche – SNC-Lavalin, 2010) supply information on the species observed south of the Renard Project.



Photo 7.7.1 Example of Cliff Flown Over during Surveys

The species targeted by aerial surveys of cliff-nesting raptors were peregrine falcon and golden eagle, both designated "vulnerable" in Quebec (MRNF, 2010). The peregrine falcon is also designated a special status species at the federal level (COSEWIC, 2010). The surveys also paid special attention to the nests of treetop-nesting raptors like osprey and bald eagle (designated "vulnerable" in Quebec; MRNF, 2010). All observations of raptors and bird species with a special species status were collated.

The technique used to count territorial pairs of golden eagle, peregrine falcon and other cliff-nesting raptors (Photo 7.7.1) is based on counting the nesting sites they use and thus on searching out their nests. The survey methodology and detailed results are described in Section 6.2 of the EBS (Roche, 2011).

The cliff-nesting and treetop-nesting raptor surveys were carried out concomitantly with the waterfowl and other waterbirds surveys, i.e. May 30-31, 2011. Therefore, the area surveyed is described in Section 7.6.1. In addition, on June 21, 2010, a helicopter survey allowed all cliffs within a 12-km radius of Camp Lagopede to be scanned for raptor nests.

7.7.1.1 Regional Environmental Conditions

A total of 13 diurnal raptor species are found in the James Bay territory at some time of the year (CRRNTBJ, 2010a). Five of them, namely osprey, bald eagle, peregrine falcon, golden eagle and rough-legged hawk, build large nests high in treetops (first two species) or on cliffs (other species) and can be seen from the air. Red-tailed hawk nests in treetops and on cliffs but some treetop nests cannot be seen from the air. The other species nest mainly in forests (sharp-shinned hawk, northern goshawk and broad-winged hawk), on the ground (northern harrier) or in cavities (american kestrel). Merlin use various environments for breeding but their small size make them difficult to spot in aerial surveys. The latter species are included in Section 7.8 on forest-dwelling birds. Survey results for the impact study on the Route 167 extension show that four diurnal cliff-nesting and treetop-nesting raptor species (osprey, bald eagle, red-tailed hawk and golden eagle) use the proposed route's study area during the breeding season. Among these species, osprey and red-tailed hawk breeding was confirmed (Roche – SNC-Lavalin, 2010).

By combining the 2010 and 2011 observations, only three raptor species were identified in the Renard Project study area during the breeding season: the osprey, the bald eagle and the red-tailed hawk (Table 7.7.1). The bald eagle, represented by a single juvenile observed in 2010, is designated "vulnerable" in Quebec (MRNF, 2010). However, the individual sighted was probably migrating. A golden eagle (*Aquila chrysaetos*), a species also designated "vulnerable" in Quebec (MRNF, 2010), was spotted 10 km north of Camp Lagopede (outside the study area) during the big game survey of March 2011. Based on the observation date, it was probably migrating to its nesting site further north (Brodeur *et al*., 1996) and was not actually using the sector.

Raptor abundance is very low in the Renard Project study area. Observations suggest the presence of two red-tailed hawk pairs (Photo 7.7.2), based on the fact that this species' territory is approximately 2 km^2 of extent (Chagnon and Bombardier, 1995). However, it could probably be more abundant since the aerial surveys do not allow to find all the nests or the individuals of this species. An osprey nest was found in 2011. It was in poor condition and probably abandoned some years ago. The osprey observed in 2010 probably nested outside the study area since it was observed only once and because this species is known to fish more than 20 km from its nest (Jamieson and Seymour, 1982). Then, it is unlikely that this raptor currently breeds in the study area.



Photo 7.7.2 Red-tailed Hawk Nest on a Cliff, May 31, 2011

By comparison, in 2004, in the Romaine project study area (50-52th parallels), which covered a few hundred square kilometres, 13 raptor species were observed (Morneau and Benoit, 2005). The abundance of red-tailed hawk was estimated at 40 territorial pairs.

Table 7.7.1 Species of Cliff-nesting Raptors and other Cliff-nesting Birds observed in the Renard Project Study Area in 2010 and 2011 and their Breeding Status

English name	Latin name	French name	Cree name[1]	Year observed	Breeding evidence (code[2])	Breeding status (level of certainty)
Raptors						
Osprey	*Pandion haliaetus*	Balbuzard pêcheur	*akusamesew*	2010	H	Possible
Bald eagle	*Haliaeetus leucocephalus*	Pygargue à tête blanche	*kâ wâpistikwânet-micisiw*	2010	X	Observed
Red-tailed hawk	*Buteo jamaicensis*	Buse à queue rousse	*sâhkutam*[3]	2010-2011	NO	Confirmed
Other birds						
Common raven	*Corvus corax*	Grand Corbeau	*kâkâciw*	2010-2011	NU	Confirmed

[1]The Cree names were taken from: Cree Research and Development Institute and Kevin Brousseau. 2010. The Cree Research and Development Institute's Trilingual Lexicon of the Fauna and Flora of Eeyou Istchee. Cree Research and Development Institute. 107 pages.
[2] See Appendix 7.6.1 for the meaning of these codes.
[3] Generic term used for Buzzard Hawks.

7.7.1.2 Mine Area

Current knowledge points to the fact that only the red-tailed hawk inhabits the mine area, where its abundance is two or more pairs. The presence and the breeding of the common raven were also confirmed in the mine area, where its abundance is apparently at least two pairs.

7.7.1.3 Airstrip Area

The airstrip area is relatively flat with no cliffs. No raptor nests were identified in treetops. The only mention of a raptor in this area was a juvenile bald eagle (a species designated "vulnerable" in Quebec; MRNF, 2010) sighted on June 20, 2010, during the forest-dwelling bird surveys (Roche, 2011). It was probably a nomadic individual.

7.7.2 Construction Phase Impacts

7.7.2.1 Impact Description

During the construction phase, the project components likely to affect cliff-nesting or treetop-nesting raptors and common raven include site preparation development and construction of mine facilities. Both the mine and airstrip areas will be affected.

- *SITE PREPARATION AND DEVELOPMENT*

Based on current knowledge, the activities associated with site preparation and development (deforestation, etc.) and the construction of mine facilities will affect a red-tailed hawk pair in the mine area and the common raven in both the mine and airstrip areas (Table 7.7.2).

The red-tailed hawk pair will lose some of its hunting territory. However, only one of the three sightings of this species was located inside the project footprint, more specifically near its eastern boundary (Map 6.2.1. EBS). This suggests that only a portion of the red-tailed hawk hunting areas will be affected by site preparation and development. Consequently, given the fluctuation in the density of its prey and the species' adaptation potential, the pair should continue to use its territory. However, it might move its hunting areas somewhat to offset any losses. It might even take advantage of areas to be cleared but not stripped, which will constitute excellent hunting grounds. This pair's nest and breeding site are probably located far away outside the project's footprint, because otherwise the species would have been seen more often.

- *CONSTRUCTION OF MINE FACILITIES*

The red-tailed hawk could use the power line poles to its advantage as hunting lookouts, since they will be higher than trees.

The impact on the common raven appears to be positive. This opportunistic species will likely use certain elevated structures (telecommunication antennae, etc.) to build its nests and take advantage of anthropogenic food sources (dead animals, waste, discarded food, carcasses of big game harvested by the Crees who will use this area because of its easier access, etc.). This could result in one or more new common raven pairs settling here.

Table 7.7.2 Estimated Number of Pairs of Raptors and other Cliff-nesting or Treetop-nesting Birds affected by the Project

English name	Construction phase			Operation phase	Closure phase		
	Number of pairs affected		Type of impact [1]	Type of impact [1] (mine and airstrip areas)	Number of pairs affected		Type of impact [1]
	Mine area	Airstrip area			Mine area	Airstrip area	
Raptors							
Osprey	0	0	0	0	0	0	0
Bald Eagle	0	0	0	0	0	0	0
Red-tailed Hawk	1	0	–	0	1	0	+
Other birds							
Common Raven	1	1	+	0	1	1	–

[1] *Type of impact: 0: zero impact*
–: low negative impact; a small proportion of pairs will be affected
+: positive impact; probable increase in population due to project

7.7.2.2 Mitigation Measures

The impact summary reflects a negligible effect, demanding no specific mitigation measures. However, disturbing and stripping the ground will be avoided in areas where only trees need to be cut (i.e. areas not intended for infrastructure, confinement or storage areas) so that they remain attractive hunting areas for the red-tailed hawk and other raptors.

7.7.2.3 Residual Impact

In the construction phase, once the mitigation measures have been applied, the impact's intensity is considered low since the impact sources should not change the two species' distribution or abundance, although it might affect common raven numbers somewhat. The extent of the impact is site specific and long term, translating into an impact of low significance.

7.7.3 Operation Phase Impacts

No impact sources were identified in the operation phase. Given the low density of these species, strike hazard with airplanes is improbable. The common raven is unlikely to frequent the trench landfill site since the latter will be managed so as to not attract animals – the solid waste dumped will systematically be buried.

7.7.4 Closure Phase Impacts

7.7.4.1 Impact Description

In the closure phase, the project components that could affect this group of birds are site rehabilitation and revegetation and dismantling and recovery of facilities.

- *FINAL SITE REHABILITATION AND REVEGETATION; DISMANTLING AND RECOVERY OF FACILITIES*

Site rehabilitation and revegetation will create hunting habitats for the red-tailed hawk (Table 7.7.2). The areas seeded with grasses will prove especially suitable, since they attract voles, one of the red-tailed hawk's preys (Chagnon and Bombardier, 1995). On the other hand, the common raven will lose additional sources of antropogenic food and perhaps nesting sites with the dismantling of infrastructure (Table 7.7.2).

7.7.4.2 Mitigation Measures

No mitigation measures are required, given that impacts will be low.

7.7.4.3 Residual Impact

Impact intensity is deemed low and positive since the abundance and distribution of neither red-tailed hawk nor common raven will be significantly affected in the study area. The extent of the impact is site specific and long term, translating into an impact of low significance.

7.8 Forest Birds

The goals of the forest birds (woodpeckers, Tetraoninae and songbirds) survey in the study area were:

- To evaluate the species composition and richness of breeding forest birds (including forest raptors such as owls and northern goshawk; common raven is discussed in Section 7.7 with cliff-nesting raptors);
- To assess the relative abundance of birds in the study area;
- To identify the bird species present with a special species status;

- To describe the bird populations of the study area's biotopes.

7.8.1 Current Conditions

No known survey specifically targeted forest birds in the Renard Project study area. However, information is available for other areas of the boreal forest. The James Bay wildlife profile (CRRNTBJ, 2010a) contains a list of bird species observed in the region. Data is also available from studies conducted for major projects covering vast areas, such as the Great Whale hydroelectric project (Consortium Gauthier & Guillemette – G.R.E.B.E., 1991) and the impact study for the Route 167 North extension (Roche – SNC-Lavalin, 2010).

Forest bird surveys were carried out between June 19 to 24, 2010, for the Renard Project Environmental Baseline Study (EBS; Roche, 2011). The period and survey methods used sought to estimate the relative abundance of most nesting species. The three survey methods used were: fixed-radius point counts (FRPC; 50 m), unlimited-distance point counts (UDPC) and call playback (specifically for nocturnal raptors, such as the great horned owl, great gray owl, long-eared owl, and boreal owl, as well as the northern goshawk). The survey methodology and detailed findings are presented in Section 6.1 of Roche's EBS report (2011).

A total of 60 stations (including 12 in the airstrip area) were surveyed using the FRPC and UDPC methods inside and outside the Renard Project facilities area. They were divided into 8 habitat types grouped here under five biotopes (Table 7.8.1). Call playback was used at 7 stations covering one to four target species per station.

Table 7.8.1 Breakdown of Listening Stations by Habitat Type

Before grouping				After grouping			
Habitat type	**Number of listening stations**			**Biotope**	**Number of listening stations**		
Project area	**Total**	**Mine**	**Airstrip**	**Project area**	**Total**	**Mine**	**Airstrip**
Spruce-lichen stands	25	24	1	Open spruce stands	35	30	5
Closed spruce-balsam fir-moss stands	11	11	0	Closed spruce-balsam fir-moss stands [1]	11	11	0
Open spruce-soss stands	7	5	2	Riparian habitat	5	5	0
Riparian habitat	5	5	0	Boulder field	5	0	5
Boulder field	5	0	5	Wooded peatland	4	2	2
Forested peatland	4	2	2				
Jack pine stand	2	0	2				
Regeneration with conifers	1	1	0				
Total	60	48	12		60	48	12

[1] *On the mine area, this biotope corresponds to the old spruce-moss stands in the valley northeast of Camp Lagopede.*

Relative abundance of each bird species (number of pairs/20 min/ha) per biotope was calculated to determine the bird population, i.e. bird species inhabiting the same biotope. This estimate was calculated separately for each project area (mine and airstrip), except for wooded peatlands for which

data were grouped together given that few stations were visited in this biotope (Table 7.8.1). Only FRPC data were used for these calculations in order to include only the individuals present in the target biotope.

An initial section summarizes knowledge on the forest bird community of the James Bay territory and certain areas near the Renard Project. The richness of the species found regionally is then compared to the richness of the Renard Project study area. Finally, the bird communities in the mine and airstrip areas are described.

7.8.1.1 Regional Environmental Conditions

The James Bay territory is covered mainly by spruce-moss stands and spruce-lichen stands with small areas of balsam fir-white birch stands (in the south), forest tundra (in the northeast) and herbaceous Arctic tundra (in the northwest) (CRRNTBJ, 2010a). Wetland abundance varies by region, with relative importance ranging from more than 65% of the surface in the west (Waskaganish area) to less than 5% in the northwest. The Renard Diamond Project is located in the spruce-lichen bioclimatic domain, whose forest cover is dominated by black spruce, and where balsam fir and jack pine are in the northern limit of their range (CRRNTBJ, 2010a). More specifically, forest stands (80% of the study area) consist of six plant communities, which, in decreasing order of importance are: black spruce-lichen stands, black spruce-moss stands, black spruce-sphagnum stands, mixed forest, jack pine-lichen stands and deciduous forest (Roche, 2011). Wetlands account for a mere 2% of the study area. Finally, some sites are dry barrens, generally characterized by boulder fields or rock outcrops. They are scarce (1.4% of the study area) and found primarily in the future airstrip area. The hydrological network (water bodies and streams) covers 17% of the study area.

Just over one hundred species of forest birds are reportedly found in the vast James Bay territory in summer (CRRNTBJ, 2010a), including diurnal forest-dwelling raptors (northern harrier,[10] sharp-shinned hawk, northern goshawk, broad-winged hawk, American kestrel and merlin), nocturnal forest-dwelling raptors (great horned owl, northern hawk owl, great gray owl, long-eared owl,[11] short-eared owl[11] and boreal owl) and shorebirds. A study covering more than 47,000 km^2 of taiga and forest tundra identified 64 species of forest birds, excluding raptors and waterbirds (Consortium Gauthier & Guillemette - G.R.E.B.E., 1991). During the surveys carried out between June 17 and July 4, 2010, for the Route 167 North extension impact study between Mistissini and Camp Lagopede, 62 species of forest-dwelling birds (woodpeckers, Tetraoninae and songbirds) were identified (Roche – SNC-Lavalin, 2010). This same study showed the presence of northern harrier, merlin and great gray owl, and confirmed northern harrier nesting.

The surveys conducted in the Renard Project study area from June 19 to 24, 2010, identified 33 species of forest birds (Table 7.8.2), which represents about one-third of the richness observed in the James

[10] These species are associated essentially with open environments, like meadows and large peatlands, and build their nests on the ground.

Bay territory and half of the richness observed in the taiga and forest tundra. All of the species observed breed in the study area with varying levels of certainty[11] (Table 7.8.2). The observations allowed 55% of these species to be classified with a high level of certainty (nesting confirmed for 11 species and probable for 7 others).

The small number of species surveyed in the Renard Project study area is due, in large part, to the fact that the biotopes of the area are not very diverse and fragmented into small parcels. Furthermore, the area has no burn or major peatland and its water bodies are very similar in size and habitat type. Many bird species inhabit only the peatlands (Morneau, 1995).

7.8.1.2 Mine Area

The mine area in the study area is essentially covered by black spruce-lichen stands (64%) and dotted with black spruce-sphagnum stands (4%) and small wetlands (bogs, fens and marshes) (2%). Large tracts of black spruce-moss stands are also found here and cover 13% of the mine area. The valley located approximately 1.5 km east of Camp Lagopede is covered mainly by an old black spruce-moss stand (> 80 years). Lakes and streams cover 16% of the mine area.

During the surveys, 33 species of forest birds were identified in the mine area (Table 7.8.3), with a relative breeding population density of 3.14 breeding pairs/20 min/ha, regardless of the species or biotope. The most abundant species were dark-eyed junco, yellow-rumped warbler, ruby-crowned kinglet and white-throated sparrow (Table 7.8.4).

While most species are distributed uniformly over the survey area, four species (yellow-bellied flycatcher, boreal chickadee, golden-crowned kinglet and swainson's thrush) are concentrated in or limited to the vast old black spruce-moss stand located in the valley east of Camp Lagopede. In addition, many species were sighted very locally. Two spotted sandpiper nests were discovered in areas altered by human activity, i.e. within the camp perimeter and north of lake F3302. Solitary sandpiper was sighted at the edge of lake F3298. Wilson's snipe was seen near deposit R-3. Finally, northern waterthrush was observed near Lake Lagopede's northern bay.

[11] There are three levels of breeding certainty: possible, probable and confirmed. They are established using different nesting indices corresponding to behaviours or observations making it possible to determine whether a given species breeds in a plot. For example, a singing male corresponds to possible breeding, mating behaviour between a male and female to probable breeding and an adult carrying food to confirmed breeding (*Atlas des oiseaux nicheurs*, 2010).

Table 7.8.2 Forest Bird Species Observed in the Renard Project Study Area between June 19 and June 24, 2010, and their Breeding Status

English name	Latin name	French name	Cree name [1]	Breeding evidence (code[2])	Breeding status (level of certainty)
Spruce Grouse	*Falcipennis canadensis*	Tétras du Canada	*iynihyew, mistikuhyew*	H	Possible
Solitary Sandpiper	Tringa solitaria	Chevalier solitaire	*tuhesk* [3]	H	Possible
Spotted Sandpiper	Actitis macularius	Chevalier grivelé	*tuhesk* [3]	NF	Confirmed
Wilson's Snipe	Gallinago delicata	Bécassine de Wilson	*tuhesk* [3]	S	Possible
Belted Kingfisher	*Ceryle alcyon*	Martin-pêcheur d'Amérique	*ucîscimanisiw*	H	Possible
Black-backed Woodpecker	*Picoides arcticus*	Pic à dos noir	*pâhpâstew, pâspâstew* [4]	S	Possible
Olive-sided Flycatcher	*Contopus cooperi*	Moucherolle à côtés olive	n/a	CN	Confirmed
Yellow-bellied Flycatcher	*Empidonax flaviventris*	Moucherolle à ventre jaune	n/a	M	Probable
Gray Jay	*Perisoreus canadensis*	Mésangeai du Canada	*wîskacân, kwekwesiw*	JE	Confirmed
Tree Swallow	*Tachycineta bicolor*	Hirondelle bicolore	*mîcihkulesîs, mîcihkusîs* [5]	V	Probable
Boreal Chickadee	*Poecile hudsonica*	Mésange à tête brune	*picikîskasîs, micikîskasîs*	AT	Confirmed
Winter Wren	*Troglodytes troglodytes*	Troglodyte des forêts	n/a	S	Possible
Golden-crowned Kinglet	*Regulus satrapa*	Roitelet à couronne dorée	n/a	S	Possible
Ruby-crowned Kinglet	*Regulus calendula*	Roitelet à couronne rubis	n/a	M	Probable
Swainson's Thrush	*Catharus ustulatus*	Grive à dos olive	*kwacîs* [6]	S	Possible
Hermit Thrush	*Catharus guttatus*	Grive solitaire	*kwacîs* [6]	M	Probable
American Robin	*Turdus migratorius*	Merle d'Amérique	*pîhpîhcew, pihpihcew*	NF	Confirmed
Bohemian Waxwing	*Bombycilla garrulus*	Jaseur boréal	*usecipatwânisîs, usecipalwâcîs* [7]	NO	Confirmed
Cedar Waxwing	*Bombycilla cedrorum*	Jaseur d'Amérique	*usecipatwânisîs, usecipalwâcîs* [7]	H	Possible
Orange-crowned Warbler	*Vermivora celata*	Paruline verdâtre	*cimiwan-piyesîs* [8]	S	Possible
Yellow Warbler	*Dendroica petechia*	Paruline jaune	*usâwask-piyesîs, sacipakâw-piyesîs*	S	Possible
Yellow-rumped Warbler	*Dendroica coronata*	Paruline à croupion jaune	*nimiscîw-piyesîs* [9]	AT	Confirmed
Palm Warbler	*Dendroica palmarum*	Paruline à couronne rousse	*cimiwan-piyesîs* [8]	S	Possible
Blackpoll Warbler	*Dendroica striata*	Paruline rayée	*cimiwan-piyesîs* [8]	S	Possible
Northern Waterthrush	*Seiurus noveboracensis*	Paruline des ruisseaux	*cimiwan-piyesîs* [8]	S	Possible
Wilson's Warbler	*Wilsonia pusilla*	Paruline à calotte noire	*cimiwan-piyesîs* [8]	S	Possible
Fox Sparrow	*Passerella iliaca*	Bruant fauve	n/a	M	Probable
Lincoln's Sparrow	*Melospiza lincolnii*	Bruant de Lincoln	n/a	AT	Confirmed
White-throated Sparrow	*Zonotrichia albicollis*	Bruant à gorge blanche	*sâsâkawâcihpesîs, kâ ayamihâsit-piyesîs, wâseskunewacisîs,* etc.[10]	M	Probable
White-crowned Sparrow	*Zonotrichia leucophrys*	Bruant à couronne blanche	*sâsâkawâcihpesîs, kâ ayamihâsit-piyesîs, wâseskunewacisîs,* etc.[10]	AT	Confirmed
Dark-eyed Junco	*Junco hyemalis*	Junco ardoisé	*pascesîs*	AT	Confirmed
Rusty Blackbird	*Euphagus carolinus*	Quiscale rouilleux	*cahcahkayuw* [11]	NJ	Confirmed
White-winged Crossbill	*Loxia leucoptera*	Bec-croisé bifascié	*âsitawikutesîs, âsicawikucesîs* [12]	M	Probable

[1] The Cree names were taken from: Cree Research and Development Institute and Kevin Brousseau. 2010. The Cree Research and Development Institute's Trilingual Lexicon of the Fauna and Flora of Eeyou Istchee. Cree Research and Development Institute. 107 pages.
[2] See Appendix 7.6.1 for the meaning of these codes
[3] Generic term used for shorebirds; also *cûscûscisîs, tehtescisîs, tûhtûscisîs, twesk, twestwescisîs*.
[4] Generic terms used for woodpeckers.
[5] Generic terms used for swallows.
[6] Generic term used for thrushes.
[7] Generic terms used for waxwings.
[8] Generic term used for warblers; also *cimiwanewacisîs, cimiwaniskacisîs, cimiwanisîs*.
[9] Generic term also used for the magnolia warbler.
[10] Generic terms used for white-throated sparrow and white-crowned sparrow.
[11] Generic term used for the red-winged blackbird and, generally, for birds of similar appearance, such as other blackbirds and starlings.
[12] Generic terms used for crossbills (*Loxia* spp.).

In the June 2010 surveys, the species of interest for the Crees were scarce. A male spruce grouse was seen near a small lake (F3295) north of Camp Lagopede. However, it was not possible to assess the species' abundance in the study area since mating seemed already completed at the time of the survey; males being hardly visible and females brooding outside this period.

Signs of willow ptarmigan (*Lagopus lagopus* or *wâpihyew* in Cree) browsing were observed on shrubby willows (*Salix* sp.) during the June 2010 surveys (Photo 7.8.1), thereby substantiating its presence in the study area in winter. At a meeting of the Environmental Exchange Group held in March 2011 with the Crees from Mistissini, it was mentioned that the willow ptarmigan was particularly abundant in winter 2011 and had even been sighted around Mistissini. Further, in the winter micromammal survey performed in March 2011 in the Renard Project study area, Tetraoninae[12] tracks were observed in most of the transects surveyed (Section 7 of the EBS, Roche, 2011).



Photo 7.8.1 **Willow Ptarmigan browsing on a Willow Branch**

[12] The Tetraoninae group include willow ptarmigan, spruce grouse and, more rarely, rock ptarmigan (*Lagopus muta* or *kascaniciy* in Cree).

Table 7.8.3 Breakdown of Forest Bird Species observed in the Renard Project Study Area between June 19 and June 24, 2010

English name	Area	
	Mine	Airstrip
Solitary sandpiper	X	
Spotted sandpiper	X	
Wilson's snipe	X	
Belted kingfisher	X	
Spruce grouse	X	
Black-backed woodpecker	X	
Olive-sided flycatcher	X	
Yellow-bellied flycatcher	X	x
Gray jay	X	x
Tree swallow	X	
Boreal chickadee	X	
Winter wren	X	
Golden-crowned kinglet	X	
Ruby-crowned kinglet	X	x
Swainson's thrush	X	
Hermit thrush	X	x
American robin	X	x
Bohemian waxwing	X	
Cedar waxwing	X	
Orange-crowned warbler	X	
Yellow warbler	X	
Yellow-rumped warbler	X	x
Palm warbler	X	x
Blackpoll warbler	X	x
Northern waterthrush	X	
Wilson's warbler	X	
Fox sparrow	X	x
Lincoln's sparrow	X	
White-throated sparrow	X	x
White-crowned sparrow	X	
Dark-eyed junco	X	x
Rusty blackbird	X	
White-winged crossbill	X	x
Number of species	33	12

Table 7.8.4 Relative Abundance (Number of Breeding Pairs/20 min/ha) of Bird Species in the Mine Area's Different Biotopes (n = 48 Stations; FRPC Data)

English name	Relative abundance (number of breeding pairs/20 min/ha)				
	Open spruce stands (n = 30)	Closed spruce-balsam fir-moss stands (n = 11)	Riparian habitat (n = 5)	Wooded peatland (n = 4[1])	Mine area (n = 48)
Spotted sandpiper	–	–	0.13	–	0.01
Yellow-bellied flycatcher	–	0.64	–	–	0.15
Gray jay	0.21	0.35	0.25	–	0.24
Boreal chickadee	–	0.06	–	–	0.01
Golden-crowned kinglet	–	0.12	–	–	0.03
Ruby-crowned kinglet	0.21	0.46	0.38	0.64	0.3
Swainson's thrush	–	0.12	–	–	0.03
Hermit thrush	0.17	0.17	0.25	0.16	0.19
American robin	0.15	–	–	0.16	0.11
Bohemian waxwing	–	0.12	–	–	0.03
Orange-crowned warbler	0.04	–	–	–	0.03
Yellow-rumped warbler	0.64	0.35	0.76	–	0.56
Blackpoll warbler	0.17	–	0.25	0.32	0.13
Wilson's warbler	–	–	0.51	–	0.05
Fox sparrow	0.17	–	–	0.32	0.11
Lincoln's sparrow	0.17	–	0.13	–	0.12
White-throated sparrow	0.25	0.12	0.38	0.32	0.25
White-crowned sparrow	0.11	–	0.38	–	0.11
Dark-eyed junco	0.76	0.46	0.38	0.32	0.62
Rusty blackbird	0.04	–	–	–	0.03
White-winged crossbill	0.04	–	–	0.32	0.05
Total	3.13	2.97	3.81	2.56	3.14

[1] *These four listening stations included 2 stations completed in the airstrip area.*

Two special status species were observed and confirmed to be breeding in the mine area: olive-sided flycatcher (designated "threatened" in Canada [COSEWIC, 2010] and likely to be designated "threatened or vulnerable" in Quebec [MRNF, 2010]) and rusty blackbird (designed "of special concern" at the federal level and likely to be designated "threatened or vulnerable" at the provincial level). Olive-sided flycatcher abundance is probably limited to a single breeding pair, given the species' very loud song and the coverage of the target area. This pair, which was building a nest (not seen) inhabited a spruce-lichen stand with tall trees west of lake F2607. Rusty blackbird nesting was confirmed in two locations in spruce-lichen stands near lakes (one nest with young west of lake F2607 and food transport east of lake F3295), thereby revealing the presence of at least two pairs.

Two other bird species that were observed warrant particular interest: the bohemian waxwing and orange-crowned warbler. The two bohemian waxwing nests discovered in the study area constituted the first two mentions of this species' nesting in Quebec. It had been suspected to nest in Quebec for two decades (Consortium Gauthier & Guillemette - G.R.E.B.E., 1991), but had not been confirmed before due to the distance of its breeding grounds. Both nests were in spruce-lichen stands, one within the camp perimeter, near Lake Lagopede, and the other, west of lake F2607. The orange-crowned warbler merits special attention since, according to David (1996), it is a rare breader in Quebec. Only one singing male was identified in an old spruce-sphagnum stand northwest of lake F2607.

It is likely that most, if not all, species targeted by “call playback” were absent from the survey area. Great gray owl and long-eared owl are associated primarily with vast open, grassy biotopes, such as peatlands and large riparian herbaceous meadows, environments that are rare in the study area and represented only by very small stands. However, the survey area contains biotopes suitable for the three other species: open biotopes for the great horned owl and forest biotopes for the northern goshawk and boreal owl (Gauthier and Aubry, 1995). The abundance, and even presence, of these species is closely linked to the abundance of their preferred prey. In the boreal forest, the primary prey of the Great Horned Owl and Northern Goshawk is the Snowshoe Hare (*Lepus americanus*) (Doyle and Smith, 1994; Boutin *et al*., 1995). However, no sign of this species’ activity was observed in the field during the 2010 bird surveys. The hare’s relative abundance in the Renard Project study area is considered average, based on the fur-bearing animal survey conducted in winter 2011.

- *DISTRIBUTION BY PLANT BIOTOPE*

In the mine area, the term open spruce stands groups together spruce-lichen stands (Photo 7.8.2), conifer regeneration areas and open spruce-moss stands (Table 7.8.1). Young spruce-lichen stands cover most of the area surveyed in the mine area. Open spruce stand posts the highest bird species richness (14 species; Table 7.8.4) of the four biotopes studied in the mine area, a fact that can be explained by a proportionally higher number of stations[13]. The relative mean density for all species (3.13 breeding pairs/20 min/ha) is similar to that of closed spruce-balsam fir-moss stands, lower than that of riparian habitats and higher than that of wooded peatlands. The five most abundant species were the same in the survey area, namely: dark-eyed junco, yellow-rumped warbler, white-throated sparrow, gray jay and ruby-crowned kinglet (Table 7.8.4).



Photo 7.8.2 Spruce-Lichen Stand

[13] Richness (number of bird species) is strongly influenced by survey effort (Scherrer, 1984) and, then, can be compared only among biotopes where a comparable number of stations were surveyed.

The closed spruce-balsam fir-moss biotope (Photo 7.8.3) consists of a large plot of old forest (old black spruce-moss stands) located in the valley in the southeastern portion of the survey area. Its richness (11 bird species; Table 7.8.4) is lower than that of open spruce stands and riparian habitats. However, this difference probably reflects the unequal number of stations more than anything else. The relative mean density for all species (2.97 breeding pairs/20 min/ha) resembles that of open spruce stands but is lower than that of riparian habitats.



Photo 7.8.3 Closed Spruce-Balsam Fir-Moss Forest

The closed spruce-balsam fir-moss biotope shelters four species that were only rarely observed, or not at all, in the other biotopes: yellow-bellied flycatcher, golden-crowned kinglet, swainson's thrush and boreal chickadee. Closed spruce-balsam fir-moss stand is these species' preferred biotope (Gauthier and Aubry, 1995).

Riparian habitats (Photo 7.8.4) include a stream and a rather narrow strip of riparian deciduous shrubs bordered by a relatively large area of spruce-moss stands and a larger area of spruce-lichen stand. The richness of this biotope (10 species; Table 7.8.4) is lower than that of open spruce stands (14 species) and open spruce-balsam fir-moss stands (11 species), but higher than that of wooded peatlands (8 species). In fact, with an equal number of stations, the richness would be significantly higher than that of all other biotopes, since riparian habitats are, by far, the boreal forest and taiga's richest environment (Consortium Gauthier & Guillemette - G.R.E.B.E., 1991; 1992). The relative breeding pair density (3.81 breeding pairs/20 min/ha) in riparian habitats is the highest of the five biotopes studied.



Photo 7.8.4 Riparian Habitat

Given its plant composition, the riparian habitat biotope is home to many forest bird species. The most abundant are: dark-eyed junco, ruby-crowned kinglet and yellow-rumped warbler. In addition, one species, wilson's warbler (Table 7.8.4), is specific to the groves of deciduous shrubs found in wetlands and was, in fact, observed only in this biotope. The presence of spotted sandpiper should also be mentioned, which inhabits shores and neighbouring open areas (Gauthier and Aubry, 1995).



Photo 7.8.5 Wooded Peatland

Wooded peatlands (Photo 7.8.5) are rare in the study area and represented only by very small plots, which explains that few stations were surveyed in these habitats.

The species observed in the wooded peatlands of the mine and airstrip areas are among the most abundant of the study area (Tables 7.8.4 and 7.8.5).

7.8.1.3 Airstrip Area

The habitats of the airstrip area are less diverse than those of the mine area. The airstrip area is mainly covered by black spruce-lichen stands (58% of the plant community) and old jack pine-lichen stands (11% of the plant community). In the centre of the area is a boulder field, and in the immediate vicinity of the proposed airstrip is an old black spruce-moss stand (2% of the plant community) and a boulder field (4%). Wetlands (3%), water bodies and streams are few (19%). The area shelters no new species compared to the mine area and only the most common are found here. In fact, only 12 bird species were identified during the surveys of the airstrip area (Table 7.8.3). None was a special status species. The relative mean density of the area was 2.17 breeding pairs/20 min/ha for all species and all biotopes combined (Table 7.8.5), what is lower than that of the mine area (3.13 breeding pairs/20 min/ha; Table 7.8.4). The species that were most abundant in the airstrip area were: dark-eyed junco, ruby-crowned kinglet, blackpoll warbler and fox sparrow.

Table 7.8.5 Bird Species Density by Biotope in the Airstrip Area (n = 12 Stations; FRPC Data)

English name	Relative abundance (number of breeding pairs/20 min/ha)			
	Open spruce forest (n = 5)	Boulder field (n = 5)	Wooded peatland (n = 4[1])	Airstrip area (n = 12)
Gray jay	0.25	0.13	–	0.16
Ruby-crowned kinglet	0.51	0.25	0.64	0.42
Hermit thrush	–	0.13	0.16	0.05
American robin	0.13	–	0.16	0.05
Yellow-rumped warbler	–	0.25	–	0.11
Palm warbler	–	0.25	–	0.11
Blackpoll warbler	–	0.25	0.32	0.21
Fox sparrow	0.25	–	0.32	0.21
White-throated sparrow	0.25	–	0.32	0.11
Dark-eyed junco	0.76	0.51	0.32	0.64
White-winged crossbill	–	0.25	0.32	0.11
Total	2.16	2.03	2.56	2.17

[1] These four listening stations include 2 stations completed in the mine area.

- *DISTRIBUTION BY PLANT BIOTOPE*

In the airstrip area, the listening stations were located in the following biotopes: open spruce stand, boulder fields and wooded peatlands. The description of the bird species composition given for the wooded peatland biotope of the mine area also applies to the airstrip area.

The open spruce stand biotope of the airstrip area includes old jack pine-lichen (Photo 7.8.6), old open black spruce-moss and young black spruce-lichen stands (Table 7.8.1). Its



Photo 7.8.6 Old Jack Pine-Lichen Forest

richness in bird species (6 species; Table 7.8.5) is lower than that of the open spruce stand of the mine area but similar to the richness of wooded peatlands and boulder fields. However, the difference observed between the open spruce stands of the two areas probably mostly reflects the unequal number of listening stations in the two areas. While the relative mean density of 2.16 breeding pairs/20 min/ha resembles that found in the airstrip area's two other biotopes (wooded peatlands and boulder fields), it is lower than that observed in the open spruce stand of the mine area (3.14 breeding pairs/20 min/ha). This lower richness could also be due to the presence of jack pine stands, which are known to be rather undiversified habitats. Dark-eyed junco and ruby-crowned kinglet were, by far, the most abundant species in this biotope of the airstrip area.

The boulder field biotope (Photo 7.8.7) corresponds to a very open spruce stand whose ground is completely covered with rocks of different sizes and dotted with scrub birch. The trees are of average height, i.e. 5 to 10 m. Eight bird species were identified in this biotope, what is similar to the number of species observed in the wooded peatland biotope (8 species; Table 7.8.4). The relative mean pair density (2.03 breeding pairs/20 min/ha) in the boulder fields is the lowest of the five biotopes visited during the June 2010 surveys in the mine and airstrip areas.



Photo 7.8.7 Boulder Field

The species inhabiting boulder fields are among the most abundant of the study area: dark-eyed junco, yellow-rumped warbler and ruby-crowned kinglet (Table 7.8.5). In fact, the bird species found here are very similar to those found in the open spruce stand.

7.8.2 Impact Assessment Methodology

7.8.2.1 Construction and Operation Phases

The number of breeding pairs of forest birds affected by biotope losses or gains was estimated differently depending on the species. For the most abundant species[14], breeding pair density per biotope, calculated using fixed-radius point count (FRPC) results, was used. The number of pairs of a given species affected was calculated as follows:

(Species density in biotope A x Surface area of biotope A lost) +
(Species density in biotope B x Surface area of biotope B lost) + ...

The surface areas for each biotope affected by the Renard Project are shown in Table 7.8.6., which also specifies the proportion of the sites to be cleared only (trees and shrubs cut but soil kept intact) and the proportion to be cleared and stripped. This distinction is important for assessing impacts on birds since

[14] Gray jay, ruby-crowned kinglet, hermit thrush, american robin, yellow-rumped warbler, blackpoll warbler, fox sparrow, lincoln's sparrow, white-throated sparrow, white-crowned sparrow, dark-eyed junco and white-winged crossbill.

certain species can use areas that have been cleared but not stripped. For these species (hermit thrush, lincoln's sparrow, white-throated sparrow, white-crowned sparrow and dark-eyed junco), the number of pairs affected by the project was multiplied by the proportion of sites to be stripped.

Table 7.8.6 Surface Area of Biotopes Frequented by Forest Birds Affected by Site Clearing and Preparation

Biotopes	Surface area affected (ha)			
	Mine area		Airstrip area	
	Construction phase	Operation phase	Construction phase	Operation phase
Open spruce stand	186.74	27.40	66.41	0
Closed spruce-balsam fir-moss stand	0.40	0	0	0
Riparian habitat	0	0	0	0
Boulder field	3.50	0	14.90	0
Wooded peatland	4.81	1.2	0	0
Total surface area affected	197.35	28.60	81.31	0
Proportion cleared only	*23%*	*22%*	*72%*	*0 %*
Proportion cleared and stripped	*77%*	*78%*	*28%*	*0%*

For less abundant species, the number of breeding pairs affected was estimated using unlimited-distance point counts (UDPC) data and other field observations. The observations associated with site preparation and development worksites were analyzed to eliminate those that were redundant. Then, the minimum number of pairs affected was determined for each species.

7.8.2.2 Closure Phase

To determine the number of breeding pairs of forest birds that will be affected in this phase, the surface areas slated for final site rehabilitation and revegetation were taken into account (Table 7.8.7).

Table 7.8.7 Surface Areas Revegetated in the Closure Phase

Activity	Surface area (ha)	
	Mine area	Airstrip area
Natural revegetation	51.3	58.4
Active revegetation (hydroseeding and planting)	97.9	22.9
Total surface area revegetated	149.2	81.3
Proportion of surface area affected by the project in the construction and operation phases to be revegetated	*66%*	*100%*

The structure and composition of plant species that will ultimately cover the revegetated areas cannot currently be determined. To assess this phase's impacts on the forest bird population, it was assumed that the new forest conditions would be similar to those observed in naturally occurring open spruce stands. For the most abundant species (see Section 7.8.2.1), the breeding pair densities observed in open spruce stand (Tables 7.8.4 and 7.8.5) were used to calculate the number of pairs of each species

that will find appropriate nesting habitats after the restoration of plant cover. For certain species (hermit thrush, lincoln's sparrow, white-throated sparrow, white-crowned sparrow and dark-eyed junco), only those areas actively revegetated were considered in the calculations. In fact, these species should continue to use the areas that were cleared but not stripped in the construction and operation phases.

For the less abundant species, the number of pairs affected was estimated based on the knowledge acquired during the field surveys.

7.8.3 Construction Phase Impacts

During the construction phase, the project components most likely to affect forest birds include site preparation and development and construction of mine facilities. This is true for both the mine and airstrip areas.

7.8.3.1 Mine Area

- *SITE PREPARATION AND DEVELOPMENT; CONSTRUCTION OF MINE FACILITIES*

Impact sources relate primarily to the activities that will cause biotopes sheltering forest birds to disappear. In the construction phase, a total of 197.35 ha of biotopes inhabited by forest birds will be affected by site preparation and development in the mine area (Table 7.8.6). Of this surface area, 77% will be cleared and stripped.

The number of breeding pairs affected will vary for each of the 33 species of this group based on their population density (Tables 7.8.4 and 7.8.5) and the surface area and location of the biotopes they inhabit. In this regard, four groups can be distinguished.

Species positively impacted

The first group consists of species that will only be positively impacted (spotted sandpiper, belted kingfisher and tree swallow; Table 7.8.8). During the forest bird survey, two spotted sandpiper nests were discovered in anthropized areas, including one inside the camp's perimeter. This species feeds on exposed lake and river shores, sand beaches and dunes (Gauvreau and Alvo, 1995). No habitat of this type will be lost. In fact, construction work will create nesting habitats. This species frequently nests on land developed by man (gravel quarries, fields, along roadways and in ditches) (Gauvreau and Alvo, 1995). The number of spotted sandpiper breeding pairs should, therefore, increase somewhat during the construction phase.

The tree swallow was sighted only in and around Camp Lagopede, which seems to be its sole breeding ground. This species nests in open environments, natural cavities, cavities created by woodpeckers and bird nesting boxes. In the taiga, cavities are rare, thus, the species will benefit from opportunities offered by openings in man-made structures (pipes, cracks, crevices, etc.). Consequently, its abundance will increase.

The belted kingfisher nests in a burrow it digs in escarpments of unconsolidated deposits on lakeshores, riverbanks and sometimes elsewhere. It has long used similar sites in borrow pits and other areas developed by man (Laporte, 1995). Its abundance is, therefore, expected to rise.

Species that will not lose suitable habitats

The second group of forest birds includes 6 species that will not lose biotope surface area (Table 7.8.8) and, as a result, suffer no impact. They are:

- Species found only in the large plot of old spruce-moss stand that will not be affected by the project, located in the valley northeast of the mine infrastructure's right-of-way (swainson's thrush, golden-crowned kinglet and boreal chickadee);
- Species using riparian habitats that will not be affected by the project (a riparian strip of at least 30 m will be maintained) (yellow warbler, northern waterthrush and solitary sandpiper).

Ground-nesting and ground-feeding species

The third group of forest birds includes species that nest and feed on the ground. Since part of the mine sector (23%) will undergo clearing and brush-cutting but not stripping, these species will gain potential habitats (open environments) that will partly offset biotopes lost, making these losses less critical for them than for species living partly or totally in trees. This group includes the following five species: hermit thrush, lincoln's sparrow, white-throated sparrow, white-crowned sparrow and dark-eyed junco (Table 7.8.8). It is estimated that approximately 216 pairs of these species will lose their nesting site in the area, with the dark-eyed junco and white-throated being the most affected.

Species associated with trees and shrubs

Finally, the last group includes species that live partly or totally in trees and shrubs. It is this group that encompasses the most species (19) and for which the project-related impacts affect the largest number of pairs (Table 7.8.8). The group includes 4 species of particular interest (olive-sided flycatcher, rusty blackbird, orange-crowned warbler and bohemian waxwing). The total number of pairs affected is estimated at about 329, with the yellow-rumped warbler and ruby-crowned kinglet being the most affected species. The abundance of gray jay, which belongs to this group, was probably largely overestimated given that this species is generally attracted to observers.

The impact assessment for bohemian waxwing, rusty blackbird and olive-sided flycatcher is marked by uncertainty. The rusty blackbird is designated as a special status species in Canada and the olive-sided flycatcher, "threatened" under the same jurisdiction. Bohemian waxwing abundance is not known exactly. Two pairs were identified and their nests discovered in the mine area. Since the call of this species is audible only over a short distance, it is possible that one or two pairs escaped the observers' vigilance. The rusty blackbird is strictly riparian and lives in open wetlands (COSEWIC, 2006). While the size of its home range is unknown, a pair can seemingly use more than one wetland. The one whose nest was located near lake F2607 may not be affected by the habitat loss since a very small fraction of

the wetland it inhabits will be lost. It is likely that one pair, at most two, will be affected by wetland habitat losses. Finally, only one olive-sided flycatcher pair was identified in the mine footprint. It is unlikely that another pair was missed since this species song carries a long way. If the nest were located near the centre of the identified pair's territory, then most of it will be destroyed by site preparation and development activities.

Table 7.8.8 Estimated Number of Forest Bird Pairs affected by the Renard Project Construction Phase

English name	Construction phase		
	Number of pairs affected[1]		Type of impact[2]
	Mine area	Airstrip area	
Species positively impacted			
Spotted sandpiper	≥ 2	0	+
Belted kingfisher	1	0	+
Tree swallow	≥ 5	≥ 3	+
Species that will not lose suitable habitats			
Solitary sandpiper	0	0	0
Boreal chickadee	0	0	0
Golden-crowned kinglet	0	0	0
Swainson's thrush	0	0	0
Yellow warbler	0	0	0
Northern waterthrush	0	0	0
Ground-nesting and ground-feeding species			
Hermit thrush	25	0	–
Lincoln's sparrow	25	0	–
White-throated sparrow	38	5	–
White-crowned sparrow	16	0	–
Dark-eyed junco	112	16	–
Species associated with trees and shrubs			
Spruce grouse	≥ 1	≥ 0	–
Wilson's snipe	1	0	–
Black-backed woodpecker	2	1	–
Olive-sided flycatcher	1	0	–
Yellow-bellied flycatcher	≥ 3	5-8	–
Gray jay	39	19	–
Winter wren	≥ 1	0	–
Ruby-crowned kinglet	45	38	–
American robin	29	9	–
Bohemian waxwing	≥ 2	≥ 0	–
Cedar waxwing	≥ 0	≥ 0	–
Orange-crowned warbler	1	0	–
Yellow-rumped warbler	120	4	–
Palm warbler	≥ 4	≥ 3	–
Blackpoll warbler	34	4	–
Wilson's warbler	1	0	–
Fox sparrow	34	17	–
Rusty blackbird	≥ 1	0	–
White-winged crossbill	≥ 10	≥ 4	–

[1] *The number of pairs affected was estimated using UDPC and FRPC data.*

[2] *Type of impact: 0: zero impact;*
–: low negative impact; a small proportion of pairs will be affected;
+: positive impact; probable project-related population increase.

The forest birds affected will have to settle elsewhere after losing their nesting habitat. Their fate will depend, to a great extent, on regional habitat saturation levels. Numerous studies suggest the existence of surplus non-breeding individuals in many forest species, at least for some years (Steward and Aldrich, 1951; Hensley and Cope, 1951). For those species to which this applies in the study area, intraspecies competition will cause the lifespan of many displaced individuals to be shortened and a local, but minimal, population decline should occur. In all cases, the regional potential abundance will be reduced. For the rusty blackbird, it is likely that the pairs affected will successfully settle elsewhere since most of the population decline will not be linked to the loss of breeding habitats (COSEWIC, 2006). The same is probably true for the bohemian waxwing, which does not defend a territory and shows no tendency to come back to nest in the same location (Létourneau, 1995).

In addition to habitat loss, the nests of many forest birds risk being destroyed in the construction phase. The number will depend on the percentage of overlap between the period when the trees and underbrush will be cut and the onset of the breeding season (June and July).

- *PTARMIGAN*

Willow ptarmigan prefers to feed in the riparian habitats where a riparian strip of at least 30 m wide will be kept. However, part of its feeding occurs in open biotopes and even forests. The loss of these environments will force the ptarmigan to travel further but should not affect its survival rate. The impacts are thus limited to a slight habitat loss.

- *FOREST-DWELLING DIURNAL AND NOCTURNAL RAPTORS*

No forest raptors were identified in the mine area. Most of these birds inhabit open or semi-open biotopes and are highly visible. Therefore, it is unlikely that their presence went unnoticed by observers. For the species that tend to remain in the forest, like the boreal owl, the only potential habitat is the old spruce-moss stand located outside the mine infrastructure. Consequently, no impact is anticipated for this group despite the loss of potential habitats.

7.8.3.2 Airstrip Area

- *SITE PREPARATION AND DEVELOPMENT; CONSTRUCTION OF MINE FACILITIES*

In the airstrip area, 81.31 ha of biotopes used by birds will be affected by site preparation and development (Table 7.8.6). However, most of this area (72%) will be cleared only and the soil will remain undisturbed. This means that species associated with trees and shrubs, especially ruby-crowned kinglet and fox sparrow, will be affected most (Table 7.8.8). Ground-nesting and ground-feeding species will be relatively unaffected by clearing activities in this area, with 1 to 16 pairs affected per species (Table 7.8.8). The bohemian waxwing was not identified in the airstrip area but one or two pairs may have been missed since its call does not carry far.

Similar to the mine area, the tree swallow could use airstrip infrastructure to build its nest.

7.8.3.3 Mitigation Measures

As recommended by the Canadian Wildlife Service (CWS), site clearing and underbrush-cutting will occur primarily in fall and winter, i.e. outside the peak breeding season of forest birds, which extends from May 1 to August 15 for the region. This will substantially reduce the number of nests destroyed. Fallen dead trees and low shrubs will be kept as far as possible in locations where the ground is not disturbed, notably in the airstrip area. This measure will significantly cut back on habitat loss for species like the palm warbler and fox sparrow.

7.8.3.4 Residual Impact

The impact intensity is considered low since the percentage of forest birds affected in the study area is 2.1% (2.7 km^2/127 km^2). Its spatial extent is site specific since it is restricted to the mine and airstrip footprint. Finally, its duration corresponds to the construction and operation phases. It is, thus, deemed long by definition and, as a result, the significance of the impact is low. This assessment applies to the component as a whole, as well as to the olive-sided flycatcher and rusty blackbird since their range seems generalized in the region and probably in the study area, considering the 13 and 28 mentions of these species, respectively, in different locations during the impact assessment for the Route 167 North extension, between Mistissini and Camp Lagopede (Roche – SNC-Lavalin, 2010).

7.8.4 Operation Phase Impacts

In the operation phase, the project components most likely to affect forest birds include open pit development, airstrip operation and disturbance generated by mining activities (ore mining, handling and storage).

Road circulation, the presence of facilities (sources of light, structures) and waste management (trench landfill site) are not considered project components likely to significantly affect forest birds, given the mitigation measures envisaged for the project (speed limits on-site, minimal lighting, waste burial as it is dumped in the trench landfill site).

7.8.4.1 Mine Area

- *PIT DEVELOPMENT*

During operations, open pit development will destroy an additional 28.6 ha of biotopes (open spruce stand) suitable for forest birds in the mine area, 6.4 ha of which will be cleared but not stripped. It is estimated that some 15 bird species may be affected by this activitiy (at least 79 breeding pairs, Table 7.8.9) albeit no species of interest. In addition to habitat losses, the nests of many forest birds could be destroyed in the operation phase, with the number depending on the overlap between clearing

and the breeding season (June and July).To avoid this impact, the open pits will be cleared in fall and winter.

- *ORE MINING, HANDLING AND STORAGE*

The different mining activities will disturb many breeding pairs of different species and, in some cases, could lead to nest abandon, notably during blasting operations.

7.8.4.2 Airstrip Area

- *AIRSTRIP OPERATION*

Airstrip operations constitute a low risk for bird strike hazard involving three species in particular (gray jay, tree swallow and white-winged crossbill), which move on larger distance than other species (Table 7.8.9). Airplane take-off and landing may disturb many breeding pairs among the species present. However, flight frequency should not be sufficiently high to lead them to abandon their nests.

7.8.4.3 Mitigation Measures

As mentioned above, clearing and underbrush-cutting will be performed outside the peak breeding season of forest birds, which stretches from May 1 to August 15 for the area, as recommended by the Canadian Wildlife Service (CWS). This will significantly reduce the number of nests destroyed.

7.8.4.4 Residual Impact

The impact is considered of low-intensity since the percentage of forest birds affected in the study area is approximately proportional to the surface area affected (0.29 km^2/127 km^2 = 0.22%), that is, less than 1%. The spatial extent is site specific since it is restricted to the mine and airstrip footprint. Finally, the duration corresponds to the operation phase and is considered moderate. Overall, the resulting impact sigificance is low.

Table 7.8.9 Estimated Number of Forest Bird Pairs affected by the Renard Project Operation Phase

English name	Operation phase		
	Number of pairs affected[1]		Type of impact [2]
	Mine area	Airstrip area	
Species not impacted			
Solitary sandpiper	0	0	0
Spotted sandpiper	0	0	0
Wilson's snipe	0	0	0
Belted kingfisher	0	0	0
Black-backed woodpecker	0	0	0
Olive-sided flycatcher	0	0	0
Yellow-bellied flycatcher	0	0	0
Boreal chickadee	0	0	0
Winter wren	0	0	0
Golden-crowned kinglet	0	0	0
Swainson's thrush	0	0	0
Bohemian waxwing	0	0	0
Orange-crowned warbler	0	0	0
Yellow warbler	0	0	0
Northern waterthrush	0	0	0
Wilson's warbler	0	0	0
Rusty blackbird	0	0	0
Species negatively impacted			
Ground-nesting and ground-feeding species			
Hermit thrush	4	0	–
Lincoln's sparrow	4	0	–
White-throated sparrow	5	0	–
White-crowned sparrow	2	0	–
Dark-eyed junco	16	0	–
Species associated with trees and shrubs			
Spruce grouse	≥ 1	0	–
Gray jay	6	≥ 1	–
Ruby-crowned kinglet	7	0	–
American robin	4	0	–
Cedar waxwing	≥ 0	0	–
Yellow-rumped warbler	18	0	–
Palm warbler	≥ 1	0	–
Blackpoll warbler	5	0	–
Fox sparrow	5	0	–
White-winged crossbill	≥ 1	≥ 1	–
Other species negatively impacted			
Tree swallow	0	≥ 1	–

[1] *The number of pairs affected was estimated using UDPC and FRPC data.*
[2] *Type of impact: 0: zero impact;*
–: low negative impact; a small proportion of pairs will be affected;
+: positive impact; probable project-related population increase.

7.8.5 Closure Phase Impacts

In the closure phase, the project components that will affect forest birds are the final site rehabilitation and revegetation and the dismantling and recovery of facilities.

7.8.5.1 Mine Area

- *FINAL SITE REHABILITATION AND REVEGETATION; DISMANTLING AND RECOVERY OF FACILITIES*

During the closure phase, plants will naturally colonize areas where the ground was not disturbed (Table 7.8.6 and 7.8.7), namely 23% of the mine area's impacted zone. Open pits R-2/R-3 and R-65 will be flooded, thereby creating two lakes with a total surface area of 22.2 ha. The areas that will not undergo revegetation, apart from the open pits, are the slopes separating the berms of the processed kimberlite confinement area and the overburden stockpile (the slopes of the overburden stockpile will be stablized using waste rock). The other sites disturbed by project-related activities will undergo active revegetation (Tables 7.8.6 and 7.8.7); grasses will be hydroseeded first to stabilize the soil and keep it in place. Then, black spruce seedlings will be planted at a density of 2,000 plants per hectare. The largest part of mine area affected (66%) will, therefore, become suitable again for forest birds.

Despite the fact that the final result of restoring the plant cover is unknown, renewed plant growth should be favourable for bird species, first for those living on the ground and depending on shrubs and, eventually, for forest bird species. The species most affected (yellow-rumped warbler and ruby-crowned kinglet) by breeding pair losses in the construction and operation phases, which are also the most ubiquitous, will be the most favoured in the closure phase (Table 7.8.10). This includes the bohemian waxwing. However, it is impossible to predict whether the olive-sided flycatcher and orange-crowned warbler will recolonize the area. Since the loss of small wetlands in the construction phase is permanent, the resulting reduction in the abundance of the rusty blackbird will also be permanent. Note that the pairs of species favoured by clearing in the construction phase (belted kingfisher and spotted sandpiper) will move to other environments once the plant cover has been restored. The tree swallow will lose its anthropogenic nesting structures (pipes, infrastructure, etc.) after facilities are dismantled and recovered.

Finally, certain species (including the savannah sparrow) that did not formerly inhabit the area could be favoured by seeding grasses over many hectares. These species will remain here as long as the area resembles a meadow.

The long-term abundance of forest birds in the mine area will be slightly lower than before the construction phase.

7.8.5.2 Airstrip Area

- *FINAL SITE REHABILITATION AND REVEGETATION; DISMANTLING AND RECOVERY OF FACILITIES*

In the airstrip area, 72% of the deforested area will revegetate naturally (Table 7.8.7), i.e. the areas not stripped since they were not intended for infrastructure (e.g. airstrip periphery and approaches). Sites stripped for borrow pit operations, the airstrip and the other infrastructure of the area will be actively revegetated as described above (hydroseeding and black spruce planting). This way, the entire airstrip area will be suitable for forest birds once again. It is important to note that the forest landscape will differ from the pre-project landscape since the boulder field initially found here will be covered with topsoil and planted with black spruce.

Like the mine area, facility dismantling and recovery will result in the loss of tree swallow nesting structures.

The long-term abundance of forest birds in the airstrip area should recover to that before the construction phase.

7.8.5.3 Mitigation Measures

At least one site should be developed in a suitable wetland in order to replace at least one of the wetlands lost during the construction phase. The site drainage rehabilitation plan should include wetland development that could be integrated along the rehabilitated streams (e.g. F3298V) in relatively flat areas.

7.8.5.4 Residual Impact

For the study area as a whole, the impact of site rehabilitation and revegetation is positive and its intensity, low. The spatial extent is site specific and the duration long, for an overall impact significance that is low.

In the mine area, 34% of the biotopes that initially supported forest birds will be lost, 22.2 ha will be submerged and 54.6 ha will not be revegetated (slopes of processed kimberlite confinement area and overburden stockpile). In the airstrip area, all the impacted areas will be restored. Thus, on the scale of the study area, 75% of the affected areas will eventually become suitable for forest birds again. This means that the significance of the residual impact of the Renard Project as a whole is deemed low.

Table 7.8.10 Estimated Number of Forest Bird Pairs affected by the Renard Project in the Closure Phase

English name	Closure phase		
	Number of pairs affected[1]		Significance of impact[2]
	Mine area	Airstrip area	
Species negatively impacted			
Spotted sandpiper	≥ 2	0	–
Belted kingfisher	1	0	–
Tree swallow	≥ 5	≥ 3	–
Species not impacted			
Solitary sandpiper	0	0	0
Boreal chickadee	0	0	0
Golden-crowned kinglet	0	0	0
Swainson's thrush	0	0	0
Yellow warbler	0	0	0
Northern waterthrush	0	0	0
Ground-nesting and ground-feeding species			
Hermit thrush	16	≥ 1	+
Lincoln's sparrow	16	0	+
White-throated sparrow	24	6	+
White-crowned sparrow	10	0	+
Dark-eyed junco	72	17	+
Species associated with trees and shrubs			
Spruce grouse	≥ 1	≥ 0	+
Wilson's snipe	1	0	+
Black-backed woodpecker	2	1	+
Gray jay	30	19	+
Winter wren	≥ 1	0	+
Ruby-crowned kinglet	30	41	+
American robin	21	11	+
Bohemian waxwing	≥ 2	≥ 0	+
Cedar waxwing	≥ 0	≥ 0	+
Yellow-rumped warbler	91	≥ 4	+
Blackpoll warbler	24	≥ 4	+
Fox sparrow	24	20	+
White-winged crossbill	≥ 6	≥ 4	+
Species for which impact is uncertain			
Olive-sided flycatcher	*	0	*
Yellow-bellied flycatcher	*	*	*
Orange-crowned warbler	*	0	*
Palm warbler	*	*	*
Wilson's warbler	*	0	*
Rusty blackbird	*	0	*

[1] *The number of pairs affected was estimated using UDPC and FRPC data.*

[2] *Type of impact: 0: zero impact;*
–: low negative impact; a small proportion of pairs will be affected;
+: positive impact; probable project-related population increase;
**: impact unknown – It is not possible to predict whether the biotopes that will regenerate in the long term will meet habitat requirements of these species.*

7.9 Micromammals

7.9.1 Current Conditions

Micromammals refer to terrestrial mammals of very small size, which play an important ecological role as one of the first links in the food chain of carnivorous mammals and raptors. This category includes different taxonomic groups: rodents (mice and voles) and insectivores (shrews and moles) (Desrosiers *et al.,* 2002). They are generally active year-round, day and night. In winter, they rarely venture into the open, preferring to travel under the snow cover in tunnels developed to protect themselves from predators.

Until now, little information was available on micromammals in the Renard Project study area. Therefore, to document the presence of species in the region, the following studies were consulted:

- Previous studies on the Renard property (Roche, 2005);
- Environmental studies carried out for the Matoush Project (Strateco Resources, 2009);
- Studies on biodiversity (Drolet and Crête, 1994);
- Data available from the *Centre de données sur le patrimoine naturel du Québec* (CDPNQ).

➢ *MICROMAMMAL SURVEY*

An initial review of these studies identified two species likely to be designated “threatened” or “vulnerable” by the MRNF, i.e. the rock vole (*Microtus chrotorrhinus*) and southern bog lemming (*Synaptomys cooperi*), which might be found in the Renard Project study area. These species and other species of micromammals potentially present were trapped using killing traps and live traps in September 2010 (Roche, 2011). The survey was performed in early September since this is when the population density of the target species is the highest, given that the young born in May, June and July are present in the population. A total of 7 traplines were set as follows: the black spruce-lichen stand (2 traplines), the black spruce-moss stand (1 trapline), a mixed stand dominated by conifers (1 trapline), a wooded fen (1 trapline) and a site with rock outcrops in a black spruce-lichen stand (1 trapline – live traps). One pitfall trap and two killing traps (Victor type) were set up, alternating every 10 m along 100 m transects (Tecsult, 2005; Jutras, 2002). Species identification was carried out using external and internal morphological characteristics (Lupien, 2001 and 2002).

7.9.1.1 Regional Environmental Conditions

Quebec is home to 23 micromammal species, whose known range can be vast or very limited. Surveys conducted since summer 2000 by the MRNF on micromammals (voles, mice, etc.) and other research group work have increased our knowledge about micromammals in the James Bay territory. All of this data is compiled in a micromammal database (CRRNTBJ, 2010a).

Throughout the entire James Bay territory, 17 species are likely to be present. Of them, 13 may well be found in the Renard Project study area (Desrosiers *et al.,* 2002). They are:

- Southern red-backed vole (*Clethriomys gapperi*);
- Meadow vole (*Microtus pennsylvanicus*);
- Rock vole (*Microtus chrotorrhinus*);
- Northern bog lemming (*Synaptomys borealis*);
- Southern bog lemming (*Synaptomys cooperi*);
- Heather vole (*Phenacomys intermedius*);
- Deer mouse (*Peromyscus maniculatus*);
- Meadow jumping mouse (*Zapus hudsonius*);
- Masked shrew (*Sorex cinereus*);
- Northern water shrew (*Sorex palustris*);
- Arctic shrew (*Sorex arcticus*);
- Pygmy shrew (*Sorex hoyi*);
- Star-nosed mole (*Condylura cristata*).

The marked presence of the southern red-backed vole was noted in many studies conducted in the boreal environment, i.e. Matoush Project and La Romaine Complex impact studies (Strateco Resources, 2009; Tecsult Inc., 2005). However, the deer mouse was the most abundant species in a biodiversity study in the La Grande-3 hydroelectric reservoir area (Drolet and Crête, 1994). Only four micromammal species were identified in the Matoush Project baseline studies while eight were caught near LG-3. Eight species were also caught in the survey of the impact study for the extension of Route 167 North (Consortium Roche – SNC-Lavalin, 2010).

7.9.1.2 Mine Area

During the micromammal survey, in five nights of trapping, a total of 110 micromammals were caught for a catching effort of 560 traps/night. In all, seven species were identified (Table 7.9.1).

Table 7.9.1 Micromammal Species Caught in the Renard Project Study Area (September 2010)

Species	Number caught
Southern red-backed vole	57
Deer mouse	26
Masked shrew	17
Meadow vole	6
Heather vole	2
Southern bog lemming	1
Pygmy shrew	1

The most abundant species was the southern red-backed vole followed by deer mouse. Only one species likely to be designated “threatened” or “vulnerable” by the provincial government (southern bog lemming) was caught. The sole individual identified as belonging to this species was caught in the black spruce-lichen stand 3.1 km west of Camp Lagopede. Since this is the study area’s most common

environment, this species is probably present (at low density) in a large proportion of the Renard Project study area.

Generally speaking, the study area's micromammal richness is comparable to that observed elsewhere in the boreal forest. The *Centre de données sur le patrimoine naturel du Québec* (CDPNQ) does not mention any special status wildlife species within the study area.

The abundance of rodents and insectivores is lower in the string fen, while the black spruce-moss, black spruce-sphagnum, black spruce-lichen and mixed stands, as well as the wooded fen show comparable abundances and diversity.

- *SPECIAL STATUS SPECIES* [15]

Southern bog lemming

The southern bog lemming is common throughout eastern-central North America. It is likely to be designated "threatened" or "vulnerable" at the provincial level.

It frequents many environments where vegetation abounds: peatlands, grassy marshes and the forests surrounding them. It is also found in clearings, among rocks where mosses are copious. From year to year in a given region, the species' abundance can vary greatly.

Only one individual of this species was caught but it is probably present in the other environments surveyed. The black spruce-lichen stand in which it was caught is considered a suboptimal habitat for this species. However, given the trapping effort, it can be said that it is not abundant in the Renard Project study area (Roche, 2011).

Rock vole

Although a special effort was made in the study area sectors offering the best rock vole potential, not a single individual was caught.

The rock vole is found in Quebec up to southern James Bay and its presence is documented eastward as far as Labrador. Only one individual was caught during the study for the extension of Route 167 North (Consortium Roche-SNC Lavalin, 2010). Within its range, there seem to be isolated populations. South of its range, it can be caught at altitudes varying from 450 to 1,600 m. It lives on damp slopes, between moss-covered rocks, at the foot of cliffs and on rock outcrops in coniferous or mixed forests. It is also present in the transition zones between open areas and mature forests. Like the pygmy shrew, it frequents environments where cutting has occurred recently. Very few studies have targeted this

[15] A species of "special concern" is a species designated "threatened" or "endangered" by the federal government under the *Species at Risk Act* or designated "threatened or vulnerable or likely to be designated threatened or vulnerable" by the provincial government under the *Act respecting threatened or vulnerable species*.

species (Desrosiers *et al.,* 2002). Its presence was confirmed on the Otish Mountains plateau at km 130 of the Route 167 North extension (Hébert, 2006).

The Renard Project study area is located at the northern limit of the species' range. Before the micromammal survey, the area's habitat potential was considered poor for the rock vole, given the relative lack of cliffs. In light of the micromammal survey results, the site's potential has been re-classified as very poor for rock vole (Roche, 2011).

7.9.1.3 Airstrip area

The airstrip area is dominated by black spruce-lichen (58%) and jack pine (25%) stands. The area directly affected by the future airstrip is poor in wetlands and, since water is essential to the survival of micromammals, this habitat is less favourable for them.

Based on the survey results for these stands in the mine area, the species most likely to be found in the airstrip area are the same as those in the mine area.

7.9.2 Construction Phase Impacts

The main sources of impact on micromammals during the construction phase are related to the following project components:

- Site preparation and development;
- Construction of mine facilities;
- Operation of quarry and borrow pits:

  The impacts linked to these activities are essentially due to the habitat losses incurred through clearing and disturbance generated by drilling, blasting, backfilling, excavation, construction of mine facilities like the ore processing plant, accommodation and services complex, power generating sets, borrow pits and the airstrip.

  The activities linked to site preparation and development, construction of mine facilities, and operation of borrow pits are likely to disturb the daily or seasonal activities of the area's wildlife.
- Use and maintenance of machinery and power generating sets; road circulation:

  The machinery used to clear the site and for other construction-related activities and vehicles travelling on the access roads will cause mortality.

7.9.2.1 Mine Area

Generally speaking, the species identified in the Renard Project study area are species that are common in the region. The southern bog lemming, which is likely to be designated "threatened" or "vulnerable" by the MRNF, was found 3.1 km west of Camp Lagopede in a black spruce-lichen stand, i.e. an environment that is common in the study area. All of these impacts do not threaten the survival of micromammal populations throughout the study area, given the many habitats of interest at the periphery of the areas affected by the project and the high reproduction rates typical of this species group.

The micromammal species present in the study area are ubiquitous and frequent a wide variety of habitats. For example, the southern red-backed vole is an abundant species that frequents especially

mixed or coniferous forests while other species, like the northern bog lemming, a special status species, uses also peatlands (Prescott and Richard, 1996).

- *SITE PREPARATION AND DEVELOPMENT*

Table 7.9.2 illustrates the habitat losses incurred during the construction phase for the study area's different micromammal species. If we group together all of the species likely to be present in the study area, they frequent all of the stands affected by this project during the construction phase. Overall, the project may destroy 197 ha of potential micromammal habitats in the mine area, i.e. approximately 2% of the surface area of the habitats found in the study area. Generally speaking, we observe a loss of less than 3% of potential habitats available for each of these species (Table 7.9.2).

- *CONSTRUCTION OF MINE FACILITIES*

By disturbing their daily activities, construction activities and road traffic are likely to chase away individuals whose home range overlaps the project right-of-way in the construction phase. The individuals disturbed will move to similar peripheral habitats located near the work area. This is likely to cause a temporary increase in competition for territories and resources.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The machinery used for clearing and other construction activities and the vehicles circulating on the access roads will cause mortality. In fact, traffic is expected to be quite steady during the construction phase. The impact on micromammals will likely be low because the risk of collision with them is limited. Furthermore, these species are nocturnal and construction work will be performed mainly during the day. Also, micromammals generally tend to avoid roads or quickly scurry across them (Fahring and Rytwinski, 2009).

7.9.2.2 Airstrip Area

- *SITE PREPARATION AND DEVELOPMENT*

Habitat losses will also be generated by development of the airstrip, borrow pits and the trench landfill site. However, since the airstrip area is poor in wetlands, its habitat is less suitable for micromammals. Nevertheless, 67 ha of potential habitats for one or more of these species, i.e. 3% of the habitats of this study area's sector, will be lost (Table 7.9.2). The meadow vole, a species that is common in the region, will be most affected proportionally. The construction and road traffic activities occurring in the airstrip area will affect micromammal species the same way as on the mine area.

Table 7.9.2 Potential Habitat Losses in the Mine and Airstrip Areas for the Micromammal Species whose Presence was Confirmed in the Renard Project Study Area

Species	Relative abundance in study area	Preferred habitats	Mine area					Airstrip area		
			Current conditions	Surface area affected				Current conditions	Surface area affected	
				Construction phase	Operation phase	TOTAL			Construction phase (TOTAL)	
			(ha)	(ha)	(ha)	(ha)	(%)	(ha)	(ha)	(%)
Southern red-backed vole	High	Coniferous or mixed forest	8118	187	27	213	3	1991	67	3
Deer mouse	High	Coniferous or deciduous forest	8031	187	27	213	3	1991	67	3
Masked shrew	Low	Coniferous or deciduous forest and wetlands	8206	192	29	219	3	2083	67	3
Meadow vole	Low	Damp areas near ponds, streams and peatlands	1625	4	0	4	0	526	0	0
			+ 69 km of streams	+ 1.3 km of streams	–	+ 1.3 km of streams	+ 1.9% of the initial length	+ 13 km of streams	–	0
Heather vole	Low	Coniferous or deciduous forest	8031	187	27	213	3	1991	67	3
Pygmy shrew	Low	Coniferous or deciduous forest, streams, peatlands or swamps	8206	192	29	219	3	2083	67	3
Southern bog lemming[1]	Low	Peatlands, grassy marshes and forests surrounding these habitats, clearings	175	5	1	6	3	92	0	0

[1] Species likely to be designated “threatened” or “vulnerable” under the *Act respecting threatened or vulnerable species* (R.S.Q., c. E-12.01)

➢ *OPERATION OF QUARRY AND BORROW PITS*

Like the activities related to the construction of mine facilities, operation of the borrow pits is likely to chase away individuals whose home range overlaps the project right-of-way. The individuals affected by noise and disturbance will move to similar peripheral habitats located near the work area. This is likely to cause a temporary increase in competition for territories and resources.

7.9.2.3 Mitigation Measures

To reduce project impacts in the construction phase, the following mitigation measures will be implemented.

➢ *SITE PREPARATION AND DEVELOPMENT*

- Maintain a 30 m wide wooded buffer strip between lake or stream's natural high water mark and mine infrastructure. To do so, clearly mark off clearing boundaries on the site (orange ribbons or fence);
- When possible, conserve a protective cover through partial cutting to limit the impact of clearing and habitat fragmentation.

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

- Allow machinery to circulate only on areas slated for clearing, excluding riverbanks, lakeshores, riparian strips and selective cutting areas, where machinery is prohibited.

7.9.2.4 Residual Impact

In the construction phase, the Renard Project's residual impact on micromammal populations is negative but of low intensity, given that they can easily move to similar peripheral habitats. The impact's spatial extent is site specific since only cleared areas and their surroundings, as well as circulation areas are affected. The impact's duration is considered long as it will last beyond the construction and operation phases. The significance of the Renard Project's impact in the construction phase is, therefore, considered low.

7.9.3 Operation Phase Impacts

The main sources of impact on micromammals in the operation phase are linked to the following project components:

- Open pit development:
  The project impacts are linked to additional habitat losses from the development and presence of open pits R-2/R-3 and R-65.
- Use and maintenance of machinery and power generating sets; road circulation;
- Ore mining, handling and storage;
- Airstrip operation;
- Progressive site rehabilitation:
  Progressive site rehabilitation will help restore certain habitats that were lost during site preparation and development.

7.9.3.1 Mine Area

- *PIT DEVELOPMENT*

The development of open pits R-2/R-3 and R-65 will cause additional habitat losses for micromammals. The potential habitat losses for each species are illustrated in Table 7.9.2. In all cases, the proportion of habitats affected by the project in the operation phase is small and less than or equal to 0.3% of the total surface area initially present in the study area.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The machinery used for clearing and other construction activities and the vehicles circulating on the access roads will cause mortality. However, micromammals generally tend to avoid roads or quickly scurry across them, thereby limiting the risk of collisions (Fahring and Rytwinski, 2009).

- *ORE MINING, HANDLING AND STORAGE*

While no monitoring study of the impacts of mining operations on micromammal populations were found, the impact of logging and development of roads and other linear infrastructure such as power transmission lines on this group of animals is well known. Generally, it seems that micromammal populations are quite resilient to forest development (Etcheverry *et al.*, 2005) and are slightly affected by the presence of roads (McGregor *et al.*, 2008; Fahring and Rytwinski, 2009).

Studies on the impact of logging on micromammal communities show that this impact can vary from one species to another (Fortin and Doucet, 2008). Forest species, like the southern red-backed vole, are disadvantaged by clearing. However, the vegetation found in open environments, like those that will border mine infrastructure, may be favourable to certain species like the meadow vole or meadow jumping mouse. Furthermore, the presence of the camp and food is likely to attract opportunistic species like the deer mouse. Their high rate of reproduction and the small size of their home range make them less vulnerable to the presence of roads.

Mining activities and road traffic are likely to chase away individuals by disturbing their daily activities. The individuals disturbed will move to similar peripheral habitats located near the work area. This is likely to cause a temporary increase in competition for territories and resources

- *PROGRESSIVE SITE REHABILITATION*

Progressive site rehabilitation will help restore a small proportion of the habitats lost during site preparation and development. In fact, during the operation phase, temporary construction material stockpiles, the temporary camp and a portion of the 8 ha of the processed kimberlite confinement area (i.e. 10% of the area affected by this element) will be covered by a thin layer of overburden before being seeded and planted with black spruce.

7.9.3.2 Airstrip Area

- *AIRSTRIP OPERATION*

In the airstrip area, no additional habitat losses will be observed during the operation phase. Little documentation exists on the impact of the noise generated by flight activity.

7.9.3.3 Mitigation Measures

No particular mitigation measure is deemed necessary for this species group in the operation phase.

7.9.3.4 Residual Impact

In the operation phase, the Renard Project's residual impact on micromammal populations is deemed negative and of low intensity, given that these populations can move to other similar peripheral habitats and that their reproductive rates are generally high. The impact's extent is restricted to the areas used for the project and traffic circulation and can, thus, be considered site specific. The duration of the impact is deemed moderate. Consequently, the significance of the impact during the operation phase is considered low.

7.9.4 Closure Phase Impacts

7.9.4.1 Impact Description

The main sources of impact on micromammals in the closure phase are related to the following project components:

- Use and maintenance of machinery and power generating sets; road circulation:

  The machinery used for clearing and other construction activities and the vehicles circulating on the access roads will cause mortality.

  Road traffic and the noise generated during the closure of the mine may affect individuals present on the site by disturbing their daily activities.
- Final site rehabilitation and revegetation:

  Site rehabilitation will help restore most of the habitats lost during site preparation and development.

- *FINAL SITE REHABILITATION AND REVEGETATION; USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The main sources of impact during the closure phase are linked to final site rehabilitation and revegetation and, to a lesser extent, the disturbance caused by road traffic. The backfilling and excavation work needed to stabilize slopes and restore the site's topography will probably cause micromammal mortality as well as major disturbances in the mine site's human habitats. Thereafter, mine site revegetation will have a positive effect by increasing the surface areas available and the number of wildlife habitats for micromammal species.

The other closure phase impacts on micromammal populations will be similar to those of the construction phase:

- Rehabilitation activities may chase away some individuals whose home range overlaps the rehabilitation areas;
- The machinery used during rehabilitation as well as vehicle circulating on access roads will cause mortality. Given micromammal behaviour on roads, the risk of collisions should be limited.

Table 7.9.3 Surface Areas Revegetated in the Post-Closure Phase

Activity	Surface area (ha)	
	Mine area	Airstrip area
Natural revegetation	51.3	58.4
Active revegetation (hydroseeding and planting)	97.9	22.9
Total surface area revegetated	149.2	81.3
Proportion of surface area affected by the project in the construction and operation phases to be revegetated	*66%*	*100%*

The disturbance generated by rehabilitation activities will cause impacts similar to those observed during the construction and operation phases. Then, seeding, planting and colonization of the area by plant species peripheral to the mine site will gradually increase the quantity and quality of habitats available for micromammals.

7.9.4.2 Mitigation Measures

No particular mitigation measure is deemed necessary for this species group in the closure phase.

7.9.4.3 Residual Impact

The residual impact in the closure phase is generally considered positive and will directly affect micromammal populations. Given the gain in wildlife habitats (Table 7.9.3), in the long term, the area will have a similar number of habitats as in its baseline conditions. The impact's intensity is deemed low, while its extent is site specific and long-lasting. Based on these criteria, the significance of the closure phase's impact (positive) is considered low for micromammal species.

7.10 Fur-Bearing Animals

7.10.1 Current Conditions

The species considered in this section are: the Grey Wolf (*Canis lupus*), the Canadian Beaver (*Castor canadensis*), the River Otter (*Lutra canadensis*), the American Mink (*Mustela vison*), the Ermine (*Mustela erminea*), the Red Fox (*Vulpes vulpes*), the Red Squirrel (*Sciurus vulgaris*), the Muskrat (*Ondatra zibethicus*), the Snowshoe Hare (*Lepus americanus*), the Canada Lynx (*Lynx canadensis*) and the American Marten (*Martes americana*). Other species, which are not trapped for fur, are also discussed: the American Porcupine (*Erethizon dorsatum*), the Northern Flying Squirrel (*Glaucomys*

sabrinus), the Woodchuck (*Marmota monax*) and the Striped Skunk (*Mephitis mephitis*). The species designated “threatened” or “vulnerable” or “likely to be designated threatened or vulnerable” (Quebec and/or federal) are the Least Weasel (*Mustela nivalis*) and the Wolverine (*Gulo gulo*).

The habitat potential for fur-bearing animals likely to inhabit the Renard Project study area was assessed by the mean of snow-track survey carried out in March 2011, the literature and currently available data (i.e. trapping data) (Roche, 2011). The *Centre de Données sur le Patrimoine Naturel du Québec* (CDPNQ) does not report any occurrence of wildlife considered as “special status species” within the study area.

- *FUR-BEARING ANIMALS SURVEY*

The riparian habitat snow-track survey as part of the Renard Project Environmental Baseline Study was conducted using the same methods as other studies carried out in the James Bay territory (Le Groupe Boréal, 1992a and b; Veillet and Vézina, 1991) and on the North Shore (Tecsult Inc., 2005; Massé *et al.*, 2000; Consortium Roche-Dessau, 1995). The survey was performed by traversing 75 riparian line transects (1 km long) and 49 forest line transects (200 m long) in different forest stands and wetlands. A helicopter transporting a team including an observer and a navigator flew over the riparian segments while experienced observers covered the forest line transects on snowshoes. The surveys were conducted at least 24 hours after a major snowfall to ensure data uniformity and optimal track visibility conditions.

To validate or invalidate the occurrence of the Least Weasel (a species “likely to be designated threatened or vulnerable”), live-catch traplines were set up in the riparian and forest segments showing the highest number of this species’ tracks. This methodological approach was selected because of the fact that Ermine tracks are not easily discernable from the Least Weasel tracks. The live-animal traps used were Havahart traps generally used for squirrel.

7.10.1.1 Regional Environmental Conditions

Quebec is home to 22 species of fur-bearing animals. The Renard Project study area offers potential for about 15 species. According to the James Bay wildlife profile produced by the *Commission Régionale de la Baie-James sur les Ressources Naturelles et le Territoire de la Baie-James* (Regional Commission on Natural Resources and the James Bay territory) (CRRNTBJ, 2010a), the current state of fur-bearing animal populations does not seem to show signs of decline. However, little information is available on this subject. The large number of species involved and the lack of effective survey techniques for each species make counting difficult and costly. Therefore, populations were assessed using essentially parameters taken from collecting and harvesting data. Gathering of systematic and classified data for population assessments has only begun in 1989, thus diagnosis may be less accurate due to the short time range of available data (CRRNTBJ, 2010a). Nevertheless, harvesting data gives a good idea of species abundance in the region (Table 7.10.1).

7.10.1.2 Mine Area

Generally speaking, the results of the winter 2011 snow-track survey showed that Wolf and Fox were attracted by the Lagopede exploration camp. It is also very likely that the high abundance of Wolf adversely affected the abundance of Beaver, Moose and woodland Caribou in the Renard Project's study area. Signs of past occurrence of the Canadian Beaver give evidence about its historic abundance, but only 3 individuals have been observed since the beginning of the environmental studies on the Foxtrot Property. American Marten and Grey Wolf were also observed ubiquitously within the study area. Weasels were present in Black Spruce-Lichen, Black Spruce-Moss and Black Spruce-Sphagnum forests. The latter was definitely favoured by Squirrel, Weasel and Marten.

Since all fur-bearing animals have preferred habitats according to their ecological requirements, relative abundance for the species likely to be present in the study area will thus be discussed separately.

Table 7.10.1 Fur-Bearing Animals Caught in Traplines Adjacent to the Renard Project Study Area

Trapline	Year	Beaver	Lynx	Marten	Mink	River otter	Fisher	Skunk	Ermine	Muskrat	Squirrel	Wolf	Red Fox	Silver Fox	Arctic Fox	Crossbreed Fox
M-10	0001	27		31	3	2				2			5			
M-10	0102	12		13	1								1			1
M-10	8889	27		2	1	4				5						
M-10	9091	22		2	1								2			
M-10	9394															
M-10	9495	5		43	6	3			6	5						
M-10	9899	14		12		1										
M-11	0001			5												
M-11	0102	3		48												
M-11	8788	56		29	22	9			5	3	8					
M-11	8889															
M-11	8990	45		63	36	11				24		2	1			
M-11	9091	9		47	23	2			8	78		2	4	2		
M-11	9394	1		2	2							2	1	1		
M-11	9495	9		12					1	3						
M-11	9596	4		122												
M-11	9697	5		4		1										
M-11	9900	1		3		1										
M-12	0001			3		1										
M-12	0102	4		34												
M-12	8788	31		17	9	7										
M-12	8889	32		28	21	12			4	2	4		1			
M-12	9394	2		2	5	6			5			5				
M-12	9495	13		83	15	13				2			4			
M-12	9697	2		31	4	5			1	1						
M-12	9798			9						3						
M-12	9899	6		61	5	1				1			1			
M-12	9900	28		16	3	5			3	7		1	2			
M-16	0001	2		4	1	1				8						
M-16	0102	12		12		3				2						
M-16	8788	33	1	32		1			1	11		1				1
M-16	8889	31		35	11	2				38						
M-16	8990	4								14						
M-16	9091	3		48	2	6			12	4		4				
M-16	9394															
M-16	9495	6		33	1	6							6			
M-16	9596			24												
M-16	9697	4		53	1							1	3			1
M-16	9798	17		58						3			2			
M-16	9899	35				2				3	3					
M-16	9900	2		114	3	1				2		1	3			
M-1A	0102			94	1	3				1			8	1		2
M-1A	8788	22		1	1					5						
M-1A	8889															
M-1A	9394	23		81	3	5			4				1			
M-1A	9495	7		147	4	8			4	16	1	1	8			1
M-1A	9596	5		123	9	3							1			
M-1A	9697			46	7	5					1					
M-1A	9798	4		35	11	5				2		3	3			
M-1A	9899			16	4	1				3						
M-23	0001			19		1										
M-23	0102	24		129	1	5			1	1			3			1
M-23	8788	7		1	2					32						

Note: Years are identified as follows: 0001 means 2000-2001, 0102 means 2001-2002, 8889 means 1988-1989, etc.
Source: Société de la Faune et des Parcs du Québec, 2003

Table 7.10.1 Fur-Bearing Animals Caught in Traplines Adjacent to the Renard Project Study Area (cont.)

Trapline	Year	Beaver	Lynx	Marten	Mink	River otter	Fisher	Skunk	Ermine	Muskrat	Squirrel	Wolf	Red Fox	Silver Fox	Arctic Fox	Crossbreed Fox
M-23	8889	51		22	2	1			8	4	2		1			
M-23	9495	2		27	4	6			2		1					
M-23	9596			12												
M-23	9697	3	1	29		3			6	31	6	2	1			
M-23	9798	4		8												
M-23	9899	8		41	2	2				1						
M-23	9900	18		116	3	1										
M-4	0102			4												
M-4	8889															
M-4	8990	35		68	28	17				15		2	7			1
M-4	9293	3		3		2										
M-4	9394	26		38	4				3	2	2		2	1		
M-4	9495	4		35	5	4							2			
M-4	9596	5		177	1	1			3		5	2	1			
M-4	9697	3		42	8	1			6		7		7			
M-4	9798			23	3	1				3		2				

Note: Years are identified as follows: 0001 means 2000-2001, 0102 means 2001-2002, 8889 means 1988-1989, etc.
Source: Société de la Faune et des Parcs du Québec, 2003

- *GREY WOLF*

The Grey Wolf (or *mahîhkan*) may travel over very long distances to track its prey. For this species, prey availability affects its distribution range more than the type of habitat (Carbyn, 1987). The Grey Wolf is opportunistic and prey choice changes depending on seasons. Beaver and other species of small mammal are more readily available in summer whereas, in winter, Ungulates like Caribou, and more specifically, Moose constitute a large part of its diet.

The Grey Wolf is common in the study area, particularly around Camp Lagopede. Analysis of riparian segments assessments' results showed that the presence of Camp Lagopede attracts predators like Wolf and Fox. At the second meeting of the Environmental Exchange Group on the Renard Project (March 16 in Mistissini), Simeon Patawabano reported that, outside the Troilus Mine, large numbers of carnivores like Wolf are present while large animals are virtually absent within a 25-km radius of the mine. Analyses also show that the abundance of predators is inversely related to the abundance of prey.

Wolf tracks were observed in 23% of riparian line transects and 0% of forest line transects. Generally speaking, Wolf is abundant in the Renard Project study area, especially near Camp Lagopede. According to observations made during the big game survey, Wolf is apparently even more abundant in areas visited by Moose.

- *RED FOX*

The Red Fox (or *mahcesiw*) is relatively common in areas inhabited by man (Photo 7.10.1). Like the Black Bear (*Ursus americanus*), the fox is very opportunistic and has an enormous capacity for adapting to human presence. It lives in a wide range of habitats and, as a result, cannot be associated with a single type of plant community. It feeds on just about whatever it finds. Its diet consists primarily of small mammals, insects, birds, fruits and seeds and it has been known to be a carrion feeder.



Photo 7.10.1 Fox observed Near the Exploration Camp in March 2011

Fox tracks were observed in 31% of riparian transects and 4% of forest transects. Based on the results of the fur-bearing animal survey, it was more abundant in the vicinity of Camp Lagopede. Fox is found in M11 trapline and adjacent traplines (Table 7.10.1).

Fox abundance in the study area is considered moderate but its abundance around Camp Lagopede may be considered high.

- *CANADA LYNX*

The Canada Lynx (or *pisiw*) inhabits the great coniferous forest. It is also found in marshlands and bushes where Hare (its main prey) is abundant. It is closely tied to the Hare's abundance cycle.

Two Lynx tracks were sighted outside the Renard Project study area, during the Caribou survey 60 km further south and 20 km northwest of Camp Lagopede. According to the table showing the fur-bearing animals caught in various traplines (Table 7.10.1), only one Lynx was caught between 1987 and 2002 in a trapline adjacent to M11, i.e. in M16 trapline, which is located southeast of trapline M11.

This species' relative abundance in the study area may, therefore, be considered low.

- *AMERICAN MARTEN*

The preferred habitat of the American Marten (or *wâpistan*) is the great coniferous forest but it also inhabits mixed and deciduous forests (Poole *et al.,* 2004). The Marten is an omnivore, whose diet consists mainly of micromammals (Squirrels, Flying Squirrels, Mices, Voles, and Shrews) as well as Hare. It also feeds on carrion, eggs, birds, amphibians, insects, nuts and fruits (Prescott and Richard, 1996). Marten is an important species for Cree trapping activities due to the considerable value of its fur.

The Marten is common in the study area and was detected over 56% of riparian transects and in 46% of forest transects. It was present in all types of forest stands.

Based on this information, the American Marten may be considered abundant in the study area.

- *ERMINE (SHORT-TAILED WEASEL)*

Ermine (short-tailed weasel or *sihkusîs*) uses a wide variety of habitats and feeds essentially on Hare, micromammals and birds. It is mainly found in regenerating areas, peatlands and meadows scattered with shrubs (Prescott and Richard, 1996). Although the Ermine is generally larger than the Least Weasel, it is impossible to differentiate the two on the basis of their respective tracks.



Photo 7.10.2 Ermine Tracks observed during March 2011 Survey

In the aerial survey of the riparian segments, weasel tracks (Photo 7.10.2) were observed in 9% of transects while, in the forest, tracks belonging to this species were observed in 22% of transects covered by snowshoe.

Since the Least Weasel is rare in the region, a large proportion of the tracks observed probably belonged to the Ermine, which seems to prefer Black Spruce-Sphagnum forests, such as its prey (Squirrels and micromammals).

Based on fur-bearing animal survey data, the Ermine's abundance in the study area can be considered low.

- *FISHER*

The Fisher (Pekan or *ucek*) is generally found in dense coniferous and hardwood forests. It feeds primarily on Hare, Red Squirrel, Voles, Shrews and Porcupines (Prescott and Richard, 1996). The study area is located in the northern limit of its distribution range.

No Fisher tracks were observed during the fur-bearing and big game surveys in 2011. Moreover, not a single Fisher was reported in the catches registered by Cree trappers (Table 7.10.1). The Fisher's scarcity could be explained by the abundance of snow and the low density of forest cover within the study area. Indeed, Fisher seeks for a dense forest cover when snow accumulations are important (Krohn *et al.*, 1995).

The Fisher's presence in the study area has not been confirmed.

- *RIVER OTTER*

The River Otter (or *nicik*) depends entirely on aquatic habitats and fish populations. It feeds mainly on fry and small fish but also eats invertebrates, frogs and aquatic insects. The Otter can travel up to 10 km on rivers in a single night (Feldhamer *et al*., 2003).

Otter tracks were observed in 9% of the riparian transects and 2% of the forest transects during the fur-bearing animal surveys and frequently during the big game survey. An individual was sighted in lake F3301 in August 2010 during the fur-bearing animals survey.

The River Otter regularly uses the study area's streams. Its abundance is described as moderate.

- *AMERICAN MINK*

The American Mink frequents forests and shrub-covered riverbanks and lakeshores. Like the Otter, it feeds on small fish, invertebrates and frogs. It also eats birds and micromammals (Voles), Muskrats and Hares.

Mink tracks were observed in only 11% of riparian transects and 8% of forest transects during the fur-bearing animals surveys. As for the Otter, these tracks were associated with riparian environments.

Despite the scarcity of Mink tracks observed during the fur-bearing animals survey, its abundance must be at least qualified of moderate, given the relatively high number of captures reported by Cree trappers (Table 7.10.1).

- *RED SQUIRREL*

The Red Squirrel (*anikucâs*) inhabits coniferous forests, mixed forests and Maple forests. In the boreal forest, it feeds mainly on conifer cones.

The Squirrel was common and present in 68% of the riparian segments and 53% of the forest segments surveyed in winter 2011. This species is obviously not limited by the abundance of available habitats. However, in the study area, it seems to prefer Black Spruce-Sphagnum stands but is also abundant in Black Spruce-Lichen stands.

The Red Squirrel's abundance in the study area is considered high.

- *NORTHERN FLYING SQUIRREL*

The Northern Flying Squirrel is generally found in coniferous and mixed forests. It often builds its nest near streams and feeds on Pine, Spruce and Balsam Fir cones, Mushrooms, and tree Lichen (Feldhamer *et al*., 2003). This species is difficult to survey since it is nocturnal and flies from tree to tree, leaving few traces on the ground.

However, its presence was confirmed in the fur-bearing animal survey. Tracks were observed twice during the survey of forest transects in Black Spruce-Moss stands located west of lake 32300 (northeast of Camp Lagopede) and near lake F2602 west of the camp.

The Northern Flying Squirrel's presence was confirmed but its relative abundance is unknown.

- *SNOWSHOE HARE*

Hare (or *wâpus*) can be found wherever young conifers grow: regenerating areas, coppice, underbrush, riverbanks and locations offering shelter and food. In summer, it feeds on grasses and broad-leafed plants. In winter, it nibbles on the buds, twigs and bark of many species of trees and shrubs. Its home range spans from 6 to 12 ha and an apparent network of trails linking rest areas and feeding grounds (Feldhamer *et al*., 2003). While the hare prefers environments offering both food and shelter (Bider, 1961; Pietz and Tester, 1983; Alain, 1986), it seems that protection potential is more important than food availability for habitat's selection (Buehler and Keith, 1982). When Snowshoe Hare populations are at low levels in the abundance cycle, this species uses exclusively the most favourable environments, i.e. covered areas such as dense and semi-dense Spruce forests located near food sources. When populations are abundant, the hare is less selective in its choice of habitats (Wolff, 1980; Pietz and Tester, 1983).

Hare tracks were observed in 27% of riparian transects and in 42% of forests transects. In the study area, Jack Pine stands constituted the most frequented habitat by this species.

Its relative abundance in the study area is characterized as moderate based on the fur-bearing animal survey.

- *MUSKRAT*

The Muskrat (or *wacask*) inhabits swamps, ponds, rivers, streams and lakes. In summer, it feeds on the leaves and stems of various aquatic plants. In winter, it uses the portions that are submerged. Sometimes, it may eat molluscs, frogs or salamanders.

The Muskrat is present in the study area, as shown by the signs of activity reported (presence of feces) during fieldwork related to plants communities survey in July 2010. However, the data available does not allow evaluation of its relative abundance since no tracks of Muskrat were detected during the fur-bearing animal survey.

- *CANADIAN BEAVER*

The Beaver (or *amisk*) inhabits streams, ponds, marshes and lakes in forested areas. The Beaver is a herbivore and feeds on the leaves, bark and twigs of most woody species growing nearby water, as well as the stems and roots of various aquatic plants (Feldhamer *et al*., 2003). Its favourite species are Trembling Aspen, White Birch, Alder, Eelgrass and Water-lilies.

Despite the presence of favourable Beaver habitats in the study area, only three Beavers have been observed since the beginning of the environmental studies on the Foxtrot Property. Further, all signs (presence of lodge, gnawed branches) reported during fieldwork were old. The abundance of Wolves on the outskirts of Camp Lagopede may have a significant effect on the area's Beaver population. In fact, in the absence of Moose, Beaver is an easy prey for the Wolf. Fieldwork carried out during the impact assessment for the Route 167 North extension reports similar findings, also characterizing the Beaver's presence in the study area as low (Consortium Roche – SNC-Lavalin, 2010).

Based on the available information, the abundance of Beaver in the Renard Project study area is considered low.

- *AMERICAN PORCUPINE*

The porcupine (or *kâk*) generally lives in mature forests, coniferous stands, rocky slopes and rock slides. In winter, it gnaws on the inner bark of many trees including Tamarack and Spruce. In summer, it feeds on Willow and Alder buds, as well as the leaves and stems of trees and various plants.

Porcupine tracks were reported in 8% of the forest transects traversed by snowshoeing during the fur-bearing animal survey. Signs of porcupine activity (gnawed bark) were also observed in mixed forests during the fur-bearing animal survey.

The American Porcupine is found in the study area but its relative abundance is deemed low.

- *WOODCHUCK*

The Woodchuck can adapt to a wide variety of habitats. Generally, it is found in pastures, rough pebble-strewn terrain, sparse forests and well-drained rocky slopes. It feeds essentially on herbaceous plants but may sometimes eat trees twigs and insects (Prescott and Richard, 1996).

Based on its range and habitat use, the Woodchuck is probably present in the study area although its relative abundance remains unknown. No signs of its presence were found during any of the surveys.

- *STRIPED SKUNK*

The Striped Skunk inhabits a wide variety of habitats: mixed and deciduous forests and meadows. It feeds on insects, garbage, fruits, seeds and nuts, herbaceous plants, micromammals, birds, reptiles and amphibians.

The study area is located in the northern limit of its distribution range. No sign of the striped skunk's activity is reported in the literature or in the surveys. Thus, its presence is not confirmed in the study area.

- *SPECIAL STATUS SPECIES*

Wolverine

The Wolverine, nicknamed glutton, is the largest representative of the Mustelidae family. It is considered threatened by both levels of government in Canada, under the *Species at Risk Act* (SARA), and in Quebec, under the *Act respecting threatened or vulnerable species* (ATVS).

The Wolverine is opportunistic and consumes a wide range of food, depending on availability (Moisan, 1996). As a result, it is not associated with any specific habitat but rather with prey abundance. In Quebec, many sightings have been reported in the past 30 years but given the absence of the tangible animal or verifiable signs, none could be formally confirmed. Sighting mentions range throughout many of the province's administrative regions: Saguenay–Lac-Saint-Jean, Côte-Nord, Abitibi, Outaouais, Capital-Nationale and Nord-du-Québec. It is possible that these observations were of errant or coming from Ontario wolverine individuals, rather than a resident population.

This species was not sighted in the project area. Besides, the area's tallyman, Sydney Swallow, mentioned to the team conducting the March 2011's big game survey, that he had never seen a Wolverine in the trapline.

Least Weasel

The Least Weasel, North America's smallest carnivore, may adapt to a very wide range of habitats. It occupies the tundra or coniferous forest in the north but, further south, it prefers open environments such as meadows, damp meadows, marshes, riverbanks and underbrush. It feeds almost exclusively on Mice and Voles.



Photo 7.10.3 Live-traps used to assess Least Weasel Occurrence in the Study Area in March 2011

Despite its extensive distribution range, this species is generally considered rare throughout the region (Prescott and Richard, 1996), and very probably in the Renard project study area. Indeed, despite an effort of 25 trap-nights, no Weasel was caught in the live traps.

In 1999, the MRNF's Nord-du-Québec regional's office launched a program to identify the carcasses of Weasels trapped by the Cree in the James Bay territory. Over three years (1999, 2000 and 2001), 1,021 Weasels were trapped and sent to the office in Chibougamau. Amongst them, 671 specimens have been analyzed and only one specimen proved to be a Least Weasel. It had been trapped near the village of Eastmain. No other official sighting of this species was reported by the CDPNQ (CRRNTBJ, 2010a).

7.10.1.3 Airstrip Area

Regarding the fur-bearing animals, the airstrip area owns a Jack Pine forest stand which represents its main particular feature. In fact, in addition to the dry barrens that cover 13% of the airstrip area, the dominant forest stands are the Black Spruce-Lichen (58%) and the Jack Pine (25%). The latter showed the highest abundance of Snowshoe Hare among all the surveyed stands.

Relatively to the mine area, the airstrip area offers basically the same potential for all fur-bearing animals. However, Black Spruce-Moss and Black Spruce-Sphagnum stands are less represented here. These two types of forests were preferred by Squirrels, Weasels and Martens.

7.10.2 Construction Phase Impacts

The major sources of impact for fur-bearing animals in the construction phase are related to the following project components:

- Site preparation and development:
- The impacts related to these activities are mostly due to the habitat losses incurred through site clearing and development.
- Construction of mine facilities;
- Operation of quarry and borrow pits:

- The impacts related to these activities are essentially due to the disturbance caused by drilling, blasting, backfilling/excavation, operation of borrow pits and construction of mine facilities such as the ore processing plant, accommodation and services complex, power generating sets and airstrip.
- Use and maintenance of machinery and power generating sets and road circulation:
- The machinery used for clearing as well as other construction activities, and vehicles circulating on mine roads may cause animal mortality.

7.10.2.1 Mine Area

➢ *SITE PREPARATION AND DEVELOPMENT*

The construction phase's related activities may affect fur-bearing animals. Site clearing and preparation will cause temporary and permanent habitat losses of at most 197 ha within the mine area, according to species. The fur-bearing species found in the study area can be found in different habitats. Table 7.10.2 shows their preferred habitats, the proportion of the study area occupied by these habitats, and the surface area affected by the project during the construction phase. Overall, within the Renard Project study area, less than 3% of the initial area of each species' preferred habitats will be affected (Table 7.10.2).

The individuals whose home ranges overlap the project's construction phase footprint will be able to move to similar suitable peripheral environments. For some herbivores (e.g. American Porcupine, Woodchuck, Snowshoe Hare), these movements may require increased energy expenditures, amplify their vulnerability to predation or lead to competition in the area surrounding the project. For example, in locations where construction will take place during winter, the Beavers directly affected by the work may have to move on snow without any cover, leading to a greater risk of predation by Wolves.

➢ *CONSTRUCTION OF MINE FACILITIES*

Due to noise and increased activity levels, all species' feeding, breeding and rearing behaviour will be disturbed, depending on the period when the construction activities will occur. The individuals affected by these disturbances will avoid working areas and will move to peripheral alternative habitats. These effects will particularly be felt by species having the smallest home ranges (e.g. Red Squirrel, American Porcupine, American Marten).

Table 7.10.2 Potential Habitat Losses in the Mine and Airstrip Areas for Fur-Bearing Species Confirmed to be Present in the Renard Project Study Area

Species	Relative abundance in study area	Preferred habitats	Mine area					Airstrip area		
			Current conditions	Surface area affected				Current conditions	Surface area affected	
				Construction phase	Operation phase	TOTAL			Construction phase (TOTAL)	
			(ha)	(ha)	(ha)	(ha)	(%)	(ha)	(ha)	(%)
Grey Wolf	High	All terrestrial habitats	8364	197	29	224	3	2196	81	4
Red Fox	Moderate but high near Camp Lagopede	All terrestrial habitats	8364	197	29	224	3	2196	81	4
Canada Lynx	Low	Coniferous forest	8031	187	27	213	3	1991	67	3
American Marten	High	Coniferous, mixed or deciduous forest	8118	187	27	213	3	1991	67	3
Ermine	Low	All terrestrial habitats	8364	197	29	224	3	2196	81	4
River Otter	Moderate	Lakes, swamps, ponds and streams	1625 + 69 km of streams	4 + 1.3 km of streams	0 –	4 + 1.3 km of streams	0 + 1.9% of the initial length	526 + 13 km of streams	0 0	0 0
American Mink	Moderate	Lakes, swamps, ponds and streams	1625 + 69 km of streams	4 + 1.3 km of streams	0 –	4 + 1.3 km of streams	0 + 1.9% of the initial length	526 + 13 km of streams	0 0	0 0
Red Squirrel	High	Coniferous, mixed or deciduous forest	8118	187	27	213	3	1991	67	3
Northern Flying Squirrel	Unknown	Coniferous, mixed or deciduous forest	8118	187	27	213	3	1991	67	3
Snowshoe Hare	Moderate	Coniferous forest	8031	187	27	213	3	1991	67	3
Muskrat	Unknown	Lakes, swamps, ponds and streams	1625 + 69 km of streams	4 + 1.3 km of streams	0 –	4 + 1.3 km of streams	0 + 1.9% of the initial length	526 + 13 km of streams	0 0	0 0
Canadian Beaver	Low	Lakes, swamps, ponds and streams	1625 + 69 km of streams	4 + 1.3 km of streams	0 –	4 + 1.3 km of streams	0 + 1.9% of the initial length	526 + 13 km of streams	0 0	0 0
American Porcupine	Low	Coniferous, mixed or deciduous forest	8118	187	27	213	3	1991	67	3

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The machinery used for clearing and for other construction activities may cause mortality, especially among arboreal species (e.g. American Marten, Red Squirrel, Northern Flying Squirrel and American Porcupine) and among juveniles of most species. After birth, the young are confined to the nest or burrow for several weeks (from March to May for most species) before being able to move around on their own.

Given the low traffic flow projected during the construction phase of the Renard Project, as well as the limited road network (2.2 km) and the low speed limits (30 km/h on the site and 70 km/h on secondary roads), these effects should be relatively insignificant for all populations of fur-bearing animals.

7.10.2.2 Airstrip Area

- *SITE PREPARATION AND DEVELOPMENT*

The airstrip area presents an analogous potential for fur-bearing animals habitat compared to the mine area. The impacts incurred in both are therefore equivalent.

Table 7.10.2 shows the various species found, their preferred habitats and the areas affected by the development of the airstrip, the borrow pits and the trench landfill site. In summary, 4% or less of the surface area representing a potential habitat for one or more species will be affected by the airstrip construction. The airstrip area's special feature is the presence of dry barrens over 18% of its footprint. The rest of its footprint is covered by forests, including a large Jack Pine forest owning a greater abundance of Snowshoe Hare. The Jack Pine stands occupies 294 ha of the airstrip area while 36 ha (12%) will be affected by mining activities.

The disturbance engendered by aircrafts taking off and landing could temporarily affect certain individuals using the area. In fact, few studies addressed this phenomenon for fur-bearing animals, thus, given this current state of knowledge, it is difficult to understand related effects.

Sound levels might increase to 50 to 60 dB during 1 to 10 minutes, during the construction phase. Given the low flights frequency, these disturbances will be of short duration and of intensity possibly comparable to, see lower than, the disturbances currently brought by floatplanes and helicopters, whose noise levels exceed those of a Dash 8.

- *OPERATION OF QUARRY AND BORROW PITS*

The activities linked to borrow pits operation will generate noise and disturbances that could disturb neighbouring animals' behaviour. The individuals affected by these disturbances will avoid work areas and move to alternative peripheral habitats. The effects will be felt mainly by the species having the smallest home ranges (e.g. Red Squirrel, American Porcupine, and American Marten).

➢ *OTHER IMPACTS*

The following impacts could also be observed during the construction phase:

- The trench landfill site, feeding of animals by workers and food smell attracting some fur-bearing animals such as Fox;
- Wolf and Fox are species which presence might increase locally, especially nearby camp facilities. These predators could cause additional pressures and cause a population decline in their prey populations (Canadian Beaver, Snowshoe Hare and Red Squirrel).

7.10.2.3 Mitigation Measures

The following mitigation measures are intended to reduce mortality rates, habitat disturbance and habitat loss by the mean of confining circulation to identified corridors and avoiding specific sensitive environments. Other measures are designed to minimize animal intrusion in work sites.

- Preserve a riparian buffer strip of at least 30 m wide along streams and water bodies. On water adjacent work sites, clearly identify clearing boundaries (orange ribbons or fence);
- Allow machinery circulation exclusively on areas to be cleared, avoiding riverbanks, lakeshores, riparian buffer strips and selective cutting areas where machinery is prohibited;
- Develop roads so as to limit the risk and frequency of road accidents (e.g. clear vegetation in curves so that drivers can spot animals);
- Ensure that Beavers to be affected by construction activities will, previously, be trapped by the Cree or caught by live traps during summer time and then relocated in appropriate habitats;
- Implement a wildlife protection plan to reduce opportunities for poaching;
- Sensitize workers on the importance of avoiding feeding animals and on appropriate food disposal in order to avoid appealing of fur-bearing animals into work areas. The awareness campaign could be outlined by educational posters and informative sessions;
- The abrasives used for winter road maintenance will be limited to sand and gravel except for otherwise exceptional circumstances. There will be no adverse effects on wildlife related to the use of calcium.

7.10.2.4 Residual Impacts

During the construction phase, the Renard Project's residual impact on fur-bearing animals may be considered negative since it will engender habitat losses and cause mortality during clearing work.

The intensity of the habitat-loss-related impact on fur-bearing animal populations can be considered as low, given the availability of similar habitats in the immediate vicinity. As for Wolves and Foxes, the camp might be an attractive site. The local increase of Wolf populations could result in an additional pressure over the Beaver neighbouring population.

The extent of the construction phase impact is restricted to the cleared areas, surrounding areas and roads and can, therefore, be considered as site specific. Its duration is deemed moderate. Consequently, the significance of this impact during the construction phase is considered as low.

7.10.3 Operation Phase Impacts

The main sources of impact on fur-bearing animals during the operation phase are related to the following project components:

- Open pits development:
- The project's impacts are related to the additional habitat losses associated with the development and the presence of open pits R-2/R-3 and R-65 pits;
- Use and maintenance of machinery and power generating sets; road circulation;
- Ore mining, handling and storage;
- Airstrip operation;
- Progressive site rehabilitation.

7.10.3.1 Mine Area

➢ *PIT DEVELOPMENT*

The main impacts related to the operation phase are associated with habitat losses due to the development of open pits and to other infrastructures required for mining operations, such as the management sites for overburden, waste rock and kimberlite.

Fur-bearing animals use a wide variety of habitats, according to species. Based on the species likely to be present in the study area, Table 7.10.2 shows the surface areas of habitats that will be affected during the operation phase. Since these habitats will be lost throughout the mining operations, the individuals whose home range overlaps the affected area will move to unaffected peripheral habitats. This situation may increase competition for the best habitats and resources found in adjacent areas. Moving may also increase energy expenditure and vulnerability to predators, thereby affecting more seriously species that are of smaller size and of less mobile such as the Ermine, the Least Weasel and the American Porcupine.

A low intensity impact related to habitat alteration is predicted for fur-bearing animals with larger home ranges (e.g. Grey Wolf and Canada Lynx), since the proportion of the surface area affected during the operation phase will be quite small, see insignificant (<0.5% of the initial surface area). The wildlife winter survey of the study area showed that the number of Wolves and Foxes may even increase locally, nearby camp facilities. The presence of these predators could cause additional pressures and a decline in their prey populations (Canadian Beaver, Snowshoe Hare and Red Squirrel).

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION; ORE MINING, HANDLING AND STORAGE*

The machinery used for the mine related activities (site development, ore mining, handling and storage) and road traffic during the operation phase may cause mortality of animals using the area. All species could see their feeding, breeding and rearing behaviour disturbed, according to the season during which the activities will take place. The effects will be felt to a higher degree by species whose home ranges

are small (e.g. Red Squirrel, Porcupine, American Marten). The individuals affected by these disturbances will move to similar nearby habitats, therefore potentially enhancing competition for territory and resources in the mine's vicinity.

The effect of roads rights-of-way on fur-bearing animals is generally neutral to negative, although the impact of roads may vary according to species and their avoidance behaviour. Table 7.10.3 summarizes the impact of road circulation toward each species. Given the low traffic flow projected as part of the Renard Project during the operation phase, the limited road network (2.2 km) and the low speed limits (30 km/h on the site and 70 km/h on secondary roads), these effects should be relatively insignificant for all populations of fur-bearing animals.

The presence of the mine and new road access are likely to attract hunters, therefore increasing hunting and trapping pressures. Hunting and trapping will be prohibited for the Renard Project's employees. The implementation of a safety zone contiguous to the mine area should also attenuate this impact. Access to the area will be facilitated through Route 167, a novel road access. This will facilitate the territory's access to Cree hunters and trappers but it could also possibly increase poaching activities. Facilitated access will increase probabilities of declines of populations of American Marten, Canadian Beaver and River Otter, which are particularly sought.

Table 7.10.3 Impacts of Roads on Fur-Bearing Animals

Species	Impact	Reference
Wolf	Uses linear corridors, including roads, to travel where human activity is limited	James et Stuart-Smith, 2000
American Porcupine, Snowshoe Hare, Muskrat, Red Squirrel, Red Fox, Woodchuck	Species that are especially vulnerable to road accident	Oxley et *al.*, 1974; Buchanan, 1987; Clevenger *et al.*, 2003; Grilo *et al.*, 2009; Barthelmess and Brooks, 2010
Canadian Beaver	Will not avoid roads, uses culvert inflow as foundations for building dams	Jensen *et al.*, 2001; Curtis and Jensen, 2004; Jakes *et al.*, 2007
American Marten	Does not avoid roads, impacts of traffic should be neutral	Mowat, 2006; Pereboom *et al.*, 2008; Fahrig and Rytwinski, 2009

During the operation phase, the following impacts could also be observed:

- The trench landfill site, animals fed by workers and food smell attracting some fur-bearing animals;
- Wolf and Fox are species whose populations could increase locally, e.g., nearby camp facilities. These predators could cause additional pressure and a prey population decline (Canadian Beaver, Snowshoe Hare and Red Squirrel).

➢ *PROGRESSIVE SITE REHABILITATION*

Progressive site rehabilitation will contribute to the restoration of a small proportion of habitats lost during site preparation and development. Indeed, during the operation phase, temporary storage areas

for construction supplies, the temporary camp and 8 ha of the processed kimberlite confinement area (i.e. 10% of the area impacted by this element) will be covered by a layer of overburden before being seeded and planted with Black Spruce.

7.10.3.2 Airstrip Area

- *AIRSTRIP OPERATION*

No additional habitat will be affected within the airstrip area during the operation phase. Although, the disturbance caused by aircrafts taking off and landing could temporarily affect some individuals inhabiting the area. In fact, few studies addressed this phenomenon for fur-bearing animals, thus, given this current state of knowledge, it is difficult to understand related effects.

The sound level may increase to 50 to 60 dB during 1 to 10 minutes during the operation phase. Given the low flights frequency, these disturbances will be of short duration and of intensity possibly comparable to, see lower than, the disturbances currently brought by floatplanes and helicopters, whose noise levels exceed those of a Dash 8.

7.10.3.3 Mitigation Measures

- Close and rehabilitate temporary accesses and sites used in the construction phase;
- Clear vegetation besides road curves so that drivers may spot incoming animals ;
- Implement a wildlife protection plan to reduce opportunities for poaching;
- Sensitize workers on the importance of avoiding feeding animals and on appropriate food disposal in order to avoid appealing of fur-bearing animals into work areas. The awareness campaign could be outlined by educational posters and informative sessions;
- The abrasives used for winter road maintenance will be limited to sand and gravel except for otherwise exceptional circumstances. There will be no adverse effects on wildlife related to the use of calcium.
- As far as possible, avoid low-altitude flights (tourism purpose flights) in order to limit the impact of this disturbance on wildlife.

7.10.3.4 Residual Impacts

During the operation phase, the project's residual impact on fur-bearing animals can be considered as negative due to direct (habitat losses) and indirect (presence of roads, road circulation, increased use of territory) processes. The presence of the camp might attract Wolf and Fox.

In summary, this impact may be considered of a moderate intensity, given the possible increase of trapping pressures brought by an easier access to the territory. Moreover, the local increase of Wolf populations could result in an additional pressure on the local Beaver's population, which already appears low.

The spatial extent of the impact is restricted to the Renard Project study area, and thus, may be considered local, with a moderate duration.

Overall, the impact's significance during the operation phase is deemed moderate.

7.10.4 Closure Phase Impacts

7.10.4.1 Impact Description

The main sources of impact on fur-bearing animals in the closure phase are related to the following project components:

- Final site rehabilitation and revegetation:
- Site restoration will help revegetate most habitats lost during site preparation and development.
- Use and maintenance of machinery and power generating sets; road circulation:

  The machinery used for final site rehabilitation and revegetation and the vehicles circulating on the access roads will probably cause mortality. Road traffic and noise generated during the mine closure are likely to affect the individuals present in the site and disturb their daily activities, despite the fact that noise levels and probability of collision will be significantly lower than during the operation phase, given the smaller vehicle fleet required for the closure phase.

➢ *FINAL SITE REHABILITATION AND REVEGETATION*

For fur-bearing species, the main source of impact during the closure phase is the disturbance caused by site rehabilitation activities and vehicle traffic. When landscape restoration and slope stabilization will be completed, the size of available habitats supporting wildlife will increase due to revegetation.

The recolonization of the site by vegetation will last about 30 years. To protect soil from erosion, hydroseeding of herbaceous species will be followed by plantation of indigenous trees and shrubs species. This primary vegetation cover will retain soil and promote the retention of seeds from neighbouring natural plant species. The environment's gradual recolonization by vegetation will provide habitat and food for the inhabiting wildlife.

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

Disturbance engendered by the rehabilitation activities will cause impacts similar to those observed during the construction and operation phases, but with a less extensive duration (given the reduced vehicle fleet required during the closure phase). Disturbances and inconveniences as well as the probability of collisions, will be low.

When this work will be completed, noise levels and traffic will decrease. This will be favourable to the animal species that might repopulate the area.

7.10.4.2 Mitigation Measures

➢ *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

- The abrasives used for winter road maintenance will be limited to sand and gravel unless otherwise exceptional circumstances. There will be no adverse effects on wildlife in relation to the use of calcium.

No other specific mitigation measure is considered necessary to protect fur-bearing animals during the closure phase.

7.10.4.3 Residual Impacts

During the closure phase, the Renard Project's residual impact on fur-bearing animals can be considered as positive due to the natural revegetation of 110 ha and the active rehabilitation of 12 ha of wildlife habitats. In summary, the impact's intensity may be considered as moderate, given the total surface area restored for wildlife habitats, as well as the progressive and permanent decrease in site use.

The spatial extent of the impact is restricted to the Renard Project study area and may, therefore, be considered as local, while its duration is deemed long.

Overall, the significance of the closure phase's positive impact is considered high.

7.11 Big Game

7.11.1 Current Conditions

The big game found in the James Bay territory include: woodland caribou (*Rangifer tarandus caribou*), moose (*Alces alces*) and black bear (*Ursus americanus*) (CRRNTBJ, 2010a). The following information sources were used to estimate the relative abundance of their populations affected by the project:

- Prior environmental studies carried out near the Foxtrot Property, including an environmental baseline study (Roche, 2005), biodiversity studies of the LG-3 area conducted by the *Centre d'Études Nordiques* (CEN) and Hydro-Québec (Drolet and Crête, 1994), the Matoush Project impact assessment (Strateco Resources, 2009) and the Route 167 North extension impact assessment (Consortium Roche – SNC-Lavalin, 2010);
- The CDPNQ was consulted to document the presence of regulated wildlife species and habitats in the study area;
- The hunting and trapping statistics published on the MRNF website of the furbearer management unit 91 and hunting zone 22, as well as the data obtained from the Otish Mountains impact assessment on trapline M11 (Consortium Roche – SNC-Lavalin, 2010);
- The information gathered on traditional ecological knowledge obtained through a description of the human environment (see Section 4.5.1) and data collected in the winter survey with the tallyman and Cree collaborator who participated in the winter wildlife surveys;
- Opportunistic observations of wildlife made on site by the various field teams that visited the Renard Project study area;
- A winter survey on big game, excluding black bear, was conducted in March 2011 (Roche, 2011).

➢ *AERIAL SURVEY OF WOODLAND CARIBOU AND MOOSE*

Aerial surveys were performed between March 19 and April 2, 2011 on forest-dwelling ecotype caribou and moose (Roche, 2011). For the forest-dwelling caribou, a plane and an helicopter flew over an area of more than 40 x 40 km in flight lines spaced every 2 km (as per Courtois *et al.* 2001). The survey was carried out in cooperation with the MRNF (Chibougamau office) in two phases. In Phase 1, a Cessna 337 was used to locate trail networks. Fly-overs were performed at an altitude of 200 m and an average speed of 200 km/h. The team consisted of two observers with experience in track sighting and a pilot/navigator. In the second phase, a S350B2 helicopter was used to count and sex individuals. The

helicopter fly-overs were performed at an altitude of about 100 m and an average speed of 100 to 180 km/h, depending on visibility conditions. For the helicopter work, the team consisted of two observers and a navigator experienced in identifying caribou ecotypes and in their capture.

A moose survey was carried out using the MRNF-recommended protocol (Courtois, 1991) with flight lines spaced every 500 m in the mine area (100 km²) and over a slightly larger area than in the airstrip area (29 km²). A 100 km² control zone with similar characteristics to the mine area was also surveyed. The work was done using only an helicopter. The survey team was composed of two observers experienced in trail sighting and a navigator.

All trail networks, isolated single-pass trails (recent and old), and animals observed during the surveys were located on maps and their positions recorded using a GPS. The trail networks were identified for the species. The habitat encountered in recent trail networks was described by hovering and collating data on plant composition of the forest cover, the slope, the exposure and the general topography.

7.11.1.1 Regional Environmental Conditions

The James Bay and Northern Quebec Agreement (JBNQA) gives harvesting priority in this area to the Crees, its beneficiaries. Forest-dwelling caribou sport hunting is prohibited throughout Quebec, due to the species' two-fold legal protection status. It is an ecotype considered "threatened" in Canada under the *Species at Risk Act* (SARA) and "vulnerable" in Quebec under the *Act respecting threatened and vulnerable species* (R.S.Q., c. E-12.01). Native people may, however, harvest forest-dwelling and migratory caribou in the context of their traditional activities. Sports hunters may hunt caribou and moose in zone 22 but not black bear, which is also considered a fur-bearing animal.

- *MIGRATORY CARIBOU*

The caribou found in Quebec and Labrador are all qualified as woodland caribou (Banfield, 1961). Given the lack of a clear consensus regarding the taxonomy of caribou in Canada, scientists have classified them according to different groups' behaviour (Edmonds, 1988; Mallory and Hillis, 1998). Four ecotypes are found in Canada: island, mountain, migratory (Photo 7.11.1) and forest-dwelling. The last three are present in Quebec and Labrador (Bergerud *et al.*, 2008). The two ecotypes found in the study area are migratory and forest-dwelling. The forest-dwelling ecotype is protected by law and will be discussed in the section on special status species.



Photo 7.11.1 Group of migratory caribou observed 40 km south of the Renard Project study area in March 2011

In Quebec, the migratory ecotype is represented by two great herds: the Rivière aux Feuilles herd and the George River herd. Historical data on the demography of migratory caribou suggests that the Nord-du-Québec herds have gone through at least three cycles of

scarcity and overabundance over the last two centuries (Couturier *et al.*, 2004). Extended periods of caribou scarcity have been followed by shorter periods of overabundance (Couturier *et al.*, 2004). The last estimate of the George River herd dates from 2001, at which time it was assessed at 440,000 individuals (Couturier *et al.*, 2004). Apparently, its numbers have declined since (Jean and Lamontagne, 2004; Brodeur, 2010). According to the latest survey of 2010, the George River herd counts 75,000 individuals, a decrease of more than 80% since 2001 (MRNF, 2011a). The Rivière aux Feuilles herd was estimated at 628,000 in 2001 and has apparently also declined since the last survey (MRNF, 2011a). In 2010, this herd could not be counted since the females were too dispersed during the post-calving season (S. Couturier, pers. comm., July 2010). The migratory caribou that potentially use the study area belong to the Rivière aux Feuilles herd.

In the James Bay territory, sport hunting's most popular game is caribou, which has been highly prized in the early 2000s. However, in the past 5 years, the number of caribou hunters has dropped drastically. The caribou's abundance in this part of the territory, from November to February, and the fact that zone 22 is easy to access, attracts a great many enthusiasts. According to hunting statistics, 8,034 to 15,234 caribou (average = 12,000 ± 2,000 caribou) were harvested annually from 1998 to 2011. Harvesting was highest in the winters of 2003-2004 and 2004-2005.

In the Renard Project study area, harvesting is reserved for Native people since sport hunting is prohibited in this sector. In the James Bay territory, the Cree currently use caribou for subsistence. While some of the caribou harvested by the Cree belong to the Rivière aux Feuilles herd, some come from the forest-dwelling groups inhabiting the region's woodlands.

The number of caribou reported for the trapline in which the study area is located (M11) for the 2001-2002 to 2008-2009 seasons is 15 individuals (MRNF, 2010b, via the Cree Trappers' Association *in* Consortium Roche - SNC Lavalin, 2010). According to St-Pierre *et al.* (2006), the Native harvest varies significantly from year to year, with more caribou being harvested when migratory caribou are present in the region. In fact, older subsistence hunting data show higher caribou harvests in the years 1989-1990 to 1992-1993, when numbers ranged from 15 to 21 individuals (Table 7.11.1).

Table 7.11.1 Subsistence Hunting of Big Game on Cree Traplines Adjacent to the Renard Project Study Area

Trapline	Year	Black bear	Caribou	Moose
M-10	1988-1989		11	5
M-10	1989-1990			
M-10	1990-1991	4		6
M-10	1991-1992	1		1
M-10	1992-1993			5
M-10	1993-1994	1	5	5
M-10	1995-1996		4	
M-10	1998-1999			11
M-10	1999-2000			14
M-10	2000-2001			13
M-10	2001-2002	2	3	7
M-11	1988-1989			
M-11	1989-1990		21	7
M-11	1990-1991	2	21	2
M-11	1991-1992			
M-11	1992-1993		15	5
M-11	1993-1994		4	2
M-11	1994-1995	1		
M-11	1995-1996		1	1
M-11	2000-2001		2	5
M-11	2001-2002	6	7	3
M-12	1988-1989			
M-12	1989-1990			
M-12	1990-1991		2	
M-12	1991-1992			
M-12	1993-1994		3	1
M-12	1994-1995		13	3
M-12	1996-1997			9
M-12	1997-1998			5
M-12	1999-2000			1
M-12	2000-2001		4	2
M-12	2001-2002	1	1	3
M-16	1988-1989		39	8
M-16	1989-1990			
M-16	1990-1991		44	34
M-16	1991-1992			
M-16	1996-1997	4		
M-16	1997-1998	4	29	7
M-16	1999-2000			9
M-16	2001-2002		8	3
M-1A	1988-1989			
M-1A	1989-1990		5	
M-1A	1990-1991		2	6
M-1A	1992-1993	2	37	
M-1A	1993-1994	1	2	1
M-1A	1994-1995	2	15	
M-1A	1995-1996		47	1
M-1A	1996-1997		34	3
M-1A	1997-1998	1	2	4
M-1A	2001-2002		7	
M-23	1988-1989		4	4
M-23	1989-1990			
M-23	1992-1993			1
M-23	1995-1996		6	11
M-23	1996-1997			1
M-23	1997-1998			9
M-23	1998-1999			4
M-23	1999-2000			7
M-23	2001-2002			8
M-4	1988-1989			
M-4	1989-1990		35	3
M-4	1993-1994	1	1	2
M-4	1994-1995	2	9	
M-4	1996-1997		6	3
M-4	1997-1998			3
M-4	2000-2001	1	24	7
M-4	2001-2002		4	

Source: Société de la Faune et des Parcs du Québec, 2003

➢ *MOOSE*

While moose is present up to the treeline throughout the James Bay territory, its density is much lower than in southern Quebec (CRRNTBJ, 2010a). According to data obtained in hunting zone 22 during the last survey (1991), its density was 0.26 moose/10 km² (Lamontagne and Lefort, 2004). Based on the sector's wildlife resource assessment, an increase in the moose population is desirable but not at the expense of other populations like the forest-dwelling caribou (CRRNTBJ, 2010a).



Photo 7.11.2 A Female Moose and her Calf observed in March 2011 during the Survey in the Control Zone survey

In hunting zone 22, the majority of moose harvesting is done by the Cree (Lamontagne and Lefort, 2004). Between 1999 and 2010, the moose harvest here varied from a minimum of 60 individuals in 2000 to 1,992 individuals in 2010 (MRNF, 2011b). Hunting statistics show a definite increase in harvesting from the late 1990s to today. The number reported for the 2004-2005 to 2008-2009 seasons for trapline M11 is 7, an average of 1.4 moose/year (MRNF, 2010b, via the Cree Trappers' Association *in* Consortium Roche-SNC Lavalin, 2010). The number of moose harvested in this area was highest from 1988-1989 to 2001-2002, with an average of 2.5 per year (Table 7.11.1).

The size of the moose's home range is directly proportional to the heterogeneity of an area's forest stands (Courtois, 2002). In fact, the moose can travel several dozens of square kilometers to meet all of its needs. Generally speaking, it prefers mixed coniferous and deciduous forests, especially balsam fir-white birch or balsam fir-yellow birch stands. It uses clearings, burns and areas that have been cut but are regenerating (Courtois, 1993). In summer, it prefers to feed in water bodies and other wetlands, which also provide protection from the heat and from insects. In winter, moose gather in small groups in woodlands where the snow cover is less thick (Prescott and Richard, 1996). In the James Bay territory, mixed and mature forest stands are its habitat of choice (Jacqmain *et al.*, 2008).

➢ *BLACK BEAR*

The black bear is a species abundant throughout Quebec and all over the James Bay territory. Little is known about the state of the populations in the James Bay territory but densities are reported to be low, i.e. in the order of 0.20 bears/10 km² (Lamontagne *et al.*, 2006). However, the black bear is a species that is very difficult to survey, given its elusive behaviour and inactivity in winter.

From 1999 to 2010, an average of 2 ± 3 bears were harvested in the furbearer management unit (FBMU 91) in which the Renard Project study area is located. More specifically, the number of black

bear pelts reported for trapline M11 for the 2004-2005 to 2008-2009 seasons was 1 bear (MRNF, 2010b, via the Cree Trappers' Association *in* Consortium Roche - SNC Lavalin, 2010). Between 1989-1990 and 2001-2002, the number was higher with a harvest of 9 individuals (approximately 1/year), 6 of which were harvested in the 2001-2002 trapping season.

Black bear is opportunistic and uses very diverse habitats. It is not associated with a particular terrestrial ecosystem and can cover large distances in search of food. The black bear is omnivorous, eating plants (stems, buds and roots), wild fruits and berries, carrion insects and young moose or caribou. It is often seen near dumps. Its home range varies from a few square kilometres to more than 1,000 km^2, depending on sex and environment type (Leblanc and Huot, 2000). Black bears may use open areas but tend to avoid recent fires. They enter their dens to begin hibernating in October, when temperatures drop significantly, and come out in April or May (Leblanc and Huot, 2000).

- *SPECIAL STATUS SPECIES*

Forest-dwelling caribou

Unlike migratory caribou, the forest-dwelling caribou is found in small, isolated herds in the boreal forest (Courtois *et al.*, 2003). It travels far less than the migratory ecotype. The forest-dwelling caribou is generally observed in low densities (1-3 individuals/100 km^2) throughout its range. The forest-dwelling caribou herd nearest to Camp Lagopede is the Témiscamie herd, located about 100 km further south. Individuals from this herd were reportedly seen in the Camp Matoush area (Strateco Resources, 2009).

The forest-dwelling caribou is an ecotype considered "threatened" in Canada under the *Species at Risk Act* (SARA) and "vulnerable" in Quebec under the *Act respecting threatened and vulnerable species* (R.S.Q., c. E-12.01). Socially, the forest-dwelling caribou has taken on increasing importance in recent years. Its precarious situation is now better known to the public and, for many, it has become an emblematic species of the boreal forest. In fact, many recommendations were incorporated into the forest-dwelling caribou recovery plan published in 2008 (Forest-dwelling Caribou Recovery Team, 2008), which defines the forest-dwelling caribou as a target species to be taken into consideration in the environmental impact assessment process, ensuring that work is compatible with the requirements of this caribou ecotype.

The main limiting factors for forest-dwelling caribou in Quebec are:

- Habitat disturbances such as logging, hydropower development, mining and forest fires;
- Predation;
- Disturbances caused by human-induced activity;
- Illegal hunting (Forest-dwelling Caribou Recovery Team, 2008).

Different scientific studies show that, in most regions of Canada, the key limiting factor for forest-dwelling caribou populations is predation (Environment Canada, 2008). To avoid predators, the forest-dwelling caribou disperses on the territory. The predation rate generally increases with natural or

human-induced landscape disturbances that rejuvenate forests. The increment of young forest leads to an increase in the quantity of food for species like moose whose abundance consequently increases, supporting a larger number of predators that adversely affect forest-dwelling caribou. The latter requires an habitat composed of vast plots of undisturbed mature forest to maintain its populations throughout its range.

The forest-dwelling caribou generally inhabits homogenous environments less favourable to other cervids like moose, probably in order to isolate itself from the latter and its predators (Courtois, 2003). The availability of food is secondary for the forest-dwelling caribou since it is usually abundant throughout its distribution range (Courtois, 2003). They live mainly in mature black spruce forests (*Picea mariana*) avoiding environments naturally disturbed (e.g. fire) or disturbed by man (Courtois, 2003) either because the risk of predation is higher or because the lichen has been destroyed. In the short term, fire creates open habitats without lichen that are not very suitable for caribou. This effect fades with time (> 60 years) and, under certain circumstances, fire can create habitats that are more suitable than initially by favouring colonization by lichen stands.

The environments used by the forest-dwelling caribou vary according to season and the location of the herds (Courtois, 2003). In spring, caribou disperse in coniferous forests and peatlands. In some regions, the females go into peatlands or onto islands to calve (from mid-May to mid-June), very probably to reduce the risk of predation (Bergerud *et al.*, 1990). They remain isolated during the calving season and summer, but return to the herd in fall to breed (Jolicoeur *et al.*, 2005). In winter, forest-dwelling caribou form larger groups. They prefer mature coniferous forests but also visit open areas rich in ground lichen until snow conditions no longer permit digging feeding craters (Vandal, 1985).

7.11.1.2 Mine Area

- *MIGRATORY CARIBOU*

Generally speaking, the Renard Project study area is located in the migratory caribou wintering ground. The latter is an important habitat for them particularly when population density is high since a good diet in winter allows the species to recover from the impacts of a less optimal summer diet (Schmelzer and Otto, 2003). However, the availability of winter habitat for the migratory caribou is not usually considered a limiting factor (Messier *et al.*, 1988). The exact boundaries of the wintering ground vary greatly and can change considerably over time based on the availability of food, population dynamics (Couturier *et al*., 1990; Schmelzer and Otto, 2003) and, possibly, snow volumes (Bergerud and Luttich, 2003). An increase in herd size generally corresponds to a vast wintering ground. A decline in herd size, on the other hand, generally corresponds to a small wintering ground closer to the traditional calving ground. Given the recent decrease in migratory caribou populations, the species' winter range is said to be shrinking (Jean and Lamontagne, 2004; Brodeur, 2010).

In the March 2011 Renard Project wildlife survey, two groups of 4 and 11 migratory caribou were observed about 40 km south of Camp Lagopede and a group of 14 individuals was sighted 34 km to the northwest (Roche, 2011). In terms of winter feeding, the study area has good potential for migratory caribou, given its abundance of spruce-lichen stands. It would thus be normal to observe that the migratory caribou's use of the study area has diminished since their herds are smaller and their movements less extensive than in the past. This information is corroborated by tallymen's comments to the effect that their occurrence in the region is less frequent than formerly (Lussier, 2010a and b). If herd numbers rise, migratory caribou may frequent the study area more in winter.

- *MOOSE*

The moose is an important element of the Cree diet and moose hunting is an integral part of the Cree culture. The results of the wildlife survey carried out for the Renard Project showed that, in March 2011, not a single moose was observed in the Renard Project study area. However, during the micromammal survey in September 2010, moose tracks were seen on two occasions within a 3-km radius of Camp Lagopede. In the 100 km² control zone, four moose were seen (two males, one female and a calf) for a density of 0.04 moose/km².

The low abundance of moose in the Nord-du-Québec region is usually attributed to the rather unproductive habitat that dominates the landscape (Maltais *et al.*, 1993). In this study, trail networks were generally located near the open spruce stand, the region's most common habitat. In fact, black spruce-lichen stands dominate this northern area's forest cover. Browse, which generally constitutes the food of moose in winter, is rather scarce in open spruce stands, making these habitats less suitable for the species' winter survival.

In light of the moose's northern location in the study area, the presence of only a few deciduous stands and the low densities of moose obtained during the wildlife survey compared to moose densities for Quebec as a whole, the number of moose in the Renard Project study area can be considered low.

- *BLACK BEAR*

No specific survey for black bears was carried out. However, as shown by the many opportunistic observations during 2010 survey work and those of company employees on the edges of drilling sites and Camp Lagopede, black bear is abundant in the study area (Roche, 2011). On the basis of observations at the Matoush Project site (Strateco Resources, 2009), it seems that black bear is more abundant in the Renard Project study area. In March 2011, the tallyman of the area, Sydney Swallow, told the big game survey team that the study area had always supported a high density of black bear even before exploration work began. However, the presence of Camp Lagopede concentrated individuals around it due to the smell of food.

➢ *SPECIAL STATUS SPECIES*

Forest-dwelling caribou

Based on its distribution range, the forest-dwelling caribou is reportedly present throughout the Renard Project study area. However, according to one of the land users, the forest-dwelling caribou used the study area in the past but, since the migratory caribou's great migrations of the 1990s, the forest-dwelling ecotype apparently abandoned the area (Sydney Swallow, pers. comm.).

In March 2009, an aerial survey was performed along the future Route 167 North extension (500 m to 2.5 km either side). Not a single forest-dwelling caribou was observed at this time (Stéphane Rivard, pers. comm., July 2010). Trail networks possibly belonging to the forest-dwelling caribou were observed 40 km from Camp Lagopede (Consortium Roche – SNC-Lavalin, 2010).

In the wildlife survey conducted in the Renard Project study area in March 2011, three groups of migratory caribou were observed (Roche, 2011). Experienced observers identified the caribou ecotype based on the individuals' morphology (forest-dwelling caribou are bigger than migratory caribou). Ecotype identification was confirmed through morphometric measurements of the largest female in one of the groups observed. The hoof length (58.5 cm) (D'Astous and Trimper, 2009) and significant signs of wear observed are characteristic of the migratory ecotype. Consequently, the presence of the forest-dwelling ecotype in the Renard Project study area could not be confirmed.

According to the survey data covering 7,621 km² centred on the Renard Project, the project's study area has low forest-dwelling caribou potential. However, given its protected status and since the Renard Project study area is an area that forest-dwelling caribou could potentially use, impact assessment and mitigation measures are recommended in the following sections to promote this ecotype's long-term presence in the area.

7.11.1.3 Airstrip Area

➢ *MIGRATORY CARIBOU*

Like the mine area, caribou densities in the airstrip area are low. In the winter wildlife survey, two groups of migratory caribou were observed 35 km to the northwest and 34 km south of the airstrip. Not a single individual was observed in the airstrip area.

The main forest stands found in the airstrip area are black spruce-lichen (58%) and jack pine-lichen (25%). Given that caribou generally use black spruce-lichen stands in the winter, it would be possible to find them in this area at this time of year. Despite the species' low abundance in the study area, the airstrip area's habitats have good winter feeding potential.

- *MOOSE*

According to the March 2011 wildlife survey, no moose were observed in the airstrip area. The area's habitat potential for moose is reportedly low, but equivalent to that of the mine area, considering that few deciduous or mixed stands are found in that area.

- *BLACK BEAR*

The bear population survey was challenging due to the constraints mentioned above. Evaluation of the species' relative abundance in the mine area was facilitated by the presence of observers during field campaigns and by Camp Lagopede staff. However, field teams and camp employees did not visit the airstrip area as intensively and it is not possible to evaluate the black bear's relative abundance in this area. However, given the size of bear home ranges (60 to 173 km² for males and 5 to 50 km² for females; Prescott and Richard, 1996), the individuals observed in the mine area may also use the airstrip area.

- *SPECIAL STATUS SPECIES*

Forest-dwelling caribou

Like for the mine area, forest-dwelling caribou densities in the airstrip area are most probably quite low. Despite a substantial survey effort, the Renard Project winter wildlife survey could not confirm the presence of the forest-dwelling ecotype in a vast area measuring 7,621 km².

7.11.2 Construction Phase Impacts

The main sources of impact on big game during the construction phase are linked to the following project components:

- Site preparation and development:
  The impacts related to these activities are essentially due to the habitat losses incurred through site preparation and development.
- Construction of mine facilities;
- Operation of quarry and borrow pits:
  Impacts are linked to disturbances caused to animals by drilling, blasting, backfilling/excavation, borrow pit operation and construction of mine facilities such as the ore processing plant, accommodation and services complex, power generating sets and airstrip.
- Use and maintenance of machinery and power generating sets; road circulation:
  The machinery used for clearing and other construction activities and the vehicles circulating on access roads may well increase the number of accidents involving big game.

7.11.2.1 Mine Area

- *SITE PREPARATION AND DEVELOPMENT*

Migratory caribou are present in the study area in winter only. Spruce-lichen stands are the species' preferred habitat during this season. Most of the Renard Project study area consists of this type of habitat, i.e. 64% (or 6,352 ha). During the construction phase, approximately 2% or 146 ha of the mine area's spruce-lichen stands will be cleared and prepared to make way for the different mine facilities (Table 7.11.2). However, data gathered on migratory caribou shows that, for several decades now, this ecotype's use of the study area is low. Therefore, if the migratory caribou's range and migration pattern remain unchanged, the project's impact in the construction phase will be low and, at most, affect only a few individuals which could adapt the way they use the area by avoiding the work area and moving into alternative habitats located on the outskirts.

Moose is a species with the potential for remaining in the Renard Project study area year-round. Although no moose were observed during the March 2011 survey, it is possible that one or more moose use the area during site preparation and development, and construction of infrastructure. For this species, a good quality habitat has a mosaic of microhabitats offering forest cover and food (Samson *et al.*, 2002). Its habitat must contain a protective cover of dense coniferous or mixed forests to reduce the energy expenditure linked to travelling in the snow and to avoid predation (Dussault *et al.*, 2005). While it may consume certain conifer species like the balsam fir, moose generally feeds on deciduous trees. In summer, it uses water bodies and marshes to keep cool and browse on aquatic plants (Samson *et al.*, 2002).

In terms of surface area, site preparation and development in the construction phase will destroy 191 ha of preferred moose habitats, or about 2% of the initial surface found in the study area (Table 7.11.2). No mixed stands will be affected by site preparation and development activities.

The black bear is an opportunistic species frequenting a great variety of habitats (Samson, 1996). The study area has good black bear potential. Clearing and other construction-related activities will result in the loss of 197 ha, or 2% of the habitats initially found in the study area (Table 7.11.2).

Large expanses of mature-to-old coniferous forests and peatlands constitute elements of prime importance for the forest-dwelling caribou (Courtois *et al.*, 2007; 2008; Environment Canada, 2008; Fortin *et al.*, 2008; Courbin *et al.*, 2009; Hins *et al.*, 2009; Bowman *et al.*, 2010). Although the forest-dwelling caribou's presence in the study area was not confirmed, its preferred habitats, expanses of mature coniferous forests and peatlands, are common in the study area, representing 76% and 1%, respectively, of the mine area (Table 7.11.2). In the construction phase, 149 ha of potential habitats will be affected by the project, i.e. 2% of the areas found in the mine area.

Table 7.11.2 Potential Habitat Losses in the Mine and Airstrip Areas for Big Game Species whose Presence was Confirmed in the Renard Project Study Area

Species	Relative abundance in study area	Preferred habitats	Mine area					Airstrip area		
			Current conditions	Surface area affected				Current conditions	Surface area affected	
				Construction phase	Operation phase	TOTAL			Construction phase (TOTAL)	
			(ha)	(ha)	(ha)	(ha)	%	(ha)	(ha)	(%)
Migratory caribou	Low	Black spruce-lichen stand and peatlands	6427	149	23	170	3	1679	26	2
Moose	Low	Coniferous, mixed or deciduous forest, marshes and lakes	9772	191	27	216	2	2518	67	3
Black bear	Moderate but high near Camp Lagopede	All habitats	8364	197	29	224	3	2196	81	4
Forest-dwelling Caribou[1]	Presence unconfirmed	Black spruce-lichen stand and peatlands	6427	149	23	170	3	1679	26	2

[1] Ecotype considered “threatened” in Canada under the *Species at Risk Act* (SARA) (S.C. 2002, c. 29) and “vulnerable” in Quebec under the *Act respecting threatened and vulnerable species* (R.S.Q., c. E-12.01).

- *CONSTRUCTION OF MINE FACILITIES*

Construction activities could potentially disturb individuals near the worksite, due to noise, road traffic and habitat destruction. The area where noise levels could be higher than naturally occurring background levels will extend over a maximum of 6 km around the facilities; in some cases, the area's topography could reduce the extent of this zone in certain directions. Some species' feeding, breeding and rearing behaviour could be disrupted if they frequent this area when the work is being performed. The few individuals likely to be affected by these disturbances will avoid the work area by moving to similar habitats located on the outskirts of the worksite.

This impact could potentially be greater in winter when animals have more difficulty travelling and the efforts required to move to peripheral habitats could make them more vulnerable to predation. In winter, the disturbances generated by construction activities could affect caribou by modifying their migration patterns (Curatolo and Murphy, 1986; Mahoney and Schaefer, 2002; Kendrick and Lyver, 2005). A study conducted in Newfoundland on the development of a gold mine (construction phase) showed that, in winter, the number of forest-dwelling caribou dropped significantly within a 4-km radius of the mine centre (Weir *et al.*, 2007). However, given the period in which construction work is foreseen (years -2, -1 and 1), it is unlikely that the forest-dwelling caribou population cycle and its migratory movements will change drastically, leading them to use the area in the short term. If certain individuals are disturbed by the work, they will move to similar habitats off the worksite, thereby making them possibly more vulnerable to predation and increase their energy expenditure.

For moose, the energy expenditure related to travel increases considerably when the snow is more than 60 to 90 cm deep (Samson *et al.*, 2002). The average snow depth in the study area did not exceed 50 cm from December to April 2011 (Roche, 2011).

Black bears, whose dens are located near the mine site, might be disturbed during their hibernation.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

Road circulation in the construction phase could potentially change the behaviour of migratory caribou that might periodically cross the study area. However, the probability of collisions between big game and vehicles is very low given the low caribou and moose densities, the road network's limited length (2.2 km), the low traffic flow anticipated in the operation phase and the low speed limit (30 km/h on the site and 70 km/h on secondary roads).

For caribou, it is known that roads that are not used much (<100 vehicles/day) generally cause few traffic accidents, do not create barriers for caribou and do not affect their migration patterns (Klein, 1971; Johnson and Todd, 1977; Johnson, 1985). Further, since most of the traffic will occur in the daytime and most collisions involving moose occur at night, in summer and fall (Joyce and Mahoney, 2001), these risks will be even lower.

For the black bear, it is considered that roads with low traffic flow (<100 vehicles/day) do not affect individuals' behaviour (Beringer *et al.*, 1990). Studies have even shown that bears use roadsides to feed and travel (Beringer *et al.*, 1990).

7.11.2.2 Airstrip Area

- *SITE PREPARATION AND DEVELOPMENT*

Although no individuals were observed during the winter survey, the airstrip area offers good potential for migratory and forest-dwelling caribou feeding grounds. In addition to the dry barrens that occupy 13% of the airstrip area, the sector's dominant forest stands are black spruce-lichen (58%) and jack pine (25%). For the airstrip's construction, 26 ha or only 2% of the black spruce-lichen stands will be affected. For moose, 67 ha or 3% of the sector's potential habitats will be lost in site preparation and development, while 81 ha or 4% of potential black bear habitats will be lost.

- *OPERATION OF QUARRY AND BORROW PITS*

Like the mine facility construction activities, borrow pit operation can potentially disturb any individual that is nearby, due to noise and road traffic. Some species' feeding, breeding and rearing behaviour may be disrupted if they frequent this area when the borrow pits are in operation. The few individuals likely to be affected by these disturbances will avoid the work area by moving to similar habitats further away.

- *AIRSTRIP OPERATION*

The disturbance caused by planes taking off and landing could temporarily affect certain individuals using the sector.

The sound level may increase by 50 to 60 dB for 1 to 10 minutes during take off and landing. Given the low flight frequency, these disturbances will be short and possibly comparable to, or lower than, the disturbances currently caused by floatplanes and helicopters, whose noise levels exceed those of a Dash 8.

The impact on caribou of the noise caused by planes will vary depending on the season, degree of habituation, as well as aircraft type, flight frequency, altitude and speed (Wolfe *et al.*, 2001). Low-altitude flights and helicopter flights will have the greatest impact (Maier *et al.*, 1998). The long-term effects of these behavioural reactions on population demographics are little known but they may increase energy expenditure by reducing feeding and resting time, while increasing time spent travelling and stress levels.

The impact on moose behaviour of the noise caused by aircrafts will vary depending on the season, degree of habituation, as well as aircraft type, flight frequency, altitude and speed and is likely to increase its stress levels (Andersen *et al.*, 1996; Støen *et al.*, 2010). The long-term effects of these

behavioural reactions on population demographics are little known but they may increase energy expenditure by reducing feeding and resting time, while increasing time spent travelling and stress levels.

Since the black bear has no known predators apart from man, it will react less than other prey species such as moose and caribou to repeated aircraft fly-overs (Støen *et al.*, 2010). Helicopter fly-overs may, nevertheless, disturb those individuals whose dens are located near the camp. However, the presence of forest cover will allow to protect themselves and the search for food should outrank noise-induced disturbance (Smith and Van Daele, 1989).

The forest-dwelling caribou tends to flee disturbance caused by aerial activity (Wolfe *et al.*, 2001). It would be affected particularly by low-altitude and helicopter flights (Maier *et al.*, 1998). Disturbance increases energy expenditure by reducing feeding and resting time, while increasing time spent travelling and stress levels.

7.11.2.3 Mitigation Measures

- Set up adapted fences to keep big game out of the camp, hazardous materials storage areas and the trench landfill site;
- Make workers aware that they must not feed the animals or leave food lying around that might attract black bears and cause them to approach accommodations. Should animals have to be killed, allow tallymen to hunt the unwanted bears;
- Implement a wildlife protection plan to reduce opportunities for poaching;
- Make workers aware of the effects of harvesting, poaching, accidental kills and disturbance of forest-dwelling caribou;
- If applicable, document forest-dwelling caribou movement on the property through opportunistic observations, aerial surveys or individuals fitted with GPS collars.

7.11.2.4 Residual Impact

In the construction phase, given the small areas of habitat affected, the low densities of caribou and moose encountered in the study area and the bear's capacity for adapting to the presence of humans, the residual impact's intensity is considered low. The impact extends on the scale of the Renard Project study area and, as such, is considered local. Its duration is deemed moderate since the infrastructure will be dismantled only upon site closure. The significance of the construction phase's residual impact on big game is considered moderate.

7.11.3 Operation Phase Impacts

The main project components likely to have an impact on big game in the operation phase are:

- Pit development:

  The project's impacts are linked to the additional habitat losses associated with the development and presence of open pits R-2/R-3 and R-65;
- Ore mining, handling and storage;
- Use and maintenance of machinery and power generating sets; road circulation;
- Airstrip operation:

Animals' daily or seasonal activities may well be disturbed by operations, traffic and the noise generated by flight activity.

Vehicle circulation on site is liable to increase the number of accidents involving big game;

- Solid waste storage and management system and trench landfill site:

  The trench landfill site is likely to attract bear, fox and wolves to the site;
- Presence of facilities:

  Opening up the area is likely to increase hunting and trapping pressure on big game. Workers feeding animals and food smells that could attract bears near camps, which might result in removing or killing unwanted animals;
- Progressive site rehabilitation:

  Progressive site rehabilitation will continue to restore certain habitats that were lost during site preparation and development.

7.11.3.1 Mine Area

➢ *PIT DEVELOPMENT*

For migratory and forest-dwelling caribou, potential additional habitat losses in the operation phase are linked to development of the open pits that will cover 27 ha of forest stands, including 23 ha of spruce-lichen stands. This represents a mere 0.4% of the initial area covered by spruce-lichen stands in the study area. However, tallymen's observations indicate that the caribou's use of the study area has been low for several decades. Consequently, if the migratory caribou's range and migration patterns remain relatively unchanged, the project's impact in the operation phase is likely to remain low, at most affecting the few individuals that might adapt the way they use the area by avoiding the mine site and moving to similar habitats located on its outskirts.

Operation-related activities may destroy an additional 27 ha of potential habitats for the moose and 29 ha for the black bear in addition to those lost during the construction phase. These areas represent only 0.3% of the pre-project potential habitats located in the study area.

➢ *ORE MINING, HANDLING AND STORAGE*

In addition to generating additional habitat losses, the various operation phase activities will disturb all individuals whose home range overlaps the project's footprint or are located in the vicinity, due, notably, to noise and increased levels of activity. The area where residual noise generated by the mine will be higher than the naturally occurring background levels will affect a maximum of 6 km around the facilities, though the area's topography could reduce the size of this noise zone in certain directions.

Various studies show that migratory caribou are sensitive to disturbance and tend to avoid industrial sites, roads and buildings by leaving a radius of about 4 km around facilities (Cameron, 2005; Weir *et al.*, 2007; Vistnes and Nelleman, 2008). Studies conducted at the Ekati Mine in the Northwest Territories reportedly showed a larger avoidance perimeter in the order of 11 to 14 km, but the distances observed are larger due to the lack of forest cover in the region (Boulanger, 2009). Traditional Native knowledge gathered in the context of the Renard Project (Lussier, 2010) and elsewhere (Kendrick and Lyver, 2005)

suggest that industrial development such as mining, especially the access roads, affects caribou migration patterns. The Renard Project could, therefore, create a caribou avoidance zone several kilometres around the facilities.

As knowledge related to caribou in the Renard Project area and the March 2011 winter wildlife survey shows, migratory caribou seem to have abandoned the area somewhat possibly due to a significant decline in herd size that resulted in moving its wintering ground further north, closer to the herds' calving grounds (Jean and Lamontagne, 2004; Brodeur, 2010).

Mine activities raise concerns related to moose among the traditional land users (Lussier, 2010). Tallyman Sydney Swallow explained that moose used to frequent the Camp Lagopede area but stopped when exploration work began (Lussier, 2010). According to him, the noise and other disturbances pushed the moose northward. The species used to feed in regenerating areas but, according to the tallyman, when mining exploration activities began, the moose moved to areas with mature forests, "probably to hide" (Lussier, 2010). Cree hunters also note a loss in body mass in the moose hunted and feel that this is due to the constant noise and the fact that the moose is "always on the lookout for something; helicopters, airplanes, landings" in the areas it frequents (Lussier, 2010). Generally speaking, moose are less sensitive to disturbance than caribou (Klein, 1973; Andersen *et al.*, 1996). However, moose flee on hearing sounds resembling those produced by people hunting (Andersen *et al.*, 1996). For example, in the area, moose is hunted using snowmobiles and may be sensitive to noise generated by machinery. The noise's impact will be limited mainly to an area not exceeding 6 km around the facilities. This impact will be greater in winter, when travel requires more energy and when the animals are in poorer physical condition (Andersen *et al.*, 1996).

Few studies show the impact of mining developments on the black bear. Moreover, it is difficult to say whether the project's impact will be positive (site's attractive quality) or negative (habitat loss, disturbance, presence of roads and increased hunting pressure) on local black bear populations. However, given the species' facility in adapting to human presence, the black bear's abundance is more likely to increase around the mine site.

The forest-dwelling caribou is highly sensitive to human disturbance. It avoids roads and areas used by man (Dumont, 1993; Dyer *et al.*, 2001, 2002; Mahoney and Schaefer, 2002; Faille *et al.*, 2010; Basille *et al.*, 2011). Based on the information gathered on this ecotype, the Renard Project study area has low forest-dwelling caribou potential and, in the short term, this species is not very likely to be affected by the project. However, should it be sighted, it would be important to document its presence and note the mine's impact on local populations in order to measure the size of the species' avoidance area, if applicable.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The presence of roads and traffic on the mine site are unlikely to cause collisions with big game, given the road network's limited length (2.2 km) and low speed limit (30 km/h on the site and 70 km/h on secondary roads). Moreover, the risk of collision with moose and caribou is unlikely, given the low densities observed in the study area.

For caribou, it is known that roads that are not used much (<100 vehicles/day) generally cause few traffic accidents, do not create barriers for caribou and do not affect their migration patterns (Klein, 1971; Johnson and Todd, 1977; Johnson, 1985).

Roads with low traffic flow (<100 vehicles/day) are not likely to affect the behaviour of black bear, which are even likely to use them to feed and travel (Beringer *et al.*, 1990).

Winter road maintenance will consist solely of spreading sand and gravel on the road's snow-covered surface. Deicing salt will be used only under exceptional circumstances. Thus, moose will not be attracted by the salt pools created when deicing salt is used (Laurian *et al.*, 2008; Grosman *et al.*, 2009).

- *PRESENCE OF FACILITIES*

It is possible that workers might feed animals, food might not be stored properly and food smells around the camp and worksites might attract some individuals, thereby potentially threatening work safety and requiring the unwanted animals to be taken away or killed. Cases of black bears being attracted to Camp Lagopede have been reported since exploration work began. However, installing an electric fence has apparently solved part of the problem. This impact could affect a significant number of individuals if nothing is done to prevent these problems.

The mine's presence will increase the area's frequentation and hunting pressure on migratory caribou and moose. Hunting will be prohibited for Renard Project workers but this access will create a new way for poachers to get in. Cree participation in traditional trapping activities will increase in the area. Greater accessibility will heighten the probability of a local decline in moose populations. Harvesting by humans, often promoted by land development, seems to play a leading role in the decline of forest-dwelling caribou populations (Quebec Forest-Dwelling Caribou Recovery Team, 2008). These concerns are shared by tallymen and other local stakeholders, who also expect moose to be overharvested given its low densities and enhanced poaching opportunities (Lussier, 2010). Implementation of a safety perimeter will attenuate part of this impact around the mine site.

The presence of roads and the camp are also likely to increase the number of predators around the camp (James, 1999; James and Stuart-Smith, 2000; James *et al.*, 2004). In fact, wolves tend to use roads as travel corridors and, according to the winter 2011 micromammal surveys, are attracted by the presence of Camp Lagopede. As a result, predation pressure on caribou and moose could rise.

➢ *PROGRESSIVE SITE REHABILITATION*

Progressive site rehabilitation will help restore a small proportion of the habitats lost during site preparation and development. During the operation phase, temporary storage areas for construction material, the temporary camp and 8 ha of the processed kimberlite confinement area (i.e. 10% of the area affected by this element) will be covered by a layer of overburden before being seeded and planted with black spruce.

7.11.3.2 Airstrip Area

➢ *SOLID WASTE STORAGE AND MANAGEMENT SYSTEM AND TRENCH LANDFILL SITE*

Generally, with the exception of individuals who have learned to associate food with humans, bears avoid approaching man. However, if it is not managed properly, the trench landfill site could attract certain individuals, thereby potentially threatening worker safety and requiring unwanted animals to be taken away or killed. Regularly backfilling the trench landfill site and installing an electric fence around the site could solve the problem.

➢ *AIRSTRIP OPERATION*

No additional habitat losses will occur in the airstrip area during the operation phase. The disturbance caused by planes taking off and landing could temporarily affect certain individuals using the area.

The sound level may increase by 50 to 60 dB for 1 to 10 minutes during take off and landing. Given the low flight frequency, these disturbances will be short and possibly comparable to, or lower than, the disturbances currently caused by floatplanes and helicopters, whose noise levels exceed those of a Dash 8.

7.11.3.3 Mitigation Measures

➢ *PRESENCE OF FACILITIES*

- Install an electric fence around the camp;
- Make workers aware that they must not feed the animals or leave food lying around so as not to attract black bears to the camp;
- Should animals have to be killed, allow tallymen to hunt the unwanted bears;
- Implement a wildlife protection plan to reduce opportunities for poaching;
- If applicable, document the movements of forest-dwelling caribou on the property;
- Continue to make workers aware of the effects of harvesting, poaching, accidental kills and disturbance of forest-dwelling caribou.

➢ *SOLID WASTE STORAGE AND MANAGEMENT SYSTEM AND TRENCH LANDFILL SITE*

- Dispose of solid waste in sites or containers so that odours do not attract wildlife;
- Regularly backfill landfilled solid waste;
- Install an electric fence around the trench landfill site.

➢ *PROGRESSIVE SITE REHABILITATION*

- Close and rehabilitate access roads and temporary facilities used during the construction phase;
- For progressive rehabilitation of construction sites, apply appropriate silvicultural practices (maintain habitat's coniferous characteristics) to promote return of forest-dwelling caribou habitat.

7.11.3.4 Residual Impact

The Renard Project study area is not frequently used by migratory or forest-dwelling caribou. Moreover, the sector's moose densities are currently low. However, given the species' social importance and recent population declines, the intensity of the project's impact on big game in the operation phase can be considered moderate.

The impact's spatial extent is considered local because it is restricted to the Renard Project study area while the duration is deemed moderate since the infrastructure will be removed only in the site closure phase.

The residual significance of the project's operation phase impact is, thus, considered moderate for big game.

7.11.4 Closure Phase Impacts

7.11.4.1 Impact Description

The main sources of impact on big game in the closure phase are related to the following project components:

- Final site rehabilitation and revegetation:
  Site rehabilitation will help restore most habitats lost during site preparation and development;
- Use and maintenance of machinery and power generating sets; road circulation:
  Road traffic and noise made during mine closure or aerial activity are likely to affect the individuals present on the site and disturb their daily activities. However, given the smaller vehicle fleet required in the closure phase, the impact of this disruption and the probability of collisions with big game are relatively limited;
- Presence of remnants of the site:
  The trench landfill site is likely to attract animals for a certain time due to the food smells associated with it. However, this impact will be short-term until the organic matter decomposes.

➢ *FINAL SITE REHABILITATION AND REVEGETATION*

For big game species, the main sources of impact in the closure phase are the renaturalization of large areas of the mine site and disturbances caused by site rehabilitation activities and vehicle traffic. Site rehabilitation will foster the site's progressive renaturalization and increase the size of habitats available. The site's recolonization by vegetation will take about 30 years. To protect the soil from erosion, hydroseeding of grass species will be followed by planting of indigenous tree and shrub species. This initial vegetation will keep the soil in place and promote the retention of seeds from neighbouring plant

species. The environment's gradual recolonization by vegetation will provide a habitat structure and food for the wildlife using the area.

- *USE AND MAINTENANCE OF MACHINERY AND POWER GENERATING SETS; ROAD CIRCULATION*

The disturbance caused by rehabilitation activities will cause impacts on big game similar to those observed in the operation phase. However, given the smaller vehicle fleet required in the closure phase, the impact of this nuisance and the probability of collisions with big game are relatively limited.

The work's completion will be associated with a permanent decrease in noise and traffic, which will be favourable to species that could recolonize the area.

- *PRESENCE OF REMNANTS ON THE SITE*

The trench landfill site is likely to attract animals for a certain time due to the food smells associated with it. However, this impact will be short-term until the organic matter decomposes.

7.11.4.2 Mitigation Measures

Apply appropriate silvicultural practices (maintain habitat's coniferous characteristics) to promote the return of forest-dwelling caribou habitat.

7.11.4.3 Residual Impact

In the closure phase, the Renard Project's residual impact on big game can be considered positive due to natural revegetation of 110 ha and active rehabilitation of 121 ha of wildlife habitats. Overall, the intensity of this impact can be considered moderate, given the habitat areas restored during this phase and the gradual and permanent decrease in the site's use by humans.

The spatial extent of the impact is restricted to the Renard Project study area and can thus be considered local while the duration is deemed long.

Generally speaking, the significance of the Renard Project's positive impact during the closure phase is considered high.

7.12 Summary of the Environmental Assessment on the Biological Environment

Figure 7.12.1 summarizes the assessment of the Renard Project's impacts on the components of the biological environment after implementation of environmental design and mitigation measures.

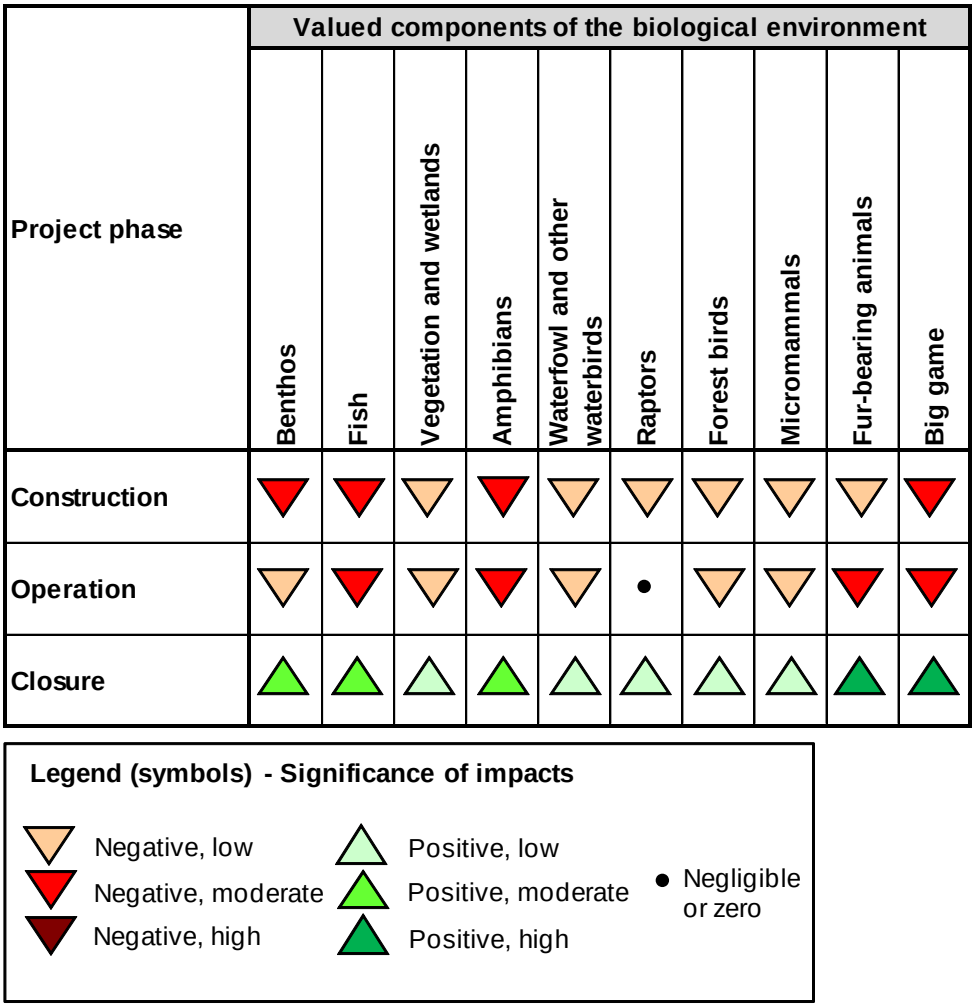


Figure 7.12.1 Summary of Residual Impacts on the Biological Environment by Project Phase

7.12.1 Construction Phase

During the construction phase, the project components constituting the main sources of residual impacts will be site preparation and development, dewatering of lakes (F3302 and F3303) and water management of the worksite.

The most striking residual impacts are linked to terrestrial and aquatic habitat losses inevitably caused by site preparation and development (clearing, stripping, backfilling, excavation, etc.), dewatering of lakes F3302 and F3303 and a few streams[16], and diversion of stream F3298V to lake F3295. Clearing will cause the loss of forest stands (254 ha or 2.5% of their initial extent), dry barrens (18 ha or 16% of their initial extent) and wetlands (4.8 ha or 1.8% of their initial extent). Since none of the forest environments or wetlands affected is rare or unique in the region and since the areas affected are small,

[16] The outlets of lakes F3302 and F3303 and streams F2607M and F3301V, which flow partly underground and partly on the surface.

the Renard Project's negative impact in the construction phase is considered low on vegetation and wetlands. Furthermore, these environments constitute habitats for forest birds, raptors, amphibians, micromammals, fur-bearing animals and big game.

The two small lakes to be dewatered total 3.75 ha of lacustrine environments and constitute only 0.17% of the total initial area covered by lakes in the study area. Despite their small surface extent, these water bodies represent benthos, fish, amphibian and waterfowl habitats. Where streams are concerned, approximately 2.3 km will be lost (equivalent of 4,625 m² of fish habitat), i.e. 3% of their initial total length in the study area. Since a significant portion of the streams affected flow underground, only a small percentage constitute suitable habitat for aquatic life, namely benthos, amphibian and fish. It is noteworthy that the bed of the new stream created by the diversion of stream F3298V will be developed over 930 m in order to create a fish habitat appropriate for benthos, fish and amphibians, which will attenuate a portion of the lotic habitat losses.

Water management on the site will ensure that the residual impacts foreseen on water quality, and therefore fish and benthos, will be low. All waters in contact with worksites will be collected through a system of collecting ditches, directed towards a sedimentation pond, treated and monitored prior to being released into Lake Lagopede. The impacts on water quality will be felt essentially within the plumes of treated domestic and mine wastewater effluents in Lake Lagopede. Plume modeling results for the treated domestic effluent (Appendix 3.10.1) indicate that the treated effluent's initial concentration will reach a dilution factor of 1:100 at a distance of 52 to 130 m from the discharge point depending on whether the flow rate is the estimated mean flow or peak flow. At the plume's edges, contaminant concentrations will be of the same range as the concentrations currently measured in the receiving environment. Based on the results of the limit dilution calculation and model CE-QUAL-W2, the domestic effluent will not significantly influence the lake's water quality. Its influence will be limited to the area adjacent to the discharge point. Within these plumes, there will likely be an impact on benthic communities and fish. For example, the additional nutrient and organic matter loads entering through the treated domestic effluent could locally increase the environment's productivity and bacterial activity, resulting in a temporary decrease in dissolved oxygen levels in and around the discharge point. The main impact on fish associated with effluent discharge is the avoidance effect. Some so-called specialized species, like lake trout, are liable to avoid the initial effluent mixing zone.

Treated mine effluent plume modeling results (Appendix 3.10.1) show that under severe low water conditions, the initial treated effluent concentration dilution will reach a dilution of 1:10 at a distance of 750 m from the discharge point (Figure 3.10.7) and 300 m during fall water mixing (see Section 3.10.5.2 and Figure 3.10.7). In the northern basin, at the plume's edge, the various contaminant concentrations will be within the range of concentrations measured in the baseline conditions (Roche, 2011), with the exception of total phosphorus, whose concentration at the plume's edge may be slightly higher (0.01 mg P/L) than in the lake (95th percentile = 0.007 mg P/L). The domestic and mine effluent plumes will not

overlap (Environnement Illimité, 2011). The phosphorus supplied by the mine effluent could, in Lake Lagopede's northern basin, result in a temporary, local increase (around August) in the concentration of total phosphorus, corresponding to an oligo-mesotrophic lake (typically 0,007-0,013 mg/L of total phosphorus; MDDEP, 2007). Depending on the proportion of this total phosphorus that will be bioavailable in the form of orthophosphates, these inputs might cause a temporary and site specific increase of the productivity and fisheries potential in this part of Lake Lagopede. Since the hydraulic residence time in Lake Lagopede is 53 days and the temperature generally drops in September, this effect will be short term and possibly limited to the month of August. To validate the impact assessment, a water quality monitoring program for Lake Lagopede and the effluents is planned (see Chapter 11).

The implementation of prevention and mitigation measures for other project components, such as use and maintenance of machinery and power generating sets, operation of borrow pits, construction of mine facilities, and fuel and hazardous material storage and management will allow preventing impacts, minimizing the probability of accidental leaks or spills and confining their impacts should they occur.

Vehicle and machinery traffic on the site constitutes a potential, albeit small, risk of wildlife mortality, either through collisions or crushing for amphibians, micromammals, fur-bearing animals and, to a lesser extent, big game.

Possible sources of contamination by fuels or hazardous materials are related to the use and maintenance of machinery and power generating sets, as well as fuel and hazardous material storage areas. The probability of accidental leaks or spills occurring and causing an impact on the flora and fauna are low, given the environmental design and mitigation measures implemented. Benthos, fish and amphibians are the components that are most sensitive to these contaminants. Implementing a fuel and hazardous material management plan will minimize the risk of leaks or spills of fuels or other hazardous products. Monitoring and surveillance programs will allow them to be detected rapidly and the emergency response plan will make it possible to limit their scope and repercussions, should such accidents occur.

Finally, most construction activities will generate disturbances such as noise and site specific dust emissions during site preparation and development, operation of borrow pits, use of machinery, and construction of mine facilities. The sound levels anticipated may be higher than naturally occurring background levels within a 6-km radius of the facilities and could affect the daily activities of wildlife (amphibians, forest birds, waterfowl, micromammals, fur-bearing animals and big game).

Overall, the construction phase's residual impact on the biological environment will be negative, ranging from low to moderate depending on the valued component considered (Figure 7.12.1): low for vegetation and wetlands, waterfowl and other waterbirds, raptors, forest birds, micromammals and fur-bearing animals; moderate for benthos, fish, amphibians and big game. It is important to note that amphibians are a low-mobility group with permeable skin that require terrestrial and aquatic environments to complete their life cycle. This makes them more vulnerable to environmental changes

than other wildlife groups, which can move more easily to unaffected peripheral habitats. The species identified and their habitats on the site are, however, all common in the region and no special status species of amphibian was observed.

7.12.2 Operation Phase

During the operation phase, additional but limited losses of forest environments and wetlands will be caused by pit development. Further clearing and stripping will be modest compared to the construction phase. It will affect only 27 ha of forest stands and 1.2 ha of wetlands, generating equivalent habitat losses for forest birds, amphibians, micromammals, fur-bearing animals and big game. However, progressive site rehabilitation (processed kimberlite confinement area berms), which will begin in this phase, will offset some of these habitat losses by hydroseeding grasses and planting spruce in the disturbed areas no longer to be used.

Like the construction phase, the water management plan implemented will limit the project's impacts on water quality by collecting all waters that come into contact with the mine site (mine waters, runoffs, water from the waste rock stockpile and the processed kimberlite confinement area, etc.) through a system of collecting ditches and directing them to a sedimentation pond. The effluents treated in the domestic and mine wastewater treatment plants will be monitored to minimize their impacts on the water quality of Lake Lagopede, and, consequently, on the quality of fish and benthic habitat. In the operation phase, domestic effluent flows are lower than those foreseen in the construction phase. Thus, initial dilution limits and 1:100 dilution will be closer to the discharge point. The 1:100 dilution limit will be reached approximately 38 m downstream of the discharge point at mean flow and 83 m at peak flow (Figure 3.10.5). The plume will not rise to the surface in the 1:100 dilution zone but remain in the water column at a depth of about 4 to 6 m.

Treated mine effluent plume modeling results (Appendix 3.10.1) show that under severe low flow conditions, the initial treated effluent concentration will reach a dilution factor of 1:10 at a distance of 750 m from the discharge point (Figure 3.10.7) and 300 m during fall water mixing (see Section 3.10.5.2 and Figure 3.10.8). In the northern basin, at the plume's edge, the various contaminant concentrations will be within the range of concentrations measured in the baseline conditions (Roche, 2011), with the exception of total phosphorus, whose concentration at the plume's edge may be slightly higher (0.01 mg P/L) than in the lake (95th percentile = 0.007 mg P/L). The domestic and mine treated effluent plumes will not overlap (Environnement Illimité, 2011). The phosphorus loads from the mine effluent could, in Lake Lagopede's northern basin, result in a temporary, local increase (around August) in the concentration of total phosphorus, corresponding to an oligo-mesotrophic lake (typically 0,007-0,013 g/L of total phosphorus; MDDEP, 2007). Depending on the proportion of this total phosphorus that will be bioavailable in the form of orthophosphates, these inputs might cause a temporary and site specific increase in the productivity and fisheries potential of this part of Lake Lagopede. Since the hydraulic residence time in Lake Lagopede is 53 days and the temperature generally drops in September, this

effect will be short term, possibly limited to the month of August. To validate the impact assessment, a water quality monitoring program for Lake Lagopede and the effluents is planned (see Chapter 11).

Other components, such as the use and maintenance of machinery, ore mining, handling and storage, airstrip operation and fuel and hazardous material storage and management will have less significant, but nevertheless potential, impacts on the biological environment.

Vehicle and machinery traffic on the site constitutes a potential, albeit small, risk of wildlife mortality, either through collisions or crushing for amphibians, micromammals, fur-bearing animals and, to a lesser extent, big game. The speed limits enforced on the site will make it possible to limit this impact. Road circulation and most other activities linked to mine (site preparation and development, ore mining, handling and storage and power generating sets) and airstrip operation will be sources of noise and dust that could potentially affect the daily activities of the wildlife species in the immediate vicinity of the mine site. The sound levels anticipated may be higher than naturally occurring background levels within a radius of less than 6 km from the facilities and could affect daily activities of wildlife.

The fuel and hazardous material management plan will minimize the risk of accidental leaks and spills (fuel or other hazardous products) that could be linked to the use and maintenance of machinery, mine operation, airstrip operation, presence of power generating sets and fuel and hazardous material storage areas. Should such accidents occur, the environmental management plan (monitoring and surveillance) and the emergency response plan will allow them to be detected rapidly and their extent and repercussions to be minimized. Contamination of the aquatic environment and the organisms inhabiting it (benthos, fish and amphibians) is, therefore, unlikely.

In short, the operation phase's residual impact on the biological environment will be negative. It will be negligible for raptors; low for benthos, vegetation, wetlands, waterfowl and other waterbirds, forest birds and micromammals; and moderate for fish, amphibians, fur-bearing animals and big game (Figure 7.12.1).

7.12.3 Closure Phase

The project's impacts in the closure phase are related primarily to final site rehabilitation and revegetation, as well as water management. Although the activities linked to final site rehabilitation and revegetation may generate disturbances (noise, dust, wildlife disturbance, etc.), their extent will be smaller than in the operation phase. The residual impact for this phase is positive, varying from low to high depending on the environmental component considered (Figure 7.12.1).

Final site rehabilitation and revegetation will allow the topography, ground cover and vegetation to be stabilized and restored to recreate suitable habitats for all valued environmental components. Industrial buildings will give way to grass meadows obtained by hydroseeding and dotted with young spruce planted at a density of 2,000 plants per hectare. This new habitat bordering Lake Lagopede could initially attract Canada goose, some forest birds and raptors, micromammals, fur-bearing animals, and

possibly amphibians in wet lowland areas. Forest habitats could gradually regenerate over 230 ha of the 307 ha of terrestrial environments affected in the project's construction and operation phases. Species that may have been attracted by the mine facilities in the operation phase (fox, wolf, bear, crow, tree swallow, etc.) may disperse throughout the area. The processed kimberlite confinement area and overburden stockpile will gradually resemble barren hills and eventually be covered by vegetation. Progressively, natural revegetation will occur on the 110 ha where vegetation was only cut and the soil kept intact. The remaining 121 ha, where the ground was stripped in the construction phase, will be covered with overburden (0.5 m) and topsoil (0.30 to 0.50 m) and hydroseeded before young black spruce are planted. Initially, the structure of the new plant communities will be comprised primarily of an herbaceous layer and a shrub layer with a sparse spruce cover. Over the years, the neighbouring vegetation will promote recolonization of the area by plants and wildlife, and trees will slowly grow. Following revegetation, migrating waterfowl (mainly Canada goose), forest birds, micromammals and fur-bearing animals are likely to use and feed on the hydroseeded grasses. The resulting new terrestrial habitats will gradually be recolonized by amphibians, forest birds and different groups of mammals.

Alongside these terrestrial habitats, aquatic habitats will be created after mining operations cease by flooding of pits R-2/R-3 and R-65, which will become deep lakes spanning a total of 28.6 ha that are especially conducive to salmonids and coregonids. These lakes will be connected to the hydrographical network, enabling fish to colonize them. The two new lakes created by flooding the open pits represent more than 222,000 m² of fish habitat. These lakes will be suitable for species valued by the Crees, i.e. lake trout, lake whitefish and burbot. Amphibians and waterfowl will also be able to settle here, preferring the shallower floodplains where vegetation will grow. Finally, these lakes will constitute interesting migratory stopovers for waterfowl, although they will be too big and deep to be used for breeding. These changes may increase the productivity of the Lake Lagopede area and its hunting and fisheries potential. Once the treated domestic wastewaters and treated mine effluent are no longer discharged into Lake Lagopede, water quality will gradually return to its baseline conditions; the same properties as those found prior to the Renard Project's implementation.

Chapter 8

Baseline Conditions and Impact of the Project on the Human Environment

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[1] The information in this section comes from the following work : *Gaudreau, Richard, Méthode d'analyse visuelle pour l'intégration des infrastructures de transport Ministère des Transports du Québec, Service de l'environnement, 1986.*

8 Baseline Conditions and Impact of the Project on the Human Environment

8.1 Regional Context

8.1.1 Overview of land use

The Nord-du-Québec region is subdivided into two sectors, with Nunavik to the North and *Jamésie*, also called the "James Bay territory" to the south. The Nord-du-Québec region covers 55 % of Quebec's surface area, which makes it the largest region of the province. The James Bay territory, which is where the Renard Project is located, has a surface area of 350,000 km². The region is inhabited by both the Crees and Jamesians. The Crees name the territory they inhabit, "Eeyou Istchee" (Land of the People).

All of the James Bay territory (Map 8.1.1) is relatively well served by a road network. One can reach this area by going through the Saguenay-Lac-St-Jean region with Route 167, or by going through Abitibi-Témiscamingue, via Route 109 or 113. The Renard Project site, however, does not have permanent road access. There is a winter road about 140 km long that extends Route 167 and joins up with the Matoush (Strateco) uranium project, as well as the old Eastmain mine camp. At the moment, most of the mining properties that are being explored in this sector are thus only accessible by air. In the winter of 2012, the *Ministère des Transports du Québec* plans on extending Route 167 as far as the Renard Project site. The region also has a railway network that is used primarily for carrying goods. This network connects southern Quebec through two railway lines with Chibougamau to the east and Matagami to the west. These lines intersect at Hervey Junction in Mauricie and from there they connect to the cities of Montreal or Quebec. A provincial airport is located in Chibougamau. In terms of maritime connections, Route 167 reaches port facilities located on the Saguenay River, about 300 km southeast of Chibougamau.

The land use and economy of the region is based on the exploitation of water (for electricity), forest, and mineral resources. The hydroelectric network is composed of the eight hydroelectric power plants belonging to the La Grande complex, located approximately 150 km north of the Renard Project, as well as all the Eastmain-1, Eastmain-1-A, and Sarcelle power plants located about 300 km to the west. Logging in the region is concentrated south of the northern limit of commercial forest, which is located about 150 km south of the Renard Project. In regard to mining, three mines are currently active in the James Bay territory, two of which are gold mines (Casa Berardi and Géant Dormant), while the third (Persévérance) is a zinc and copper mine. Three other mining projects are under development south of the Renard Project, and could begin operating in the short to medium term: the Matoush uranium project developed by Strateco Resources Inc., the Lake MacLeod Molybdenum-Copper project by Western Troy Capital Resources Inc., and the iron, titanium, and vanadium BlackRock mining project by BlackRock Metals Inc., near Chibougamau.

There is currently no commercial exploitation of wildlife (outfitters) in the surrounding areas of the Renard Project site. The closest outfitters to the site are mostly situated along the Trans-Taiga road, 100 km north of the project, or around Lake Mistassini, which is 150 km south. However, within roughly a 100-km radius of the site, three areas with various conservation statuses can be found: to the south-southwest, the *Réserve faunique des lacs Albanel-Mistassini-et-Waconichi*; to the southeast, the Albanel-Témiscamie-Otish National Park Project; and to the northeast, the Hirondelle Proposed Biodiversity Reserve. The Renard Project does not affect any of these areas.

8.1.2 Territorial organization

The boundaries of the James Bay territory are essentially the same as those of the Municipality of Baie-James (MBJ), which is a vast regional administrative entity that is separate from regional county municipality (RCM). The MBJ was created in 1971 by the *James Bay Region Development Act.* This statute was replaced in 2001 by the *James Bay Region Development and Municipal Organization Act* (RSQ, c D-8.2)[2]. Under this law, the MBJ may, at the discretion of the Quebec government, declare its jurisdiction over the territory in respect to one or more elements within an RCM. Besides the MBJ, the James Bay territory includes the inland towns of Chibougamau, Chapais, Lebel-sur-Quévillon and Matagami. These towns have the same judicial powers as any other town in Quebec, as defined by the *Cities and Towns Act.* It is mainly the communities of Chibougamau and Chapais that are involved in this project.

In addition to this territorial organization, there is a territorial management and land regime that is specific to the Crees, which was defined in 1975 in the *James Bay and Northern Quebec Agreement* (JBNQA). The JBNQA applies to a vast territory, in which these nine villages are found: Whapmagoostui, Chisasibi, Wemindji, Eastmain and Waskaganish on the coast, as well as Nemaska, Waswanipi, Oujé-Bougoumou and Mistissini, which are inland. Mistissini is the Cree community directly affected by the Renard Project.

The land regime established in the JBNQA subdivides the territory into three land categories, which are defined by the various levels of exclusive rights to hunting, fishing and trapping granted to the Crees. These lands are known as Category I, Category II, or Category III lands. The Renard Project is located in Category III land, which is an area where the Crees have exclusive trapping rights, while other users also have certain rights for recreational hunting and fishing.

[2] This new law comes from the Bill n°40: An Act to amend the James Bay Region Development Act and other legislative provisions.

80° 200 000 mE 78° 400 000 mE 76° 74° 600 000 mE 72° 800 000 mE 70°

6 000 000 mN
5 800 000 mN
52°
5 600 000 mN
50°
5 400 000 mN
48°

Chisasibi
LG-1
Robert-Bourassa
Radisson
LG-2-A
Réservoir Robert-Bourassa
LG-3
Réservoir La Grande 3
LG-4
Route Transtaïga
Réservoir La Grande 4
LaForge-1
LaForge-2
Réservoir Laforge 1
Réservoir Laforge 2
Brisay
Réservoir Caniapiscau
Wemindji
Eastmain
Baie James
Eastmain-1
Réservoir de l'Eastmain 1
Waskaganish
Nemaska
Route de la Baie-James
Route du Nord
Mistissini
Lac Mistassini
Lac Albanel
Oujé-Bougoumou
Chapais
Chibougamau
Waswanipi
Matagami
Persévérance
Casa Berardi
Géant dormant
Lebel-sur-Quévillon
Amos
Lac Saint-Jean
Saguenay

Projet Renard / Renard project

Réserve de biodiversité projetée Hirondelle
Parc national projeté Albanel-Témiscamie-Otish
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Réserve faunique Assinica

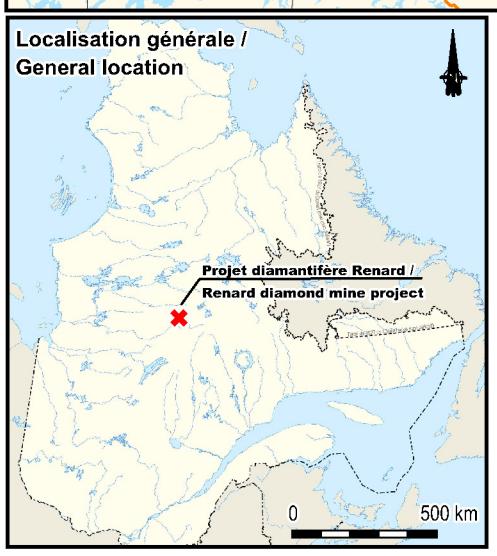
ELEONORE / Goldcorp inc.
JAMES BAY LITHIUM, Lithium One
PIVERT-ROSE, Critical Elements
WHABOUCHI, Exploration Nemaska
LAC MACLEOD / Western Troy Capital Resources Inc.
MATOUSH / Ressources Strateco
TROILUS
BRACEMAC-MCLEOD, Xstrata
VEZZA (N.A. Palladium)
LAC BACHELOR, Métanor
BLACKROCK / Blackrock Metals inc.
LANGLOIS, Nyrstar Canada

10526-07 10511-04 10610-A 10536-03 10620-01 10536-01 10611-01 10616-01 10537-02 10536-02 10609-01 10537-01 10605-01 10526-06 10612-01 10526-02 10526-03 10526-05 10580-04 10580-03 10580-02 10580-01 10525-01 10619-01 10554-08 10554-09 10554-05 10554-06 10554-03 10554-04 10554-10 10554-11 10554-07 10554-02 10554-01 10552-02 10552-01 10621-01 10549-01 10555-01 10623-01 10565-01 10553-01 10557-01 10563-01 10556-01 10563-02 10564-01

172 171 170 165 168 169 167 164 166 163 162 161 107 108 138 109 122 118 120 119 113 114 115 110 116 152 153 155 139 154 135 140 147 146 149 150 141 133 134 144 145 137 143 131 130 132 128 126 127 125 136 123 124

0 50 100 km
Échelle / Scale : 1 : 2 750 000
UTM, zone 18 (NAD 83)

Localisation générale / General location



- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Pourvoirie sans droit exclusif / outfitter without exclusive rights
- Aéroport / Airport
- Hydrobase / Hydrobase
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec electric power line
- Réseau routier principal / Main road network
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Mine active / Operating mine
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Projet minier en stade de développement avancé / Mining project in advanced stage of development
- Ancienne mine / Old mine
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Limites de l'aire d'étude / Study area limits
- Propriété Foxtrot / Foxtrot property

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social / Environmental and Social Impact Assessment

Occupation générale du territoire de la Baie-James / Overview of land use in the James Bay territory

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_TerritoireBJ_111221.WOR
Source : - Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010
Pourvoiries / Outfitter, MRNF, 2010
Décembre 2011 / December 2011

Carte / Map 8.1.1

The JBNQA also contributed to the progressive implementation of political and administrative Cree institutions, the two most important ones being The Grand Council of the Crees of Quebec (Eeyou Istchee) (GCC(EI)) and the Cree Regional Authority (CRA).

The provisions of the JBNQA were specified and reinforced in 2002 with the signature of the *Agreement Concerning a New Relationship Between le Gouvernement du Québec and the Crees of Québec,* also known as the *Paix des Braves,* and the signature of the *Agreement Concerning a New Relationship Between the Government of Canada and the Cree of Eeyou Istchee* in 2008. Among other things, the latter agreement plans a process whereby the Government of Canada and the Quebec government would undertake negotiations with the Crees about their governmental autonomy with a view to modernizing their current methods of governance. This step was partially taken on May 27, 2001, with the signing of the *Accord-cadre entre les Cris d'Eeyou Istchee et le gouvernement du Québec sur la gouvernance dans le territoire d'Eeyou Istchee Baie-James* (Quebec Government and the Crees of Eeyou Istchee, 2011). According to the provisions which will be agreed upon in the pending final agreement, a public regional government on Category III lands will be implemented. This regional government will be established by a Quebec law and will be referred to as the "James Bay Eeyou Istchee Regional Government." It will be composed of representatives from the Cree and Jamesian communities, as well as a representative from the Quebec government for the first five years of operation.

Finally, it is important to note that land use planning and management in regard to the Renard Project will be greatly affected by the *Plan Nord*'s actions and orientations, which was officially launched on May 9, 2011. The *Plan Nord* includes development in the industries of energy, mining, forestry, bio-food, tourism, and transport. It also promotes wildlife development, environmental protection and biodiversity conservation. It is based on an initial five-year program, covering the period from 2011 to 2016 (Quebec government, 2011a). The Plan will be coordinated by the *Société du Plan Nord,* which filed the bill for the project on June 9, 2011 (Quebec government, 2011B).

8.1.3 Socio-economic Background

In 2010, the population of Nord-du-Québec was 42,175 inhabitants, representing only 0.5 % of the total population of Quebec. Currently in Nord-du-Québec, the population of the James Bay territory is shared almost equally between the Crees (15,922) and Jamesians (14,186). The *Institut de la statistique du Québec* (ISQ) predicts that in 2031, the Cree population will represent nearly two-thirds (63 %) of the territory's population.

In the wake of the JBNQA, the Cree population developed several institutions that have contributed to the improvement of its social and economic conditions in the past 35 years. Between 1971 and 2006, the Cree population of James Bay nearly tripled, from 4,758 to 14,715. The community of Mistissini is

one of the largest Cree communities of the region with 3,500 people. It alone represents nearly a quarter of the Crees of Eeyou Istchee.

As is the case with other Cree communities, the main characteristic of the population of Mistissini is its youth. In fact, almost half (49.9 %) of its population is between 0 and 24 years old. Conversely, only 5.5 % of the population is over 65 years old, while this age group represents 14.3 % of Quebec's overall population. The vast majority of the Crees (86.1%) speak Cree at home, while the official spoken and written language is English.

The level of education of the Cree population is below the provincial average, but the enrolment rate has increased slightly in recent years. With the aim of increasing the participation of Cree students in post-secondary education, special efforts are being made in the areas of technical and vocational training.

In 2008, Mistissini's manpower consisted of 1,990 people, which is nearly a quarter of the manpower in all the Cree communities combined. Much like the other Cree communities, Mistissini displays a high unemployment rate, at 23.0 %, compared to Quebec's overall unemployment rate, which is about 7.5 %. In addition to the available manpower, which has some experience in mining, there are also a few companies and services in Mistissini.

In regard to the James Bay territory, mining has played an important role in the economic development of the towns of Chibougamau and Chapais. The decline of the mining industry in the 1990s and of the forest industry in the 2000s resulted in the loss of many jobs in the region. For these reasons, among others, the populations of Chibougamau and Chapais declined by 12.7 % and 19.7 %, respectively, between 1996 and 2006. During the same period, the population of the entire municipality of James Bay recorded a decrease of 18.9 %.

In contrast to the age structure of Mistissini's population, the populations of Chibougamau and Chapais are aging. Over 90 % of Jamesians consider French their mother tongue.

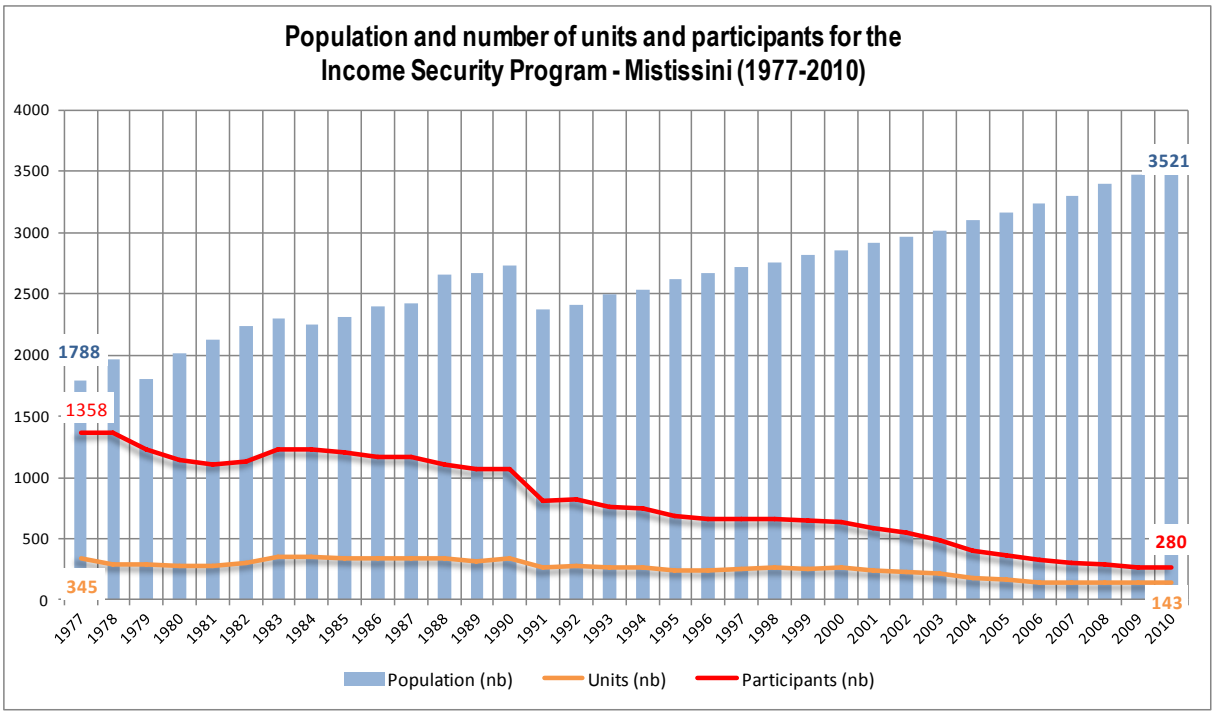
Recent mining activities and hydroelectric developments in the territory have contributed to the decrease of the unemployment rate in the region, which now stands at 7.5 % and is comparable to the rest of Quebec. This economic progress is noticeable in the towns of Chibougamau and Chapais, which have experienced a significant increase in their property assessment rolls. Both towns are also in good standing in terms of services and infrastructure. Given the anticipated mining boom in the region, the strategic planning of various educational organizations in the region shows a real desire to meet the future manpower needs. Also, in anticipation of a possible shortage of skilled personnel in the mining sector, initiatives have been taken by locals in order to attract young people from all over Quebec to come for training in the region, as well as for working and more permanent settlement.

8.2 Land and Natural Resources Use

8.2.1 Current Conditions

The territory where the Renard Project is found is mainly used for the traditional Cree practices of hunting, fishing, and trapping. A system of traplines is set up, where various trapping camps and trails can be found. Based on a rich heritage of local knowledge, the use of the territory is founded on the exploitation of wildlife resources and related activities carried out according to an annual cycle. Activities carried out in the traplines and their facilities are an important part of the cultural identity of the Crees.

Cree participation in traditional activities in Mistissini and all other Cree communities are decreasing with time. In the case of Mistissini, between 1977 and 2010, the number of beneficiaries (units, participants) of the family program that guarantees an annual sum to Crees who choose hunting, trapping and fishing as a lifestyle has greatly declined, while the community's population has steadily increased (Figure 8.2.1).



Source: Dialog, 2011.

Figure 8.2.1 Demographic predictions by age group (Jamesian population (2011-2031))

The Renard Project is located on the M11 trapline, which is managed by the cousins Sydney and Roderick Swallow, who are members of the Cree Nation of Mistissini.

The use of this territory and the exploitation of its natural resources were defined at various meetings held with land users. The information presented below regard the entire M11 trapline area and is described in detail in the Renard Project Environmental Baseline Study (EBS) (Roche, 2011). Information deemed confidential by Cree land users, however, has not been included or mapped in this report[3]. Map 8.2.1 illustrating the land use data for the project study area is presented in Volume 3.

8.2.1.1 Land Use

M11 trapline is in the shape of an elongated diamond and extends along a north-south line between Lake Mistassini and the Trans-Taiga road. It is located entirely on Category III lands and extends over an area of approximately 3,800 km^2. It is surrounded by six other traplines, whose owners are also members of the Cree Nation of Mistissini[4] (Map 8.2.2). The tallymen spend most of the year on the territory and they are accompanied by approximately 25 other Cree land users who use M11 trapline on a regular basis. In addition, tourists and other visitors occasionally visit the area.

Currently, M11 trapline is only accessible by plane or snowmobile (Photo 8.2.1), from the Mistissini community, or from the hydrobase located on the Témiscamie River, near Lake Albanel.

Sydney Swallow and his family have a permanent camp situated about 7 km south of Camp Lagopede, near the site where Stornoway plans to build an airstrip (Photo 8.2.2). This camp, equipped with two units, is the family's base camp for the hunting activities that take place in the winter and fall. Another permanent camp, which is further south, is used mainly by Roderick Swallow and his extended family. It lies about 25 km south of his cousin Sydney's camp. The construction of two additional permanent camps is being planned by the Swallow family: the first for Sydney Swallow, on Orillat Lake, north of Camp Lagopede; the second, for Roderick Swallow, in the northern part of M11 trapline, near the border and adjacent to M01A trapline.

Among the former camp sites used by the Swallow family in the past, there are some that could be reused in the future. One of them is located at the southeastern boundary of the trapline. This is a seasonal camp where the extended families of both Swallow cousins gathered for the spring hunting season. This camp was mainly used for otter trapping. Another camp of the same nature, this time located north of Camp Lagopede on Bray Lake, was used by the Swallow family in the 1970s. Finally, it is important to note that the presence of a Jamesian camp was reported near the western boundary of M11 trapline.

[3] It is important to underline that there is a general understanding with the tallymen that the interview summaries and the survey maps of traplines are confidential work documents used solely for the purposes of the current study, and cannot be distributed without the consent of the tallymen.

[4] These traplines are the following: M04, M12, M16, M23, M10 and M01A.

The tallymen have recently developed a series of new snowmobile trails on the trapline to facilitate ground travel and hunting trips. One of these trails, which is about 35 km long, begins at Roderick Swallow's permanent camp and follows a traditional walking trail to Orillat Lake. Another trail was built to link up with a hunting trail established by the users of the adjacent M01A trapline, located north of M11 trapline. A snowmobile trail also runs along the west side of camp Lagopede and diverges to the north of the Renard mine's proposed facilities area, then returns to its starting point at Sydney Swallow's camp. Finally, another trail passes through the southern part of Lake Lagopede. This trail network also includes some additional walking trails and portages. In addition, M11 trapline users can also navigate along the line running between the Misask River and Lake Lagopede.



Photo 8.2.1 Snowmobile Use on M11 Trapline

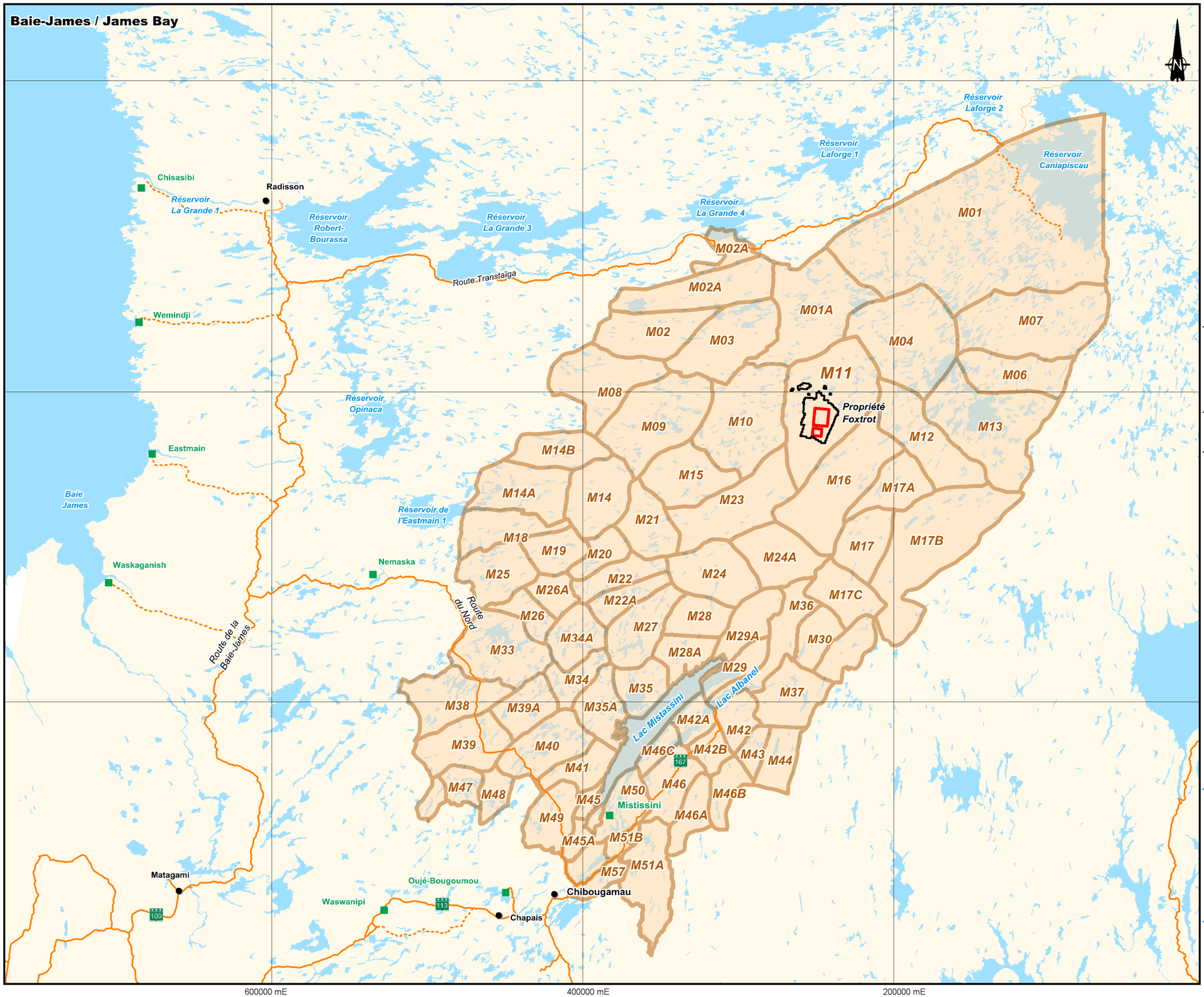


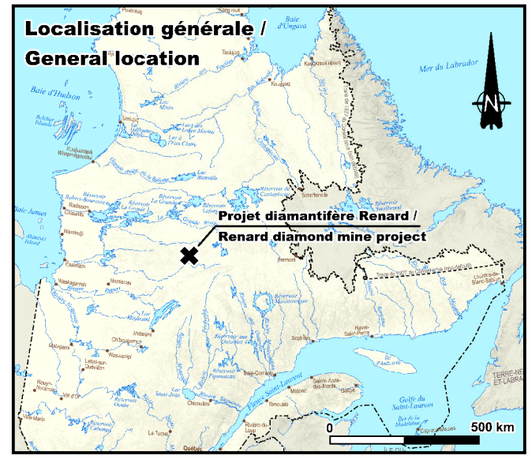
Photo 8.2.2 Native camp on M11 trapline

8.2.1.2 Natural Resource Exploitation

Hunting, fishing, and trapping fur-bearing animals are the main activities on M11 trapline. These activities take place throughout the year, according to specific schedules and practices.

Moose and caribou are hunted mainly in the fall and winter. Two areas of big game hunting favoured by the Swallow family are north of Camp Lagopede, and a third one exists south of the camp on the Misask River. The tallymen explain that these areas have been disturbed by mining exploration work that scare the moose and cause them to leave the area. Cree representatives have also noted a feeding ground for moose that is now abandoned, about 4 km west of the camp. Regarding the recent use of the trapline, one of the tallymen underlined that the moose used to visit the area surrounding his base camp, but this is no longer the case since Camp Lagopede has been active. According to him, the noise and general disturbance have pushed the moose north. He also noted that bears are abundant everywhere in the trapline.





les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social /
Environmental and Social Impasct Assessment

- Communauté crie/ Cree community
- Localité jamésienne / Jamesian municipality
- Limites de l'aire d'étude / Study area limits
- M11 — Terrain de trappage / Trapline
- Réseau routier / Road network

0 50 100 km

Échelle / Scale 1 : 2 500 000
UTM, zone 18 (NAD83)

Terrains de trappage de la communauté de Mistissini / Mistissini traplines

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_Lots_111221.WOR
Décembre 2011 / December 2011

Carte / Map 8.2.2

Data from the *Société de la Faune et des Parcs du Québec* (2003) show that the average annual number of moose killed for the period between 1989 and 2002 on M11 trapline was 2.8. This is comparable to or greater than the data provided for traplines located to the east for the 1996 to 2001 period: 3.0 for M18 trapline, 1.7 for M25 trapline, 0.0 for M26 trapline, and 1.3 for M33 trapline (Hydro-Québec, 2004).

In the spring, the return of the Canada geese marks the beginning of a period of intense activity in the territory, known as the "goose break[5]". Goose and waterfowl hunting thus monopolizes the time of the hunters and their families for several weeks. Two main areas of waterfowl hunting were indicated by land users. The first is near the Swallow camp, located 7 km south of Camp Lagopede, and the second is in the vicinity of this camp, about 5 km east of it.

In the summer, the activity on the territory slows down. It is a time for resting and visiting friends, for community gatherings and recreational activities.

Trapping activities take place in the late fall until the spring thaw period. At this time, the trappers use snowmobiles as their mode of transportation on the land, and they generally follow the waterways and water bodies that could harbour beaver dams. These activities take place on most of the trapline, alternating between different sectors. There is a trapping area that is mostly devoted to marten trapping, near the northern boundary of the trapline. Another important area for marten trapping extends from both sides of the snowmobile trail, southeast of Camp Lagopede. A third area used for the trapping of otter and muskrat during the months of March and April is located along the southeastern edge of M11 trapline.

According to data provided by the *Société de la Faune et des Parcs du Québec* (2003), the average annual number of fur-bearing animals captured on M11 trapline, or those captured for which the skin was sold by Cree land users, was 72 for the 1987-2002 period. This is slightly higher than what was recorded on the adjacent M1A, M4, M10, M12, M16 and M23 traplines, where the average annual number of fur-bearing animals captured for each of these areas is 66. On M11 trapline, the marten is the most trapped fur-bearing animal, representing nearly half of all captured animals (46.5 %). The situation is similar for adjacent traplines, where the rate is even higher (60 %). The prevalence of the marten is significantly higher than on other Mistissini traplines located further west, where the rate is about 30 % (Hydro-Québec, 2004). The other fur-bearing animals that are most sought after on M11 trapline are beavers, mink, otters and muskrats. These animals represent 48.3 % of the animals caught.

As for fishing, it is practiced in the many lakes and streams of the trapline. The fish species preferred by M11 trapline users are walleye, burbot, brook trout and lake trout. One lake in particular, which is located about 10 km northeast of Camp Lagopede, is known among land users for its abundance of burbot. The Swallow family also fishes in the Sakami River, mainly in search of lake trout and brook

[5] The « goose break » is one of the high points of the annual cycle of wildlife resources exploitation. For the Crees, it is an important break period. Indeed, during this time, schools and local administrations are closed.

trout, and in Lake Lagopede. On the latter, land users have reported an old fishing site in the upper part of the lake, and a current fishing site in the central part.

Berries are harvested in old burned areas in several sectors of the trapline, while the gathering of wood for snowshoes and other tools is carried out in two stands to the east and to the south of Camp Lagopede.

Like what is usually observed in Eeyou Istchee, M11 trapline uses a system which alternates between two or more sectors of land. This is a type of fallowing system that ensures a renewal of resources. The tallymen pointed to two specific sectors where natural resources are exploited in rotation:

- A first sector, northwest of the trapline, which covers all of Orillat Lake. It is currently unused and the family believes that this area is healthy and highly productive in terms of wildlife resources. This area is in the form of a circle, with a diameter of approximately 25 to 30 km;
- A second sector is currently used by the two Swallow families. This is the area surrounding Camp Lagopede, making a circle with a diameter of about 25 to 30 km. This sector includes hunting areas usually exploited during the winter season.

With respect to access to drinking water by trapline users, respondents explained that all the lakes contain clear water that is fit for drinking, so they have been drinking water from lakes and mountain springs since they began using these grounds 34 years ago. They explained that they mainly drink the water of the larger lakes and rivers. To this day, they still drink the water from Lake Lagopede and surrounding lakes.

The inhabitants also wanted to underline that the recent exploitation of their land has been affected by climate change. They explained that it is now more dangerous to travel on the land because river ice seems to melt along the shore, even in the heart of winter. The snow conditions have also changed, especially on lake surfaces. Although snowmobiles are now equipped to withstand more difficult conditions (frazil ice, slush), accidents are increasing.

In future years, land users plan to continue the exploitation of their land, while making some adjustments. In this way, they plan on taking advantage of the presence of the infrastructure planned by Stornoway to improve access to their trapline, thereby increasing the intensity of their activities in the northern part of the trapline. The tallymen are in fact planning to develop a duck hunting pond near the northwestern boundary of the trapline and the Sakami River, to replace the one that Sydney uses near his camp, which is further south and closer to the future mine site. The Swallow family also intends to continue hunting, fishing and trapping in the central part of the trapline, northeast of Camp Lagopede. One of the family members has indicated his intention to hunt in the southern portion of M11 trapline, near its southeastern border.

The land is not yet equipped with all-terrain vehicle trails, but the family plans on developing these in the near future. The Swallows are also considering the development of a family business, which would consist of canoe trips and outfitters for fishing in three areas of the land: in the northeast, the northwest, and to the south of Camp Lagopede.

8.2.1.3 Valued Areas and Sites of Specific Interest

Beyond the current and traditional exploitation of natural resources through hunting, fishing, and trapping activities, M11 trapline users have also identified certain valued areas and sites of specific interest that are important to their cultural and family heritage.

For example, the tallymen identified a lake north of Bray Lake as an area valued by the family because it is associated with a time when the Crees depended solely on hunting for survival, and a time when fish was their main food source.

Crees have also identified a large number of camp sites that they or other members of their family have used in the past. Some of these sites are of historic value and are part of the family heritage.

Respondents recall an old hiding place for food on an island where they used to leave their possessions for the winter season. They also remember a series of old camp sites located in an area about 30 km northeast of Camp Lagopede.

Crees have also identified an area that they consider to be of archaeological interest in the southeastern part of the trapline where arrowheads can be found. The area was used in the past by people building their canoes.

Some sites where members of the Swallow family were born have also been identified. These include, among others, the birthplaces of Roderick's two brothers and the birthplaces of Sydney's brother and two sisters. Burial sites have also been identified, including those of Roderick's two sisters and that of a tallyman's uncle.

8.2.2 Construction Phase Impacts

8.2.2.1 Impact Description and Assessment

The sources of impacts on land use and natural resources during the construction phase are the preparation and development of the sites, the use and maintenance of machinery and power generator sets, road and air traffic, the dewatering of lakes, and the construction of mine facilities.

Site preparation and development, as well as the dewatering of F3302 and F3303 lakes due to mining deposits will remove 307 ha of land that could be used for the natural resource exploitation by the M11 trapline users. The use and maintenance of machinery and power generator sets, road traffic, air transport and the construction of mine facilities will lead to various other nuisances that might cause a number of animals avoid the mine site, while also causing inconveniences to land users of the area (noise, dust etc.).

It should be noted that, according to information provided by Cree land users, the project site does not interfere directly with any snowmobile trails. However, the mine project and the trail network developed by M11 trapline users will simultaneously evolve. Thus, it is possible that the snowmobile trails will eventually intersect with mine access roads and facilities. Still, no information suggests for the moment

that the project will impact movements of trapline users, in regard to both snowmobile and boat transportation.

Moreover, it seems that the base camp of one of the two trapline holders is located 2.1 km east of the airstrip, right on the same axis as the air corridor leading to the airstrip. Landings and takeoffs will inevitably cause some disturbance to this trapline users. For arrivals and departures of personnel, three flights a week are estimated during the construction phase and two flights a week are estimated during the operation phase. The aircrafts that will be used are Dash-8 Q-300 and Dash-8 Q-100 aircrafts. Hercules C-130 aircrafts will occasionally use the airstrip to freight transport.

Finally, it is worth noting that the disturbance affecting hunting, fishing and trapping activities on M11 trapline also represent an impact on the cultural heritage of its users.

8.2.2.2 Mitigation Measures

The first mitigation measure that will be taken concerning the project's overall impact on the cultural heritage of land users will be to recognize and respect the role of M11 trapline holders in the traditional and contemporary management of the area's natural resources. In this way, Stornoway will keep local land users informed of the anticipated progress and location of construction work. Stornoway will make sure to discuss any accommodation deemed necessary with these locals. In addition, an awareness program about Cree culture, their presence and the M11 trapline land uses will be developed for all workers.

Out of respect for traditional Cree land uses, during the periods of waterfowl hunting in the spring, and moose hunting in the fall, measures will be taken to limit the disturbance that the project could cause for these activities that are both socially recognized and of cultural interest. In particular, these measures will reduce noisy activities to a minimum (e.g. helicopter or all-terrain vehicle travel) on certain parts of the land. The duration and extent of territory on which these measures will apply will be established in cooperation with the tallymen. If necessary, they will be revised annually.

Stornoway will also maintain ongoing communication with trapline users to avoid interfering with the movement of Cree hunters and trappers. The goal of this ongoing dialogue will also be to inform trapline users of the work schedule to ensure their safety during more dangerous operations (e.g. dynamiting). To reduce the risk of accidents, signs will also be put up adequately. Moreover, the project will ensure that the mine facilities do not interfere with any boat or snowmobile transportation. In the latter case, during snow removal, Stornoway will make sure to remove snow in areas where the project trails intersect with the snowmobile trails, in order to facilitate movement for land users.

To avoid putting pressure on the hunting and fishing systems of M11 trapline, such activities will be prohibited for project workers and contractors. In addition, a security perimeter will be established around the project site where the practice of hunting, fishing and trapping will be suspended.

In regard to inconveniences and disturbances caused by noise, dust, and all other sources, these will be mitigated by the measures that are currently being considered (in particular, see Sections 6.3.2 on Air Quality, 6.4.2 on Sound Levels, and 6.8.2 on Water Quality). Appropriate measures will also be taken to remedy any spillage and to reduce impacts on fauna and flora (see Chapter 7).

In regard to the tallyman whose base camp is located 2.1 km east of the airstrip, Stornoway will discuss with him in order to reach an agreement to compensate for the disturbances. Fruitful discussions between the two parties are underway, with a view to relocating the camp to the northwest sector of the M11 trapline. The signing of an agreement will confirm the verbal agreements reached between the two parties.

8.2.2.3 Residual Impacts

During the construction phase, the impact on land use for the trapline users will be negative and of moderate intensity because, although land use will only be slightly affected by the project, the construction will be located in the heart of the trapline. This impact, however, concerns a population of more than twenty users, thus impacting on the local level. Its duration will be short because it will focus on the construction period. The residual impacts are thus of moderate importance.

8.2.3 Operation Phase Impacts

8.2.3.1 Impact Description and Assessment

During the operation phase, the sources of impacts on land use are road traffic, the maintenance of machinery, ore mining, handling and storage, the management of materials resulting from the mining operations, activities on the airstrip, the presence of facilities and of the manpower, and the gradual rehabilitation of the site. These project components will cause M11 trapline users to lose access to some important sites. In general, the whole area affected by the project will disrupt hunting, fishing, and trapping activities.

The area where the project will impact on land use and on natural resource exploitation covers an area of approximately 1,500 ha. This includes the area occupied by mine facilities and a security perimeter of one km around the mine site. These 1,500 ha represent about 0.4 % of valued land used for hunting and trapping on M11 trapline. This includes the territory of Lake Lagopede and Emmanuel Lake. The elements affected most in this area are the diverse facilities and wildlife resources, such as the trapping grounds for beaver and other fur-bearing animals, and areas for bear hunting.

In addition to the direct prohibitions for hunting and trapping that will affect, in whole or in part, the mine site and its security perimeter, the surrounding area will also experience a series of disturbances that will likely cause a number of animals to flee, and will impede the practice of traditional hunting and trapping. The most common nuisance will be related to noise (dynamiting, drilling, vehicle and aircraft

circulation, mining operations) and dust (excavation, crushing, transport). It is anticipated that these disturbances will affect three moose hunting grounds, which are within 10 km of the mine site.

Because of these disturbances, M11 trapline users will have to relocate some of their hunting, fishing and trapping activities to other sectors of the trapline. In terms of fishing, its main exploitation areas will not be affected and much of Lake Lagopede will continue to be used for boat use and snowmobiling. In regard to the valued areas for hunting and trapping found around Lake Lagopede and Emmanuel Lake, much of it (96 %) will remain available as previously mentioned. This area represents about 37,750 ha. In addition to this area of usable land, other exploitation areas can be found around the Grand Portage stream, which is southeast, and around Bray Lake, which is in the north. These areas will not be affected by the project.

Despite the availability of these areas, land users have also identified several sites on the M11 trapline that they intend to exploit in the future, particularly areas that will be easier to access because of the Renard Project and the extension of Route 167. Thus, from the site of their future camp on Orillat Lake, the trapline users intend to move in a northeasterly direction to position their hunting, fishing and trapping activities. They also plan to develop a duck hunting pond near the northwestern boundary of the trapline and on the Sakami River. New hunting and trapping sites are also being considered near the southeastern border of the trapline, and in its central part, to the northeast of the Renard Project site.

The future land use of the M11 trapline, as imagined by Cree land users involved, is in large part based on the new opportunities presented by the opening up of the territory. As such, the northern extension of Route 167, initiated by the Renard Project, among others, constitutes a long-term positive impact and facilitates land use. However, the M11 trapline holders and other involved parties, fear an increased use of the land and even the establishment of camps or cabins by other users, whether native or not. Depending on the intensity of the pressure from outsiders, improving access to the M11 trapline may have a negative impact. At this point, we can only assume that the land use rules established by the future James Bay Eeyou Istchee Regional Government with respect to vacationing and trapping, as well as sport and subsistence hunting and fishing, will ensure a harmonious and sustainable exploitation of resources of the M11 trapline and its neighbouring properties.

The disturbances related to activities on the mine site, such as noise and dust, will be comparable to what has been assessed for the construction phase.

Impacts on the water quality of Lake Lagopede will be site specific and mainly limited to the zones affected by the treated effluent plumes. Cree land users will therefore be able to continue using the lake as they did previously (see Section 6.8.3). Water outfalls into Lake Lagopede will have no impact on the stability of the ice cover outside the security perimeter. Thus, no disruption to snowmobile circulation is predicted.

Lastly, regarding the impacts on land use and the natural resource exploitation on the M11 trapline, these seem relatively limited if we only consider the project's impacts on the resources themselves. For example, the assessment of impacts on fur-bearing animals reported mainly the movement of certain species in response to a loss of habitat associated with the presence of mine facilities (Section 7.10.3). The impacts will especially affect small, less mobile species, such as short-tailed weasels, least weasels, and porcupines.

The impacts will have little effect on fur-bearing animals with a very large home range, such as the gray wolf, the American marten and the Canadian lynx. In general, the scale of this impact is considered moderate. For big game (moose, caribou, and black bears), the impact is considered low (Section 7.11.3). Despite the generally moderate impact on the main wildlife resources of the M11 trapline, it is nevertheless important to mention the concerns expressed by land users and the fact that, given the presence of the mine, they will have to abandon some areas where wildlife will be affected. As such, they will need to redesign their activities on the land according to the new distribution of the species of interest.

Finally, it is important to mention that the Renard Project will increase employment or business incomes for the M11 trapline users (see Sections 8.3.3 and 8.4.3), while encouraging land use and traditional activities, depending on their availability and their interest to do so.

8.2.3.2 Mitigation Measures

All the mitigation measures already applied during the construction phase (Section 8.2.2.2) will be renewed during the operation phase. No additional action seems necessary. Throughout the duration of the project, unforeseen impacts will be assessed and appropriate mitigation measures will be applied.

8.2.3.3 Residual Impacts

Hunting, fishing, and trapping are activities that are highly valued by the M11 trapline users and these activities will be disrupted as of the beginning of the construction phase. When the project moves into the operation phase, land users will already have begun to adjust to the changes happening on the land by reorganizing their activities and facilities. They will then be able to continue their activities in areas not affected by the project. From that moment on, disturbance and nuisance caused by the project will have a low negative intensity impact, because only minor changes in the practice of activities will occur compared to the construction phase. As is the case for the construction phase, the extent of the impact is local because it concerns the same land users. However, this is considered a long-term impact because it spans over 20 years. The importance of the impact is therefore moderate.

8.2.4 Closure Phase Impacts

8.2.4.1 Impact Description and Assessment

The activities associated with the mine's closure will have the same general impact as during the operation phase, but on a smaller scale and with a much shorter duration. These negative impacts will be outweighed significantly by the revegetation and rehabilitation of the site that, beyond the visual improvement of the landscape, will allow a gradual reestablishment of flora and fauna in the area. However, some traces will remain, such as the processed kimberlite confinement area and an overburden stockpile. However, the flat surfaces of these areas will grow some vegetation and will gradually become similar to other hills in the area, although their shapes will be different (Section 8.3.4). Pit flooding during the closure phase will create deep artificial lakes that can be colonized by Salmonids, among others. Some related mine facilities (e.g. buildings, parking lots) will eventually be transferred to M11 trapline users for their own use. Such a possibility will be discussed further with the trapline holders.

8.2.4.2 Mitigation Measures

For the closure phase, the mitigation measures implemented in previous project phases will also apply to reduce negative impacts. Eventually, the use of certain facilities for the benefit of M11 trapline users could be considered as an enhancement measure related to the rehabilitation of the area. Also, as presented in the closure and progressive rehabilitation plan (Section 3.18.14), the airstrip will be offered to local authorities because it is an infrastructure that can serve for the regional development of the community. If, for some reason, local authorities do not want to take over the airstrip, it will be scarified and revegetated.

8.2.4.3 Residual Impacts

The positive impact associated with the rehabilitation and revegetation of the area will be of medium intensity, as it will moderately improve the conditions and use of the area affected by the mine. Its extent will be limited to the mine's perimeter. It will be a permanent impact, and thus considered long term. The impact will therefore be of moderate importance.

8.3 Socio-economic Context

8.3.1 Current Conditions

8.3.1.1 The Cree Context

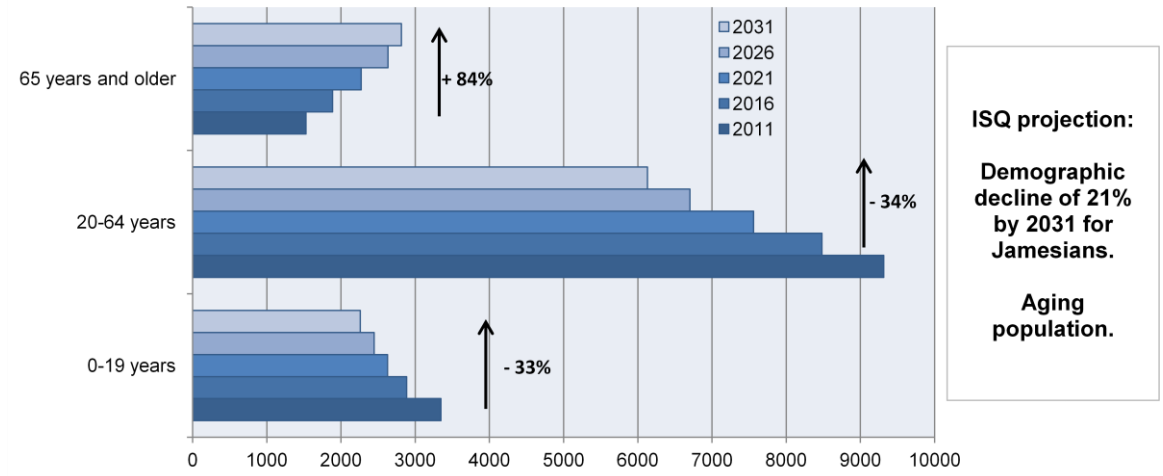
- *POPULATION*

The Cree population experienced significant population growth between 2000 and 2010. Indeed, the population rose by 27 % during this period to nearly 16,000 people. This trend has persisted since the early 1950s, following the implementation of health care and social assistance. The community of

Mistissini registered a somewhat higher increase during this period (29 %): 3,384 people in 2010, compared to 2,616 in 2000.

According to predictions by the *Institut de la statistique du Québec* (ISQ, 2009), the Cree population will continue to increase in coming years, from 15,922 in 2011 to 19,033 in 2031. The age group whose population will increase the most is the 65 and older group, with an increase of 149% (Figure 8.3.1). However, the Cree population is generally young and will continue to be so for several more years. In Mistissini, for example, half the population is aged between 0 and 24 years old, while the 25-44 age group represent 30.8 % of the community. Only 5.5 % of the population is aged over 65, in contrast with 14.3 % for all of Quebec.

In Eeyou Istchee territory, the Cree language is spoken by children at home and by adults at meal times, in public meetings and other social functions. However, the Crees mainly use English for correspondence and communication purposes with the outside world, and relatively few Cree adults have sufficient knowledge in French to feel comfortable in that language, especially in technical fields. In some communities, however, there is some growth in the number of Crees who can speak French. Mistissini shows an increase of two percent between 2003 and 2008 in the proportion of Crees who speak French, from 27.9 % to 30.2 %. The French language is also becoming better known amongst members of the younger generation. Recognizing that knowledge of French is an important advantage in the economics of the region, many parents sign their children up for French programs in the Cree schools (Penn *et al.,* 2008).



Source: ISQ, 2009.

Figure 8.3.1 Demographic predictions by age group (Cree Population (2011-2031))

High School

An analysis for the 1991 to 2001 period shows that the Cree enrolment rate was low overall. Indeed, the percentage of students who graduated high school was between 20 % and 40 % during this period, whereas it was around 75 % across Quebec as a whole (Collette et al., 2010). During the 2007-2008 school year, the CHRD (2009) shows that nearly half of the individuals aged between 15 and 24 in Mistissini were not enrolled in school. Of these 258 people, 71 % (183) had no diploma. Across all the Cree communities, the ratios were similar: 59 % were not in school and 61% without a diploma. This situation can be explained by relatively high dropout and absenteeism rates, thus illustrating low attendance rates.

The problem of school dropouts is illustrated in statistics on school attendance compiled by the *Ministère de l'Éducation, des Loisirs et du Sport* (MELS). One can see that, over a period of three years, as the age of groups increases, so does the dropout ratio. Table 8.3.1 shows the example of Mistissini. The group of 46 young people who entered Secondary 3 in 2008-2009 had only 15 individuals the following year (Secondary 4), and only five individuals the year after in Secondary 5. There was thus a significant loss of 41 students for this group only. In other words, 89% of students who were in school three years before did not stay. In addition, out of the five students who attended Secondary 5 in 2010-2011, only two girls graduated.

Table 8.3.1 Monitoring of High School Attendance in Mistissini - 2008-2009 to 2010-2011

Groups	2008-2009	2009-2010	2010-2011	Gain or loss for the period
Grade 6	58	54	73	15
Secondary 1	58	80	60	2
Secondary 2	61	46	33	-28
Secondary 3	46	15	5	-41
Secondary 4	23	2	-	-21

Source: MELS, 2011.

In regard to school attendance, it is predicted that this situation will improve in the coming years, especially when considering the number of students enrolled in educational programs related to preschool, elementary and secondary school teaching. Thus, while it is predicted that all of Quebec will experience a 10.7 % decrease in enrolments in these levels between 2006 and 2016, a 6.4 % increase of the Cree School Board (CSB) clientele is predicted for the same period (Collette et al., 2010).

Finally, it should be noted that, although the current educational success rate of the Cree population is still below the provincial average, it has increased slightly in recent years. Indeed, in 2003, 26 % of the Cree population aged 15 years and older had at least a high school diploma, while in 2008, this

percentage had risen to 29 %. There has also been an improvement in post-secondary graduation. For the 2009-2010 school year, 441 Crees were enrolled in college or university studies. Of these 441 individuals, 22 % came from the community of Mistissini (CBS, 2011).

Vocational Training

Although the school dropout phenomenon is indeed present in the communities, it should be taken into consideration that many young Cree people, from 20 to 30 years old, do return to school in adult education programs to complete high school studies, to continue in a vocational training program, or to move toward post-secondary education outside of the Cree communities. Table 8.3.2 shows that 90 young adults have completed their high school diploma (*Diplôme d'études secondaires*, or DES) since 2005, while 168 others have obtained a vocational diploma (*Diplôme d'études professionnelles*, or DEP). It should also be noted that enrolment has increased significantly, from 79 in 2005, to 525 in 2010.

Table 8.3.2 Attendance and Graduation in General Adult Education and Vocational Training (2005-2006 to 2010-2011)

		2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	*Sub-Total*
Attendees		79	123	151	284	320	525	
Diploma	*DES*	*18*	*15*	*14*	*19*	*8*	*16*	***90***
	DEP	*4*	*15*	*34*	*33*	*43*	*39*	***168***
	Total	**22**	**30**	**48**	**52**	**51**	**55**	***258***

Source: Data obtained from the Cree School Board in June, 2011, and from the Sabtuan Regional Vocational Training Center in September 2011.

With the aim of improving the participation of Cree students in post-secondary education, the efforts to improve graduation in young Cree people focus on technical or vocational training. To this end, several programs are now available at the Sabtuan Regional Vocational Training Center, in the Cree communities, and at the *Centre de formation professionnelle de la Jamésie* (CFPJ). Since 2002, 127 Cree obtained a DEP (through the CSB) in programs related to the mining sector, namely: Operation of Heavy Equipment (20 graduates), Joinery/Carpentry (19 graduates), Nursing and Health Care (18 graduates), and Secretarial Studies (17 graduates). Since 2007, more than forty Crees have graduated in the Mineral Extraction program as well as the Drilling and Blasting program (through the James Bay School Board (CSBJ)).

More recently, the Sabtuan Centre undertook the development of training programs for the 2010-2011, 2011-2012 and 2012-2013 academic years. These programs aim in part to prepare individuals for some jobs related to the Renard Project. The programs include, among others, training programs for heavy equipment operators, Class 1 and Class 3 truck drivers, ore mining (underground), drilling and blasting,

as well as heavy equipment mechanics, industrial maintenance mechanics, and processing of minerals and metals.

Post-secondary Education

The post-secondary training service supports Crees who wish to continue their education outside of the Cree communities. For the 2010-2011 school year, 442 students attended post-secondary institutions: 61 % at college levels, 29 % in universities and 10 % in vocational training. 150 graduates are predicted, with 30 of them being university graduates (CSB, 2011).

Workplace Training

In addition to classroom training, many Crees acquired in recent years more experience on worksites where job requirements were similar to those that will be available for the Renard Project. This was the case for the Troilus mining project and the Eastmain 1 and Eastmain-1-A-Sarcelle-Rupert hydroelectric projects.

In regard to the Troilus mining project (Penn et al., 2008), statistics show that in 1998, which was the first full year of operation, the manpower consisted of 289 people, of which 74 were Crees (25.6 %). The peak of the Cree manpower was reached in 2001, with 76 workers. From 2002 onwards, the number of Cree workers declined each year to finally reach 34 workers, or 13.1 % of the total manpower in 2006, which was the last full year of operation. The majority of jobs held by Crees were in the mine rather than in the ore processing plant, given their general experience in the operation of heavy machinery.

On the Eastmain-1-A-Sarcelle-Rupert worksite (Hydro-Québec and SEBJ, 2009) in 2007, Cree workers represented 16 % of the average monthly manpower, with 212 workers. In 2008, Cree participation rose to a monthly average of 282 workers. In 2007 and 2008, the Cree workers staying in the *Société d'énergie de la Baie James* (SEBJ) camps were mainly from the community of Mistissini (over 40 %), Waskaganish (15%) and Nemaska (about 10 %). On the worksite, the Crees mainly occupied positions in the construction sector, as day labourers, heavy equipment operators, or truck drivers (about 35 %). About 30 % of Crees also held maintenance jobs on the construction site. Approximately 25 % of Cree workers were involved in land clearing work.

- *INCOME*

Census data from 2006 indicate that the median household income in Mistissini in 2005 was $66,645, versus $46,419 for all of Quebec. This is not unrelated to the fact that households in the community have more members on average (4.2) than other Quebec households (2.3). The median individual income of the Cree community of Mistissini ($21,984) remains below that of the rest of Quebec ($24,430).

In regard to the composition of income for the Crees of Mistissini, about 85 % is from employment earnings and about 15 % is from government transfers. Some of this income comes from the Income Security Program government transfers (ISP) for Cree hunters and trappers.

Finally, it should be noted that the Crees who work in the territory of a Cree community or for Cree organizations are exempt from income taxes, which, in some cases, can lead to companies from outside the community having difficulty in recruiting workers from the Cree population.

- *EMPLOYMENT AND LABOUR MARKET*

A recent study on the labour force in Cree communities (CHRD, 2009) revealed that 44.4 % of the labour force is hired permanently, 27.6 % temporarily, and 28 % seasonally.

Concerning jobs, a monitoring study of the Troilus mining project (Penn *et al.,* 2008) pointed out that several Crees gained some experience in operating heavy equipment during hydroelectric developments on the territory. Thus, training programs associated with the mining sector were offered by the company, thereby increasing the skills related to the mining industry of a number of Cree people.

Statistics from March 31, 2008, indicate that the potential manpower consisted of 1,990 people in Mistissini (population aged between 15 and 64 years living in the community), representing more than a quarter (27.4 %) of the potential manpower of all Cree communities combined, which, in numbers, is 7,255 people (CHRD, 2009).

Economic indicators show that Mistissini has slightly lower activity and employment rates than those observed for all the Cree communities. Like the other communities, Mistissini displays a high overall unemployment rate (23.0 %) (Table 8.3.3). Although this percentage is lower than the one observed in 2003, it remains much higher than the provincial average, which is around 7.5 %.

As the demographic structure of the population of Mistissini is made up of a young and growing manpower, one challenge for the community is therefore to integrate this population into the labour market, while local employment opportunities are limited.

Table 8.3.3 Principal Labour Market Indicators. Mistissini Community and all Cree Communities Combined (2003 and 2008)

	Mistissini		Sum of Cree Communities
	2003	2008	2008
Total population of 15 years and older	1,700	1,990	9,245
Labour force	1,530	1,540	7,525
Working labour force	1,100	1,185	5,806
Unemployed	430	355	1,716
Inactive	170	450	1,720
Activity rate	90.0 %	77.4 %	81.4 %
Employment rate	64.7 %	59.6 %	62.8 %
Unemployment rate	28.1 %	23.0 %	22.8 %

Source: CHRD, 2009

Data compilation: Roche ltée, Groupe-Conseil, 2010

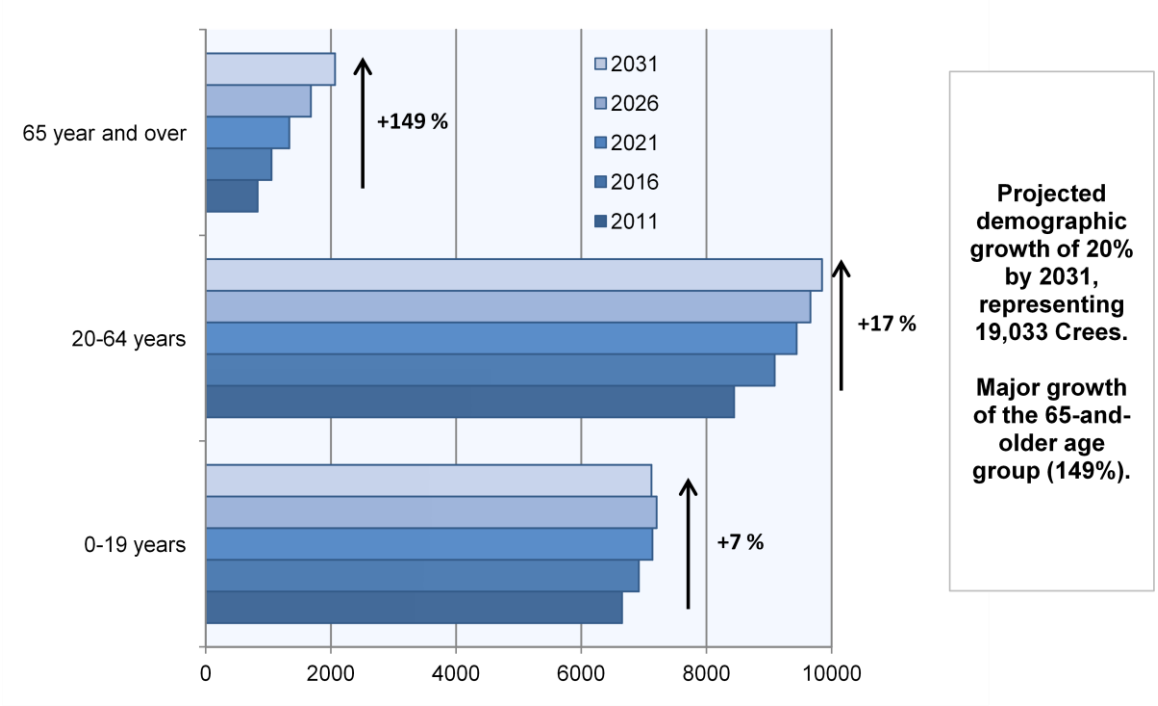
8.3.1.2 The Jamesian Context

- *POPULATION*

With about 7,600 inhabitants, Chibougamau is the main town of the James Bay territory which has a total population of just under 15,000 people. Chapais, for its part, has a population of about 1,600 people. Like the entire municipality of James Bay, Chibougamau and Chapais have experienced a population decline in recent years, losing 12.7 % and 19.7 %, respectively, between 1996 and 2006, and resulting in their populations decreasing from 8,664 to 7,565, and from 2,030 to 1,630, respectively. The region experienced a population migration to other regions, which can be explained among others things, by the end of major Hydro-Québec construction projects, paired with the closing of several mines.

In the long term, according to predictions by the *Institut de la statistique du Québec (ISQ),* the James Bay population will continue to decline. In fact, the ISQ predicts that the population of the James Bay territory will decrease by 21.0 % between 2011 and 2031, going from 14,186 to 11,203 (ISQ, 2009).Unlike the age structure of the population observed in Mistissini, Chibougamau and Chapais have an aging population. Indeed, the percentage of people aged over 45 is 36.8 % in Chibougamau and 39.7 % in Chapais, which is almost double of that is observed in the Cree communities (19.1 %). This aging population trend will further increase for all of the James Bay territory (Figure 8.3.2).

French remains the mother tongue and mostly used language in Chibougamau and Chapais.



Source: ISQ, 2009.

Figure 8.3.2 Demographic predictions by age group (Jamesian population (2011-2031))

- *EDUCATION AND VOCATIONAL TRAINING*

Chibougamau and Chapais have a slightly higher proportion of people without a high school diploma (28.9 % and 38.8 %, respectively) than what is observed across the province (25.0 %).

However, both cities stand out with a higher percentage of graduates from a trade school (22.6 % in Chibougamau and 23.5 % in Chapais) than the percentage at the provincial level, which is 15.3 %. The presence of the *Centre de formation professionnelle de la Jamésie à Chibougamau* probably explains this situation. Since its creation, the Centre has provided various programs in several sectors, including mining, forestry, construction, mechanics, welding, health, and administration. The mining sector remains one of the niches of excellence of the Centre, which, in recent years, has reached agreements with miners in the area for the use of their facilities for the Ore Extraction program. Diamond Drilling and Drilling and Blasting programs are also offered by the Centre, as well as various other programs of interest for the mining industry (Automated Systems Electromechanics, Heavy Equipment Mechanics, Carpentry/Joinery, Industrial Construction and Maintenance Mechanics, etc.).

Judging from the strategic planning of various educational organizations in the region, it is clear that there is a real concern for manpower needs in businesses operating in the territory, especially those in the mining industry. It is with this mindset that the *Institut national des mines* was formed by the Quebec government in 2010. With its headquarters in Val-d'Or, the *Institut*'s mission is to coordinate the opportunities for training in trade schools, technical programs and professional programs in the mining industry so that the industry's requirements are met and offers are available where needed.

➢ *INCOME*

Census data from 2006 indicates that the median household income of Chibougamau ($58,587) and Chapais ($50,534) is higher than the Quebec average ($46,419). Moreover, the median individual income in Chibougamau ($28,037) exceeds the provincial average ($24,430), while it is slightly lower in Chapais ($22,505).

Regarding income distribution, it is similar to the distribution model that is common in most of Quebec in terms of employment earnings and government transfers. There is, however, a higher proportion of government transfers in Chapais (17.3 %) than the provincial average (13.9 %).

➢ *EMPLOYMENT AND LABOUR MARKET*

The rise in economic activity in recent years has led to improved employment conditions in the Nord-du-Québec region. In 2010, the unemployment rate was 7.5 %, while it is now (August, 2011) 6.5 %[6] (ISQ, 2011). This rate is better than the provincial average, which was 7.6 % in 2011. This economic progress has in fact been observed by the towns of Chibougamau and Chapais that have experienced a tangible increase in their property assessment rolls.

Although there is no disaggregated data on the current unemployment rate in the James Bay area, we can assume that at this time, the situation has improved significantly since 2006, when the unemployment rate was 10.8 % (Table 8.3.4). Based on data from the 2006 census, Chibougamau seems to have a better employment situation than the region as a whole, whereas the situation is reversed for Chapais.

Table 8.3.4 Principal Labour Market Indicators - Chibougamau and Chapais and all of MBJ (2006)

	2006			
	Population of 15 years and older	**Unemployment rate (%)**	**Activity rate (%)**	**Employment rate (%)**
Chibougamau	**6,045**	**9.5**	**73.2**	**66.2**
Chapais	**1,340**	**14.5**	**59.3**	**50.7**
Lebel-sur-Quévillon	2,220	11.6	74.1	65.5
Matagami	1,225	11.2	65.7	58.0
Non urban territory	1,140	12.2	64.9	57.0
Total population of MBJ	11,970	10.8	70.3	62.6

Source: Statistics Canada. 2006

Data compiling and treatment: Emploi-Québec, Direction régionale du Nord-du-Québec.

[6] Data for Côte-Nord and Nord-du-Québec regions.

8.3.1.3 Employment Opportunities

The Renard Project is part of an employment dynamic that is characterized by significant growth prospects in the mining industry and an increased demand for qualified personnel.

Currently, the mining sector is generating the equivalent of 34,000 jobs in Quebec, including more than 16,400 direct jobs and nearly 14,000 indirect jobs (MRNF, 2011a). The average pay for working directly in the mining sector was $70,000 in 2008, meaning more than twice the average employment income of workers in Quebec.



In recent years, investment for mining exploration activities in Quebec has been favourable. On December 31, 2010, there were 228,564 active exploration titles in Quebec, representing 6.2 % of the province's total area (MRNF, 2011B). These exploration activities are primarily conducted in the regions of Nord-du-Québec, Abitibi-Temiscamingue and the Côte-Nord. Mining expenditures in capital and repairs have averaged nearly $750 million per year for the 2000-2008 period (MRNF, 2011a).

The Nord-du-Québec region has a rich sub-soil with very diversified mineral resources. Mining projects currently in operation in Nord-du-Québec provide nearly 1,600 jobs and include two gold mines (Casa Berardi by Aurizon Mines Ltd. and Géant Dormant by North American Palladium Ltd.) and two polymetallic mines (Persévérance and Raglan by Xstrata Canada Corporation). Furthermore, there are some exploration projects in advanced stages have reached the development, such as the Bracemac-McLeod Project by Xstrata Canada Corporation, the Éléonore Project by Les Mines Opinaca (Goldcorp) and the Nunavik Nickel Project by Jien Canada Mining Ltd., not to mention the reopening of the old Gonzague Langlois mine by the Belgian company, Nystar. In addition to the Renard Project, there are eight other projects that have reached an advanced stage of development in the region: the Matoush Project by Strateco Resources Inc., the Bachelor project by Metanor Resources Inc., the Vezza Project by North American Palladium Ltd., and the Lake MacLeod Project by Western Troy Capital Resources Inc., the Whabouchi Project by Nemaska Exploration, the BlackRock mining project by BlackRock Metals Inc., the Pivert-Rose Project by the Critical Elements Corporation, and the James Bay Lithium Project by Lithium One Inc.

As shown in Table 8.3.5, the mining industry generated a payroll of 146 million U.S. dollars in 2008. While this amount represents 9.6 % of the payroll for all industries for all of Quebec's three mining regions, it represents nearly 20 % for the Nord-du-Québec region only, thus illustrating the importance of this industry in the regional economy.

Table 8.3.5 Mining Sector Weighting in the Regions' Total Payrolls (2008)

Administrative Regions	Payrolls		
	All Industries *	Mining Sector **	
	M$	M$	Weighting (%) in the regional payroll
08 - Abitibi-Témiscamingue	3,790	218	5.8
09 - Côte-Nord	1,827	254	13.9
10 - Nord-du-Québec	789	146	18.5
Total	6,406	618	9.6

** Estimated data*

***Includes direct jobs in production and primary transformation*

Source: « Données de l'ISQ », cited in MRNF, 2011c

The importance of the Nord-du-Québec region in Quebec's mining industry was highlighted recently by a study conducted by the *Comité sectoriel de main-d'œuvre de l'industrie des mines* (CSMO Mines, 2010). This study showed that, in 2009, the Nord-du-Québec region was the region with the highest recruitment in mining (69 % of new jobs). This study also demonstrated that for the next ten years, the manpower needs in Nord-du-Québec represent 58 % of the demand for all Quebec mines (7453 of 12 812). This percentage will be 45 % in the next five years (2486 of 5589 jobs). However, the study did estimate that despite these facts, only 8 % of the new workers in the industry will come from Nord-du-Québec.

The CSMO Mines assessed the distribution of demand by field of activity as follows:

- Support Services: 26 %;
- Technical Services: 23 %;
- Extraction: 22 %;
- Concentrators and plants: 21 %;
- Administration: 8 %.

In the medium and long term, the jobs related to the operation and maintenance of machinery will be the most in demand. Geologists and mining technicians will also be greatly needed. The main jobs to be filled in order of priority are: heavy equipment operator, stationary equipment operator (surface), diamond driller (surface), heavy equipment mechanic, industrial mechanic, mining technician, geologist, assistant diamond driller (surface), day labourer, underground truck operator.

8.3.2 Construction Phase Impacts

The impact assessment presented in Section 8.3 (employment and training) and Section 8.4 (economic spinoffs) uses two economic spinoff analysis models developed by EcoTec Consultants, which are the interprovincial model (calculations across Canada, for each province) and the interregional model (calculations at the level of administrative regions in Quebec). The interregional model is used in parallel with the interprovincial model, which ensures that the sum of economic spinoffs by all administrative regions is equal to the economic spinoffs for the whole province of Quebec.

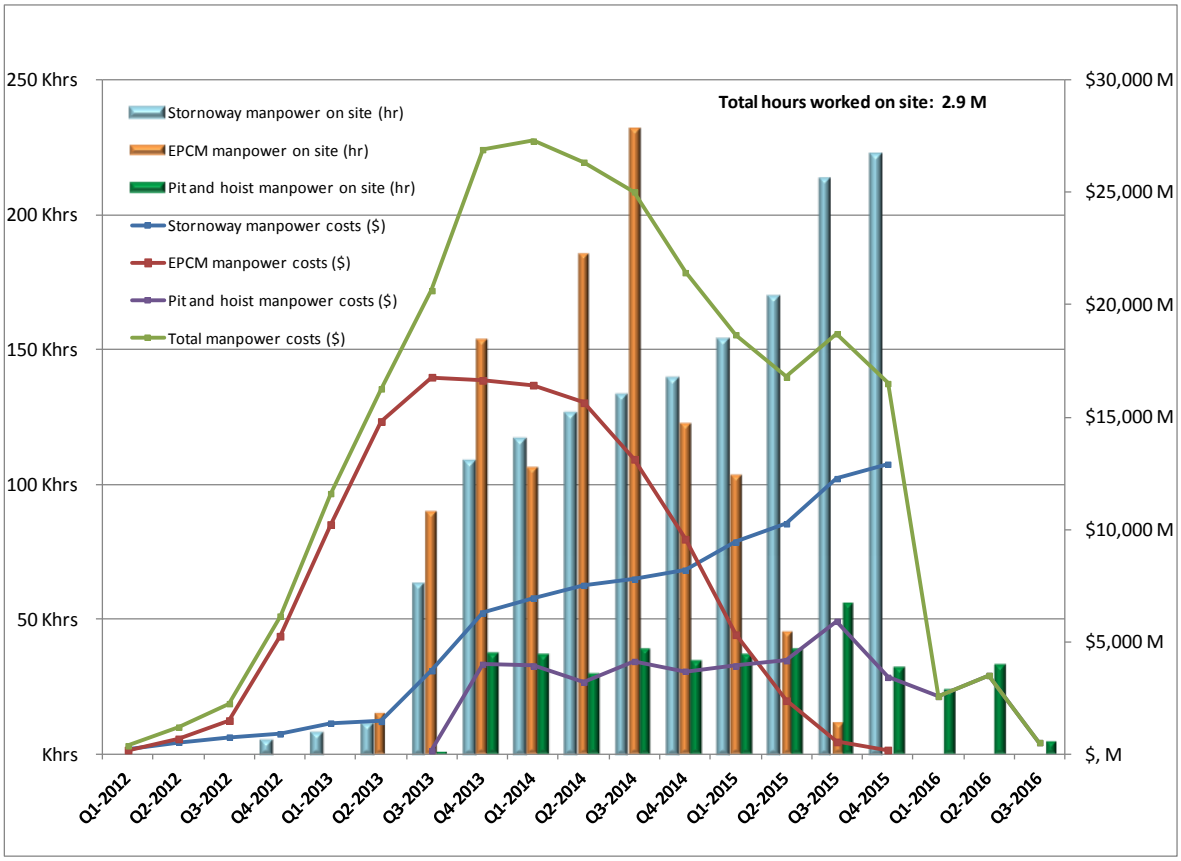
The models identify direct, indirect and induced effects, in financial terms and in terms of employment:

- The direct effects are the incomes (wages and profits) generated by the direct expenses of the company in the regional economy. First, the company pays wages to its employees. Second, through the purchase of goods and services (raw materials, semi-finished products, production services, etc.), the company generates revenues for its first-tier suppliers, part of which consists of income (wages and profits) for employees and the owners of these companies;
- The indirect effects are the revenues obtained by the owners and employees of businesses located in the intermediate level supply chain. Indeed, the first-tier suppliers must purchase goods and services from other companies, which produce at the regional level, resulting in income for other employees and owners, and so on;
- The induced effects are the revenues generated by the consumer spending of households who benefit from the direct and indirect spinoffs of the project. Some of these goods and services are obtained in the regional economy, from the retail stores, for example.

8.3.2.1 Impact Description and Assessment

During the construction phase, as in the operation and closure phases, the project component that is likely to have an impact on the socio-economic context is manpower and procurement.

At the peak of the construction phase, up to 550 workers will be required on the Renard Project site. The main job creators will be: Stornoway, with regard to mining development, the Engineering, Procurement, and Construction Management team (EPCM), and subcontractors for the construction of pits, the headframe and different surface infrastructure (civil works, buildings, power plant, ore processing plant, etc.). Throughout this phase, from 2013 to 2016, an annual average of 343 jobs will be created, which corresponds to approximately 2.9 million hours of work on site (Figure 8.3.3). For economic spinoff assessment purposes, manpower is reflected in person-years. A person-year is the number of hours normally worked for a year by the workers in a given sector. For example, 100 workers who work 10 % overtime equals 110 person-years. Two people working for six months each correspond to one person-year. The concept of employment expressed in person-years does not correspond to the number of people employed, but rather to the regular workload that includes the measured activities. During the period of nearly three years of the construction phase, approximately 1,421 person-years in jobs will be created or upheld throughout this project.



Source: Stornoway, December 2011

Figure 8.3.3 Hours worked on site and total cost of manpower

The positions to fill are in construction, engineering, mechanics, electricity, civil engineering, architecture, mine site development, the setting up of the plant, the construction of the airstrip, etc. Construction jobs require the possession of a certificate of competency issued by the *Commission de la construction du Québec* (CCQ). The types of trades needed are, for example: land surveyor, electrician, mechanic, heavy equipment operator, excavator operator, interior systems installer, welder, pipefitter, truck driver, and labourer.

Wherever possible, the involvement of the local and regional manpower will be maximized in the construction of the mine. The factors favorable to this goal are:

- Stornoway intends to prioritize the recruitment of workers from the Cree, Chapais and Chibougamau communities;
- The Cree population is growing, which means access to a larger labour pool within the next few years (expected growth of 13 % between 2008 and 2013);
- Many Crees are looking for jobs, and are therefore potentially available for work at the mine site or for training;
- Over the years, many regional workers, including Crees, have acquired experience and training in mining (e.g. Troilus, more recently);

- Several training programs offered by recognized institutions in the region are related to the mining industry;
- Regional workers have experience in construction, especially in development projects in their community, but also on various past and present hydroelectric projects. In addition, the Eastmain-1-A-Sarcelle-Rupert hydroelectric project should be completed during the year 2012, thereby freeing up regional labourers for the project;
- 9 % of the Cree manpower is employed in the construction industry.

Some other factors influence the availability of local and regional manpower, such as:

- The involvement and cooperation of regional stakeholders and the signatories of the IBA in the training of the population, their participation in the project and the maximizing of local economic spinoffs;
- The level of progress of other projects in the territory, putting pressure on the demand for workers;
- A possible shortage of manpower in the mining world due to the employment changes in the mining industry (gains and losses) and the turnover (interregional migration, intersectorial migration, retirement, etc.) (CSMO Mines, 2010);
- Competition from other projects in regard to the attraction and maintenance of the manpower. For example, the availability of Cree manpower following the completion of the work at the Eastmain-1-A-Sarcelle-Rupert site remains uncertain, considering the many mining projects in the region;
- The limited labour pool in the James Bay territory;
- The economic aspects in the Cree communities (construction, tertiary, etc.) that compete with the Renard Project (regular work schedule, closeness of families, tax exemption in Native communities, etc.).

Considering all these factors as well as the data from the interprovincial and interregional models of economic spinoff assessment, it appears that the James Bay territory and Abitibi-Témiscamingue region should provide more than a quarter of the manpower required for the construction phase of the Renard Project, with nearly 400 direct jobs in equivalent person-years (Table 8.3.6). It should be noted here that, for the purpose of analysis of labour pools, Stornoway takes a "broader" region into consideration, combining the administrative regions of Nord-du-Québec (NDQ) and Abitibi-Témiscamingue (AT). This approach is justified both by the industrial structure of the two respective regions and also by the high specialization of mining jobs. The feasibility study of the project has shown, based on a detailed analysis of business needs as well as suppliers in the region, that this “broadened” region will be able to provide about 12 % of construction costs for the Renard Project (see Section 3.19.3.1). In the context of the Eastmain-1-A-Sarcelle-Rupert hydroelectric project (Hydro-Québec, 2004), it was also established that "the economic context of Abitibi-Témiscamingue is denser than that of Nord-du-Québec, and the businesses of this region have strong technical and financial capacities." In this context, it was therefore concluded that in the region, "as the application of certain measures proved to be difficult, due in particular to an insufficient number of local businesses to ensure fair competition, ComaxNORD (*Comité de maximisation des retombées économiques dans le Nord-du-Québec*) has partnered with ComaxAT (*Comité de maximisation des retombées économiques en Abitibi-Témiscamingue*)". Such an interregional collaboration still exists and the two organizations work together in order to broaden their scope of intervention to mining companies (http://www.comaxat.com/activite/a-4.html). In regard to the

specialization of mining jobs, the latest market analysis of employment in mining, done by the *Table jamésienne de concertation minière* (CSMO Mines, 2010), showed that the current place of residence of Quebec's mine workers is divided between 7 % in Nord-du-Québec and 43 % in Abitibi-Témiscamingue, thus illustrating the dominance of the latter region in regard to the mining industry's labour pool. At the same time, the CSMO Mines indicated that the need for manpower in the mining industry would amount to 7,453 workers in Nord-du-Québec by 2020, which suggests a strong competition for new jobs in the future mines of this region.

Conscious of Nord-du-Québec's commitment and desire to contribute significantly to the construction and operation of the Renard Project, specifically in the Eeyou Istchee James Bay territory, Stornoway will develop a policy for hiring and for the maximization of economic benefits that will give priority to the residents of that region. To this end, provisions have been made in the Impact and Benefit Agreement (IBA) to maximize employment among the Cree of Eeyou Istchee. In addition, there are plans to create a working group with representatives from Chibougamau and Chapais, in consultation with local and regional organizations working in economic and training sectors, to develop tools to monitor economic spinoffs and to increase employment and economic benefits.

In total, while also taking into account the indirect employment and induced employment, this phase should provide 6,642 jobs in equivalent person-years, divided among:

- Direct employment (21 %): jobs related directly to the mine site;
- Indirect employment (36 %): jobs with suppliers who are related to the mine site;
- Induced employment (42 %): jobs created or maintained by the expenses of workers.

Nearly 70 % of all jobs in relation to the construction of the Renard Project will be found in Quebec (4,590 jobs in equivalent person-years out of 6,642).

Table 8.3.6 Economic Spinoffs of the Renard Project in Terms of Employment (person-years) – Construction Phase

Impacts on employment	Region (NDQ and A.T.) (1)	Regional % in relation to the Canadian total	Rest of Quebec	Other provinces	Canadian total	Importance of impacts
Direct	397	28 %	807	217	1,421	21 %
Indirect	90	4 %	1,462	860	2,412	36 %
Induced	192	7 %	1,642	975	2,809	42 %
Total	679	10 %	3,911	2,052	6,642	100 %
Geographic distribution	10 %	-	59 %	31 %	100 %	-

(1) Nord-du-Québec and Abitibi-Témiscamingue.

One positive effect derived from the creation of jobs is the improvement of employability and skills, especially for the Cree population. For workers who will not be able to continue working during the operation phase, the overall experience gained during the project will be particularly useful for finding new employment on the regional labour market. In addition, for construction workers, the number of hours worked at the mine site will contribute to the recognition of their expertise by obtaining certificates of competency from the CCQ.

8.3.2.2 Enhancement Measures

In order to encourage the creation of jobs during the construction phase in the James Bay territory and Abitibi-Témiscamingue region, Stornoway will develop a recruitment policy favouring regional hiring, more specifically in the Eeyou Istchee James Bay territory. For example, Stornoway's intention is to work closely with the communities of Chapais and Chibougamau to maximize employment spinoffs. To this end, the plan is to create a work team with representatives from Chibougamau and Chapais, in consultation with local and regional organizations working in economic sectors and training, to develop monitoring tools for assessing economic spinoffs. In regard to the Cree manpower in particular, the Impact and Benefit Agreement (IBA) also plans a series of measures that will encourage the employment, integration, advancement and retention of Cree workers in all levels of activities at the mine. In this regard, it should be noted that during the exploration phase, the company has already paid particular attention to hiring Cree workers. For the 2004-2009 period, the Crees have worked on the project for a total of 7,539 days, which represents 23.5 % of the 32,039 working days on site, and does not count the specialized work of external companies. For the 2010-2011 period, the work was greatly reduced and consisted mainly of maintenance activities. Half the manpower retained for this work was Cree. Finally, a communications plan with a full description of the human resources required for the project will be disclosed to potential local stakeholders. The number of vacant positions and the requirements and qualifications for each of them will be identified in order to establish the best possible match between the needs of the Renard Project and the labour supply from the Jamesian and Cree communities.

8.3.2.3 Residual Impacts

Although short, the construction phase will have a positive impact on the socio-economic context by creating and maintaining several jobs in the region. The intensity of the impact has been judged as being moderate and on a regional scale. The residual impacts are thus of moderate importance.

8.3.3 Operation Phase Impacts

8.3.3.1 Impact Description and Assessment

The operation phase will begin with open pit mining activities (overlapping the construction period) and will then make way for underground mining activities. On average, 450 workers are predicted to be hired for the twenty-year lifespan of the Renard mine operation activities, without counting the labour turnover

rate. The available jobs at the mine site are classified in the various services listed in Table 8.3.7. Also, Figure 8.3.4 shows the flow chart of the project's operation phase. It contains all the required job positions and the number of jobs per position.

In addition, twenty jobs in the management and administration team are found primarily in Longueuil, at Stornoway's project office.

The planned annual payroll for the operation activities of the mine is $48.2 million. With 39 % of the annual operation budget, the cost of labour represents a large part of this budget.

Table 8.3.7 Jobs at the Mine Site during the Operation Phase

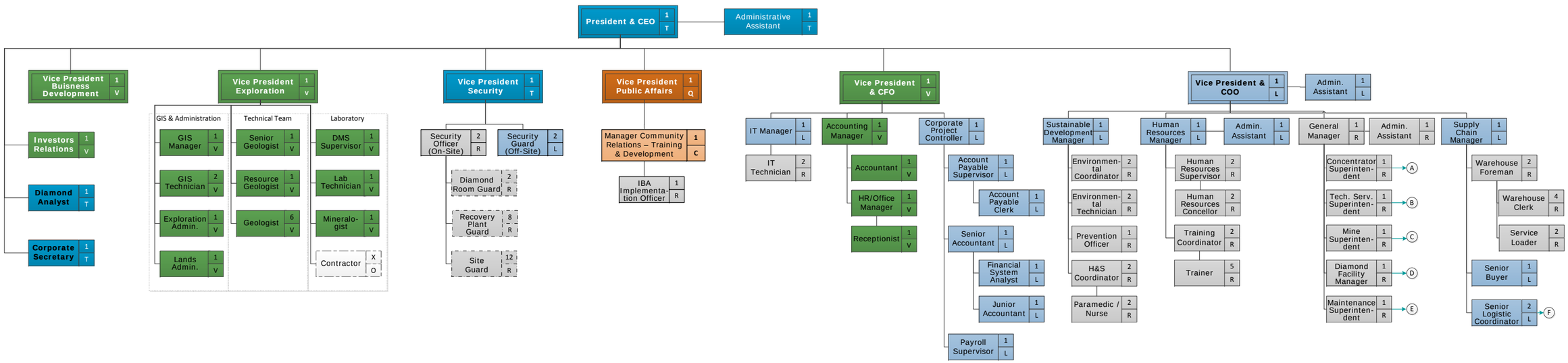
Activity, Service, or Department	Examples of jobs needed
Ore processing plant	Process engineers and technicians, foremen, operators
Services	Mine project engineers, surveyors, ventilation technicians, drill-blast technicians, geologists and geological technicians
Mining operations	Operators (trucks, excavators, dozers, loaders), miners, drillers, blasters, underground foremen
Diamond sorting installations	Glove box sorters, diamond cleaners, controllers, operators
Maintenance	Foremen, electrical and mechanical engineers, instrumentation technicians, mechanics, welders, mobile equipment planner, airport operators, power plant operators, maintenance superintendent
Accommodation and related services	Camp managers and various attendants (for the laundry, house-keeping, catering, etc.)
Environment/health and safety	Environment technicians, nurses, prevention officers, occupational health and safety coordinators
Human resources	Supervisors, advisors, trainers
Supplying	Warehouse clerks, service loaders
Security (subcontracted service)	Security officers, security guards

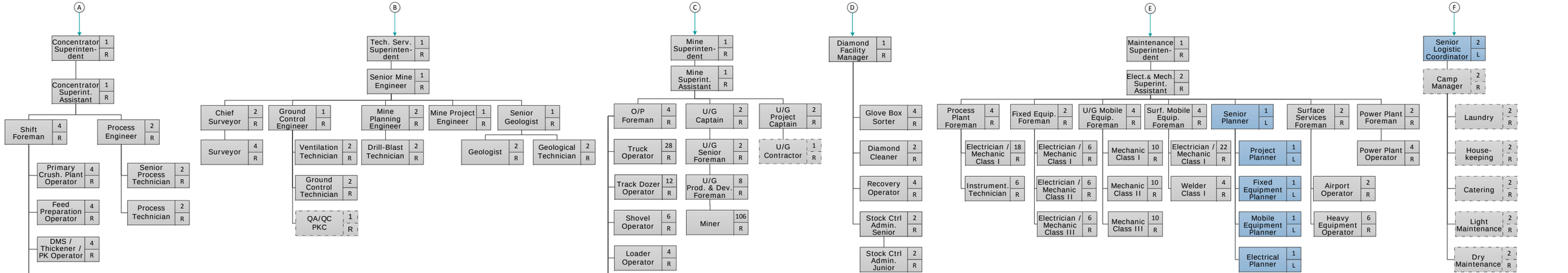
Figure 8.3.4 Organizational chart - Operation Phase

Updated: 2011-10-18

les diamants stornoway (canada) inc.

Stornoway – Operation Organizational Chart

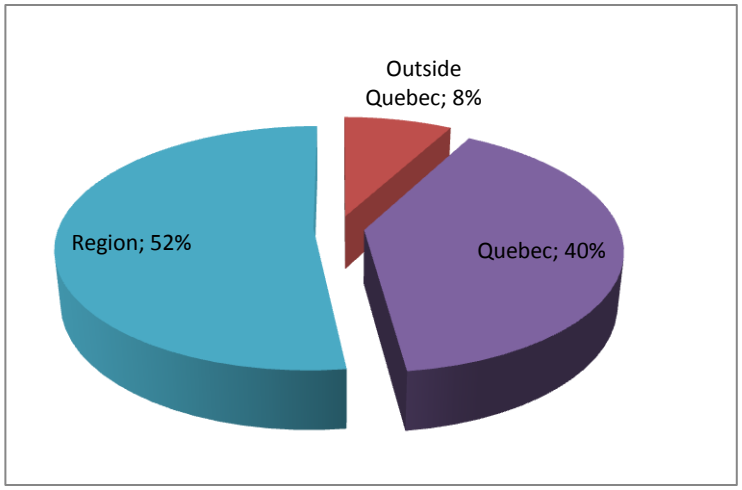




Stornoway will implement a recruitment plan that aims to achieve its hiring goals concerning the regional manpower, including the Cree communities. In regard to the Cree manpower more specifically, the IBA states that, “subject to the availability of a qualified Cree manpower and the employment needs for the Renard Diamond Project, the parties are collaborating to establish measures that will pursue their intentions of having a composition of workers at the mine site that will, in the long term, reflect the ratio of Cree people to the total population of the Eeyou Istchee James Bay territory.”

In 2006, according to Statistics Canada, the total population of the Eeyou Istchee James Bay territory was 29,316, of which 14,332 people, or 49 %, came from Eeyou Istchee (ISQ, 2011). Applying the reasoning described in the IBA, the goal would be that the pool of Jamesian workers at the mine would eventually be composed of 49% of Cree workers. To do this, the IBA plans on the implementation of various measures of integration and retention of Cree workers at the mine. The aim is that the Cree manpower remains as long as possible on the project, and that they reap the same benefits as all other workers.

As demonstrated by the most recent analysis on the mine labour market made by the *Table jamésienne de concertation minière* (CSMO Mines, 2010), the current place of residence of the mine workers of Quebec is divided between 7 % in Nord-du-Québec and 43 % in Abitibi-Témiscamingue. In this context, the realistic objectives of Stornoway are to prioritize the James Bay territory and Abitibi-Témiscamingue region in its distribution of the place of residence of its employees. Further analysis of the market by the proponent indicates that approximately 52 % of all workers for the whole project will come from this broadened region (Figure 8.3.5), meaning employees who already live near the mine sites of the region and who know their region, its geography, and its climate. As mentioned previously (Section 8.3.2.1), a special effort will be made to encourage the hiring of workers from the James Bay territory.



Source: Stornoway, December 2011.

Figure 8.3.5 Predicted distribution of manpower according to geographical origin – Operation Phase

Of course, achieving this objective depends on the cooperation and participation of regional stakeholders in the training of its manpower and its involvement in the project. Through the economic spinoffs work team discussed above in Section 8.3.2.2, Stornoway will facilitate this collaboration by regularly informing the regional stakeholders about the available jobs at the mine and of the qualifications required for these jobs.

In addition, some factors may also influence the degree of attractiveness of the Renard Project to workers and have an impact on the degree of involvement of the regional and Cree manpower. These include the following:

- The Renard Project site is remote and isolated (350 km from Chibougamau, 270 km from Mistissini). It is important to note that it is in the Nord-du-Québec region that the labour turnover rate is highest with 10.4 %, of which nearly 7 % would be attributable to workers leaving for other industries. Census data from the *Table jamésienne de concertation minière* demonstrates that the remoteness of many mines from urbanized centers has an impact on the turnover rate of employees, who prefer jobs closer to their family residence (CSMO Mines, 2010);
- The particular life conditions on the site: the obligation to live in a room in a camp, significant safety measures for all employees (camera surveillance, X-ray, various restrictions on areas, etc.);
- The fact that the mine site will be alcohol free;
- The difficulty for some candidates to obtain the necessary mining training, more specifically the underground mining training, considering the obligation to obtain a permit for handling explosives, which is dependent on a good criminal record;
- Isolation from family and the disruption of daily life;
- Maintaining good availability in terms of traveling across communities, so that no community, whether Jamesian or Cree, appropriates a particular mining project, with location as the only reason;
- The more difficult working conditions (cold, damp, underground work);

- The official language of the project is French (although the failure to speak French will not be a barrier to hiring, it is required for supervisory and higher level positions);
- The income tax for all workers, including the Cree.

Stornoway's objective to maximize the hiring of local and regional workers therefore exists in this specific context. The fact that the manpower is aging and becoming scarcer must also be taken into consideration. Indeed, the mining industry is faced with the following facts:

- That many skilled and experienced individuals are already occupied with projects (there are currently more than 6,000 mining workers living in Nord-du-Québec, Abitibi-Témiscamingue and Côte-Nord);
- That the need for skilled, trained, and competent manpower is rising;
- That in the near future, it will have to be taken into consideration that many retirees will need to be replaced;
- That other competitive projects in the territory will be launched shortly and all will compete for a specialized manpower;
- That although 58 % of manpower needs will be for projects in Nord-du-Québec within the next ten years, the CSMO Mines predicts that only 10.6 % of workers needed to fulfill Quebec's requirements will come from this region (CSMO Mines, 2010).

As shown in Table 8.3.8, the Renard Project's operation phase will allow for the direct employment of 244 regional workers (in equivalent person-years), or 52 % of all workers (in equivalent person-years). In total, the Renard Project will provide 432 direct jobs related to mining activities and ancillary facilities per year in Quebec. In addition to these direct jobs, the project will allow for the maintenance of 275 jobs with suppliers (mainly Quebec suppliers) and 465 jobs at merchants who will experience an increase in their activities due to the maintained or additional earnings of direct and indirect workers.

Table 8.3.8 Annual Economic Spinoffs of the Renard Project in Terms of Employment (person-years) – Operation Phase

Impacts on employment	Region (NDQ and A.T.)	Regional % in relation to the Canadian total	Rest of Quebec	Other provinces	Canadian total	Importance of impacts
Direct	244	56 % *	188	0	432	37 %
Indirect	60	22 %	138	76	275	23 %
Induced	87	19 %	269	110	465	40 %
Total	391	33 %	595	186	1,173	100 %
Geographic distribution	33 %	-	51 %	16 %	100 %	-

Person-years – Operation Phase

* *The regional percentage is higher than the proportion estimated by the project designer (52%), as this percentage is calculated according to the Canadian total, while jobs are also going to be filled by foreign workers.*

In addition to these positive spinoffs, the following positive impacts are anticipated:

- An overall increase in incomes for individuals, which will help raise their living standards and that of their families;

- The increase and strengthening of abilities and qualifications of the regional manpower due to the acquired experience, and the improvement of work skills and the opportunity to attend specialized training in employment. In this regard, as can be read in the report for the monitoring of the integration of Cree workers on the Eastmain-1-A-Sarcelle-Rupert project: "Work on site has enabled workers to experience several benefits that can increase their future employability. In this way, 44 % feel that they have sufficiently or greatly developed their network of contacts, 66 % believe that they have sufficiently or greatly developed their skills, and 52 % say they have improved their level of confidence in their abilities "(Hydro-Québec and SEBJ, 2009);
- The acquisition of regional expertise in a field that is new for Quebec (diamond extraction and processing).

8.3.3.2 Enhancement Measures

➢ *A TRAINING STRATEGY*

Stornoway will develop a training strategy for promoting skill development for employees at all levels of the organization. This strategy will focus on skills and the continuous development of qualifications, the opportunities for promotion, the planning for replacements and awareness raising in terms of the multicultural exchanges at stake. In addition, Stornoway will develop internal training programs and be involved in some external training programs. As such, Stornoway intends on working with educational institutions to encourage young people and students of the region to follow training programs related to the mining industry and to the trades that are specific to the Renard Project.

In addition, Stornoway will attribute up to eight of its employees the task of supervising training programs. Throughout the mine's lifespan, Stornoway will put aside up to 1.5 % of its payroll to ensure the successful development and implementation of training programs.

With regard to training for the Cree people, a specific chapter of the IBA is devoted to this topic and attests to the cooperation that will occur between Stornoway and the Crees on this subject. To achieve the training objectives established in the IBA, the agreement plans for the establishment of a Training and Employment Committee, which will be composed of an equal distribution of representatives from Stornoway on the one hand, and the Crees on the other (The Cree Nation of Mistissini, the Grand Council of the Crees (Eeyou Istchee) and the Cree Regional Authority).

➢ *A SYSTEM OF SHIFT ROTATION WORK ACCESSIBLE BY AIR*

All employees working at the mine will be flown from Montreal with a stopover in Chibougamau, and then on to the mine site. The return will be through Chibougamau, then on to Montreal. Employees will work in rotation: two weeks on, followed by two weeks off. This shift rotation system, accessible by air only, is commonly known as *fly-in fly-out*, and it will be greatly appreciated by potential candidates. With ArcelorMittal in Fermont, it was observed that older workers in the process of retiring are interested in doing rotating shift work. It is the same with younger people. This system is thus seen as a hiring incentive.

- *A QUALITY OF LIFE OUTSIDE OF WORK*

The employees of the Renard mine will stay in an accommodation and service complex and will each have their own room, which will include among other things, a television, a telephone and Internet access. All employees will have access to many services or related infrastructure, for example, a cafeteria, a kitchen, a library, a common room with a TV and home theater, areas set up for social interaction, etc.

- *COMPETITIVE WAGES AND OTHER BENEFITS*

In addition to an attractive base[7] salary, performance bonuses will be paid to employees who work beyond the normal requirements of their employment. Also, a pension fund in which Stornoway intends to pay up to 50 % of the voluntary contribution of the employee is being considered. Group insurance will be offered (life, accident, disability, medical, dental, etc.). An employee assistance program will also be introduced.

INTEGRATION AND AWARENESS RAISING MEASURES

To facilitate the integration of Cree workers, several measures will be implemented, including awareness raising with workers with regards to cultural differences (see Section 8.5.3.2). Also, Stornoway will inform and educate subcontractors about the importance of encouraging the participation of Cree workers.

Stornoway's human resource policies will be developed in accordance with accepted principles for equal opportunity of employment.

8.3.3.3 Residual Impacts

The impact of mining operations on the socio-economic context is positive. The impact is considered of a high intensity, of a regional extent, and of moderate duration. The importance of the residual impact is high.

[7] In 2007, the average weekly wage of a worker in the mining industry was higher than the earnings of workers in the sectors of construction, manufacturing, forestry and finance / insurance, by 30%, 29%, 24% and 22%, respectively (MIHR, 2011).

8.3.4 Closure Phase Impacts

8.3.4.1 Impact Description and Assessment

Closure phase activities at the mine will decrease considerably compared to the operation phase. It is estimated that fifty workers (part time) and some planters will be needed. An environmental monitoring program will also be implemented. Given the nature of the work to be done, it is quite conceivable that a significant proportion of workers required for this work valued at $ 9.7 million will come from the Nord-du-Québec region.

The assessment of the economic spinoffs in terms of jobs in the region, therefore, considers the direct impact to be 34 person-years. In total, closure activities would support some 135 jobs in the country (Table 8.3.9).

Table 8.3.9 Economic Spinoffs of the Renard Projet in Terms of Employment (person-years) - Closure Phase

Impacts on employment	Region (NDQ and A.T.)	Regional % compared to Canadian total	Rest of Quebec	Other provinces	Canadian total	Importance of impacts
Direct	34	87 %	5	0	**39**	29 %
Indirect	9	17 %	30	13	**53**	39 %
Induced	8	19 %	23	12	**43**	32 %
Total	**51**	**38 %**	**58**	**25**	**135**	**100 %**
Geographic Distribution	**38 %**	**-**	**43 %**	**19 %**	**100 %**	**-**

Note also that the closure of the mine will involve a massive loss of jobs in the Renard Project facilities. Stornoway will provide certain severance pay varying from one job group to another and will participate in measures under the *Act respecting labour standards* which concerns the creation of a committee to assist in manpower relocation. Moreover, the company will set aside budgets to track post-closure relocation of workers.

8.3.4.2 Enhancement Measures

As in other phases of the project, the proponent will support the hiring of regional manpower. This intention was reflected in the IBA, which extends to mine closure activities.

8.3.4.3 Residual Impacts

The impact of closure activities on job creation is short. Its intensity is low and its extent is local. The importance of the impact is therefore low.

8.4 Economic Environment

8.4.1 Current Conditions

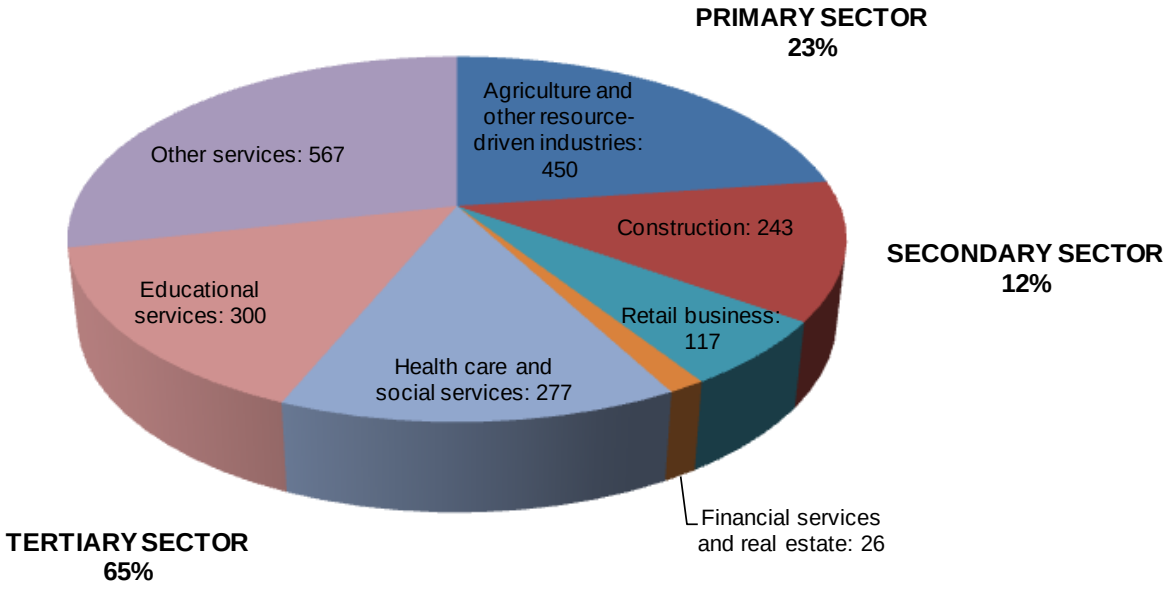
8.4.1.1 The Cree Environment

➢ *ECONOMIC STRUCTURE*

After the signing of the JBNQA, many jobs were created in the Cree communities, particularly in the utilities sector. The jobs held by Crees are more specialized. Today, a significant number of Cree workers can be found in teaching, social work, and administration. The largest employers in the communities are band councils, the Cree School Board and the Cree Board of Health and Social Services of James Bay. The Crees are also employed by companies involved in construction, transportation, logging and mining.

In terms of employment distribution by industry, the tertiary sector includes the majority of workers (65 %). In particular, the areas of health and education occupy an important place, involving nearly a third of the manpower (Figure 8.4.1).

Finally, note that tourism-related activities have a positive economic impact in the community of Mistissini, thus promoting the establishment of reception facilities in the village: accommodation (Mistissini Lodge) and restaurant services; reception, information, and reservation centres; docking facilities and services for boats and float planes, etc.



Source: CHRD, 2009.

Figure 8.4.1 Job distribution by sector of economic activity. Mistissini community (2008)

➢ *INDUSTRIES AND BUSINESSES*

Several regional companies belonging to the Crees or to the band councils are present in Cree territory. These companies operate primarily in the construction, communications, and services sectors. Included among the most important are the Cree Construction and Development Company (CCDC), Air Creebec, the PetroNor oil company, and Groupe Kepa.

Besides these companies, the Cree communities have several local businesses, most of which belong directly or indirectly to the band councils. Note also that a number of partnerships between Cree, Jamesian, and Quebec companies have been formed in the past and have enabled these associations to carry out major mandates in the context of the Eastmain-1-A-Sarcelle-Rupert hydroelectric project.

In Mistissini, the community includes more than forty companies in fields as diverse as food, restaurant, secretarial services, financial services, etc. According to a survey conducted in June 2011, with the authorities of the community of Mistissini, there are 27 companies whose expertise can be harnessed in a mining project. The majority of these are certified to bid on various construction contracts determined under the *Cree-Naskapi (of Quebec) Act* (S.C. 1984, c.18). The firms surveyed work in the following categories: excavation, infrastructure, trucking, snow removal, construction, renovations, electricity, hardware, landscaping, forestry, etc. (Roche, 2011).

➢ *INFRASTRUCTURE AND COMMUNITY SERVICES*

Like the other Cree communities, Mistissini has good quality amenities and services (arenas, police and fire departments, community radio, community hall, etc.).

Mistissini also houses regional services for the Cree Human Resource Development (CHRD) and the Cree School Board (CSB).

In addition to these regional services, Mistissini has a clinic run by the Cree Board of Health and Social Services of James Bay (CBHSSJB) and various other social services. Finally, note that the Cree School Board is headquartered in Mistissini. Elementary and secondary education in the community of Mistissini is provided by the Voyageur Memorial School. From kindergarten to elementary grades, the teaching program is given in Cree, and then replaced by the Quebec program, either in French or in English.

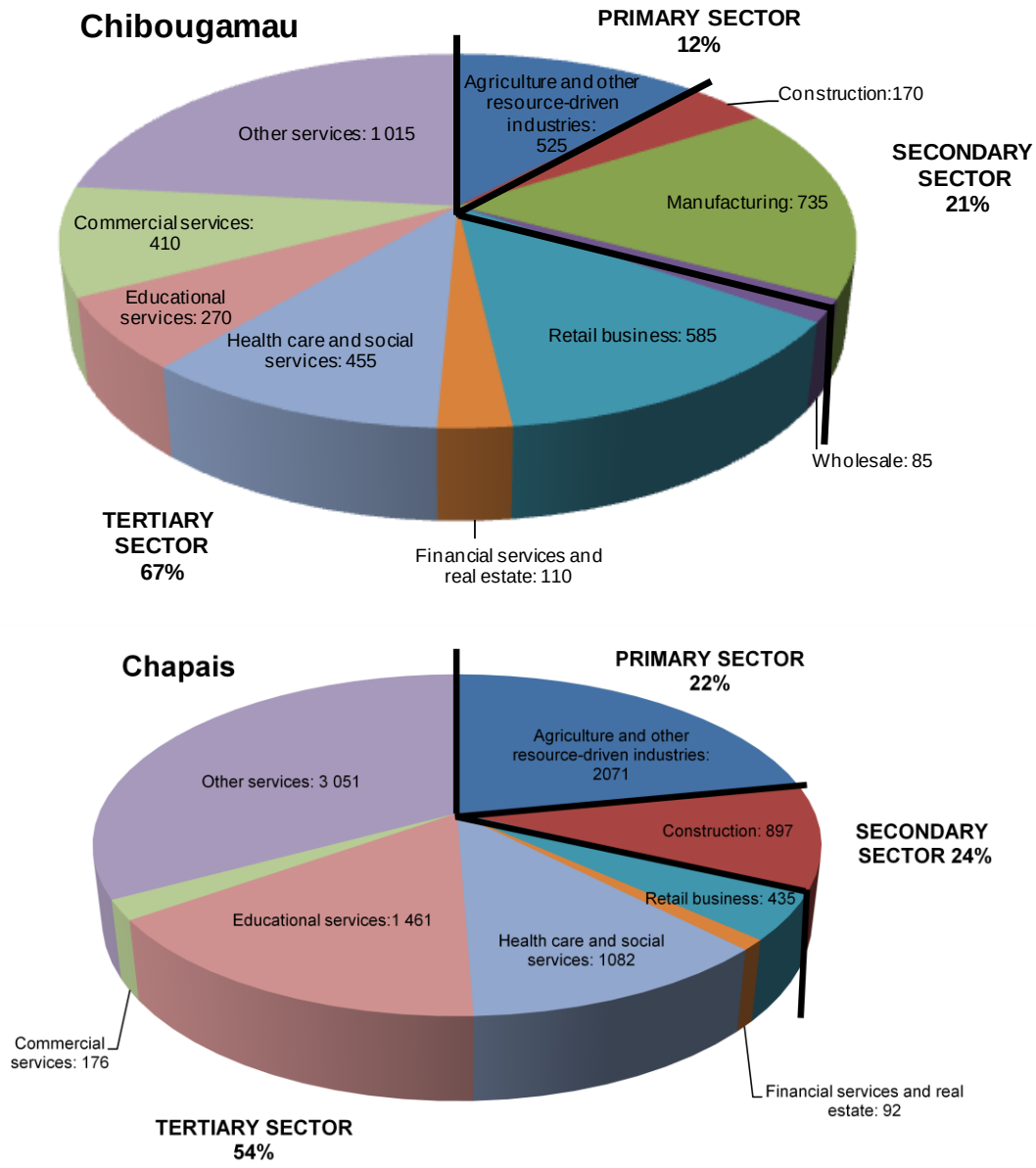
8.4.1.2 The Jamesian Context

➢ *ECONOMIC STRUCTURE*

Chibougamau and Chapais, two towns founded on mining, now benefit from forestry, an activity that marks the local economy.

Chibougamau and Chapais stand out from the rest of Quebec by the quite significant number of people associated with the primary sector, respectively 12.0 % and 21.5 %, versus 3.7 % for all of Quebec.

They also play an important role in the tertiary sector, mainly in Chibougamau, resulting from the diversification of the regional economy in recent years (Figure 8.4.2). We must remember that, in regional economic history, the decline of mining in the 1990s, following the depletion of resources for several mines, resulted in the loss of a considerable number of jobs. These were later made up by jobs in the forestry industry and services to the population, and finally the construction of hydroelectric projects, namely the Eastmain-1 and Eastmain-1-A-Sarcelle-Rupert projects.



Source: Statistics Canada, 2006

Figure 8.4.2 Job distribution by sector of economic activity. Chibougamau and Chapais (2006)

- *INDUSTRIES AND BUSINESSES*

Although employment in the forestry industry has declined dramatically in recent years, this industry continues to take up significant room across the MBJ because it represents one in four jobs in the region. In Chibougamau particularly, the forest industry plays a major role with the presence of Chantiers Chibougamau, a company that employs 600 people. Chibougamau is also home to more than a hundred businesses from various sectors: grocery, bulk trucking, concrete, brush cutting, etc.

In Chapais, the forest industry is the most important driver of economic development with the Barrette-Chapais company, which offers 350 high quality jobs. There are also medium-scale industries, such as the cogeneration plant, *Chapais Énergie*, *Soudure et Usinage Chapais*, and *Les fournitures minières Simard*. Besides these industries, several other businesses and services are also present in Chapais.

The ComaxNORD (http://www.comaxat.com/comaxnord.html) has found, in the towns of Chibougamau and Chapais, all companies that are able to offer specialized services for major projects such as the Eastmain-1-A-Sarcelle-Rupert project. The analysis of this directory identified 47 companies in these two towns that could in principle work on a mining site such as the Renard Project. The various services these companies offer cover the following categories: general contractor, machining, welding, framing, concrete, forestry, landscaping, excavation, backfilling, carpentry and joinery, earthwork, heavy transport, hydraulics, beams, explosives, drilling and blasting, etc.

- *INFRASTRUCTURE AND COMMUNITY SERVICES*

The towns of Chibougamau and Chapais benefit from infrastructure and services typical of cities in Quebec.

Chibougamau also houses the headquarters of the *Centre régional de santé et de services sociaux de la Baie-James* (CRSSSBJ), which provides health services to regional customers at the *Centre de santé de Chibougamau* and at the *Centre de santé René-Ricard* in Chapais. Chibougamau has three primary schools (Bon-Pasteur, Notre-Dame du Rosaire, and Vatican II) and one high school (La Porte-du-Nord), which offers instruction in French. English speakers have access to MacLean Memorial, which includes elementary and secondary school levels; this is run by the Central Quebec School Board (CQSB).

Chapais has, in turn, a primary school and a high school that provides secondary level 1 to 4 courses. Young people from Chapais wishing to complete their secondary 5 go to La Porte-du-Nord in Chibougamau.

In terms of other levels of training, Chibougamau is home to the *Centre d'études collegiales de Chibougamau*, associated with the *Cégep de Saint-Félicien*. It also offers services to businesses and the community, some programs of the *Université du Québec en Abitibi-Témiscamingue* (UQAT), the *Centre de formation générale de Chibougamau*, and finally, the *Centre de formation professionnelle de la Jamésie*.

8.4.2 Construction Phase Impacts

As for what was done previously (see Section 8.3.2), the economic spinoff assessment uses two analytical models developed by EcoTec Consultants, which is the interprovincial model (calculations across Canada, for each province) and the interregional model (calculations at the level of administrative regions in Quebec).These models identify the direct, indirect and induced effects, in monetary terms.

In the construction phase, as in the operation and closure phases, the project component that is likely to cause an impact on the economic environment is manpower and procurement.

8.4.2.1 Impact Description and Assessment

According to an estimate by Stornoway, the construction work for the Renard Project will require a large initial investment estimated at $801.8 million. The elements of cost are detailed in Table 8.4.1. The major elements are: the development of mining infrastructure accounting for 29 % of expenditures ($236.2 million), construction of the ore processing plant representing 21 % of total costs with $168.4 million, utilities and infrastructure adding up to 13% ($102.4 million) and the owner's costs, accounting for 11 % of the total budget ($86.2 million).

More specifically, among the work to be performed or the purchases to be made for construction activities of the mine site, are included:

- Land clearing and earthwork;
- The construction of mine roads;
- The purchase, assembly and installation of specialized equipment;
- The installation of buildings necessary for the operation of the mine (including prefabricated infrastructure);
- The construction of the building that will shelter the power generator sets;
- The construction of the airstrip and the terminal;
- The construction of the ore processing plant;
- The transport of materials and equipment;
- The purchase of mobile equipment;
- The purchase of food;
- The purchase of diesel.

Table 8.4.1 Cost Distribution for Initial Investments

Elements of Cost	Amount ($)	%
Direct costs	***$530,597,391***	
Site preparation	$22,938,518	3
Mining infrastructure*	$236,193,724	29
Surface mining infrastructure	$674,045	0.1
Ore processing plant	$168,423,172	21
Utilities and infrastructure	$102,367,932	13
Indirect costs	***$271,189,490***	
Owner's costs	$86,153,168	11
Spare parts, tools, and inventory of the processes	$10,170,767	1
Engineering, Procurement, and Construction Management services (EPCM)	$45,000,000	6
Standard construction costs	$13,101,363	2
Construction costs – diverse provisions	$6,887,000	1
Accommodation and transport during construction	$24,976,257	3
Technical representatives, start-up support	$2,473,746	0
Logistics and transport, customs fees	$8,108,937	1
Contingencies	$74,318,252	9
Total for investments before production	**$801,786,881**	100 %

** Costs associated with mining infrastructure include the operation of open pit mining sites, since these activities are undertaken simultaneously with the construction phase.*

Note: Investment costs are estimated with -13 % and +17 % accuracy. The high voltage power line is not included in these costs.

Source: Stornoway, November 2011.

The work on the site should begin in May 2013 and be completed by the end of 2015. Some equipment that has a long delay for delivery (24 months) will be ordered before the work begins in order not to delay the start of the project. Indeed, some highly specialized equipment required for the construction of the mine, such as the ore crusher, will come from abroad, and represents the equivalent of 12 % of investment costs. For the remaining expenses, a large proportion of them will occur in Quebec since the proposed activities relate to areas of construction where Quebec firms are qualified. In fact, early estimates from the mining designer indicate that almost two-thirds of the investments should be directed to Quebec companies ($500.1 million), including 12 % of businesses from Eeyou Istchee James Bay and Abitibi-Témiscamingue (approximately $95 million)[8]. Depending on the capacity of regional

[8] The indicated amounts include employee salaries.

businesses, it is more specifically estimated that they could perform the civil engineering and construction work, including:

- Land clearing;
- The transport of aggregate materials to the site;
- Concreting work;
- The sites preparation and development for building;
- The construction of various facilities such as an office, a cafeteria, a medical clinic, etc.;
- Offices supplies and televisions;
- The operation and maintenance of infrastructure;
- General and final cleaning;
- Etc.

Of course, the degree of involvement of regional businesses will also depend on their interest in the project and on their submission of a competitive bid. In this respect, we can probably assume that the interest already expressed jointly by the Crees, Jamesians and Abitibians vis-à-vis the economic spinoffs of the *Plan Nord* is a guarantee of concrete participation of regional businesses in the Renard Project (Desbiens, 2011a). In addition, Stornoway is committed to maximizing the opportunities for regional businesses in a competitive context.

➢ *ECONOMIC SPINOFFS*

The economic spinoffs associated with Stornoway's investment expenditures for the construction work result in value added and the contribution of government revenue for the two superior levels of government.

The value added (or the gross domestic product) is the measure of the value of domestic production of a given economy. It is obtained by adding the remuneration of the production factors together: wages and salaries, the net income of individual businesses, social contributions, other gross income (profits and capital depreciation), indirect taxes on consumption and production, and subsidies for products and production. Thus, the value added represents the earnings of households, businesses and governments.

During the nearly three years of the construction phase, the initial investment of $801.8 million should generate economic spinoffs of about $733 million nationwide, with 14% in the Nord-du-Québec and Abitibi-Témiscamingue regions and 55 % in the rest of the province of Quebec (Table 8.4.2). The difference between the initial investment and the total economic spinoffs is mainly due to goods and services that are manufactured outside of the country.

Note also that across Canada, the induced effects are as important as the direct effects, meaning that workers' incomes represent a very important component of the total spinoffs and that the retail sector will greatly benefit from the construction phase.

The income of regional economic agents, or the value added by region, is evaluated at over $99 million, including direct[9], indirect[10] and induced[11] effects. Salaries before taxes represent 70 % of this added value, or nearly $70 million (Table 8.4.3).

Table 8.4.2 Renard Project's Economic Spinoffs – Construction Phase

Effects	Region (M$) (NDQ and A.T.)	Rest of Quebec (M$)	Other provinces (M$)	Canadian total (M$)	*Importance of impacts*
Direct	71.9	149.3	40.4	**261.6**	*36 %*
Indirect	7.9	118.1	83.0	**209.0**	*29 %*
Induced	19.5	139.2	103.7	**262.4**	*36 %*
Total	**99.4**	**406.6**	**227.1**	**733.0**	***100 %***
Geographic Distribution	*14 %*	*55 %*	*31 %*	*100 %*	-

Table 8.4.3 Regional Economic Spinoffs – Construction Phase

Element of value added	Direct effects	Indirect effects	Induced effects	Total effects	%
	M$				
Salaries and wages before taxes	57.7	5.0	6.7	**69.3**	*70 %*
Other income before taxes	14.4	2.9	12.8	**30.1**	*30 %*
Total value added	**71.9**	**7.9**	**19.5**	**99.4**	*100 %*
%	*72 %*	*8 %*	*20 %*	***100 %***	-
Manpower (person-years)	397	90	192	**679**	-

➢ *GOVERNMENT REVENUES*

The construction work should also benefit both superior levels of government through tax revenues. These revenues come primarily from the personal income tax, the goods and services tax (GST) or the Quebec sales tax (QST), as well as other indirect taxes and the tax on business profits. In total, more than $150 million should go to both levels of government following the introduction of expenditures for construction work in the Canadian economy (Table 8.4.4).

[9] The direct effects are the revenues (wages and profits) generated by the direct expenditures of Stornoway in relation to the project. First, Stornoway pays wages to its construction workers. Second, through the purchase of goods and services (raw materials, semi-finished products, production services, etc.), the company generates revenues for its first-tier suppliers, part of which consists of income (wages and profits) for employees and the owners of these companies.

[10] The indirect effects are the revenues obtained by the owners and employees of businesses located in the intermediate level supply chain. Indeed, the first-tier suppliers must purchase goods and services from other companies, which produce at regional level, resulting in income for other employees and owners, and so on.

[11] The induced effects are the revenues generated by the consumer spending of households who benefit from the direct and indirect spinoffs of the project. Some of these goods and services are obtained in the regional economy, from the retail stores, for example.

Table 8.4.4 Government revenues arising from the Renard Project – Construction Phase

Description *	Direct effects	Indirect effects	Induced effects	Total effects
	M$			
Provincial revenues	**20.4**	**11.4**	**27.7**	**59.6**
Personal income tax	19.7	6.0	5.9	**31.6**
QST and other indirect taxes	0.7	2.0	17.4	**20.1**
Taxes on business profits	0.1	3.4	4.4	**7.9**
Federal revenues	**22.1**	**19.2**	**49.5**	**90.7**
Personal income tax	20.6	7.1	7.3	**35.0**
GST and other indirect taxes	1.2	4.8	32.5	**38.5**
Taxes on business profits	0.3	7.3	9.7	**17.3**
Total provincial and federal revenues	**42.5**	**30.6**	**77.2**	**150.3**

** Does not include Stornoway's property taxes, mining rights, and income taxes.*

8.4.2.2 Enhancement Measures

In order to maximize regional, and particularly local, economic spinoffs, which includes the Jamesian and Cree communities, Stornoway commits itself to working in close collaboration with the communities from Chapais and Chibougamau to increase the advantages for suppliers. To this end, the intention is to create a working group with representatives of Chibougamau and Chapais, in consultation with the local and regional organizations operating in the sectors of employment and training in order to develop tools to monitor economic spinoffs.

Concerning Cree enterprises in particular, the IBA includes the following explanations and provisions:

- In granting contracts to Cree enterprises (Article 7.4 of the IBA), the following criteria will be taken into account, whenever applicable, and according to a relative weighting that will vary depending on the nature of the contract in question: cost competitiveness, health and safety data and program, the performance and the environmental programs, the availability and the continuity of services, financial capacity, the quality and work experience of the bidder, punctuality, and finally, Cree content;
- The Crees have the responsibility to establish and keep up to date the list of Cree enterprises interested in working on the Renard Project (Article 7.5); this list must include data on the goods and services offered, on pertinent experience, on the number of Cree employees, on the ownership and management structure of the business, and finally on its location.

At the same time, other provisions deal with the procedure for the negotiation of contracts (Articles 7.7, 7.8, 7.9, and 7.10) and business opportunities for M11 trapline users.

More specifically, in regard to the contracts during the construction phase (Article 7.6.4), the IBA specifies that, in the 60 days after the IBA comes into effect, and each following year, no later than 30 days after the adoption of the enterprise's annual budget, Stornoway will submit to the IBA monitoring committee (Renard Committee) the list of goods and services required during the year.

8.4.2.3 Residual Impacts

Although of a short duration, the positive residual impact is considered of high intensity and of regional scope. The impact is therefore moderate.

8.4.3 Operation Phase Impacts

8.4.3.1 Impact Description and Assessment

During the operation phase of the Renard mine, the extraction of 7,000 tonnes of ore a day is expected over a twenty-year period, i.e. from 2015 to 2033. The facilities are designed to operate continuously (24 hours a day, 365 days a year). Annual expenses for the operation of the Renard diamond mine will reach $125.1 million. Salaries and the purchase of gasoline and diesel make up the two principle budget items for the proponent, accounting for 39 % and 27 %, respectively, of the total annual budget (Table 8.4.5).

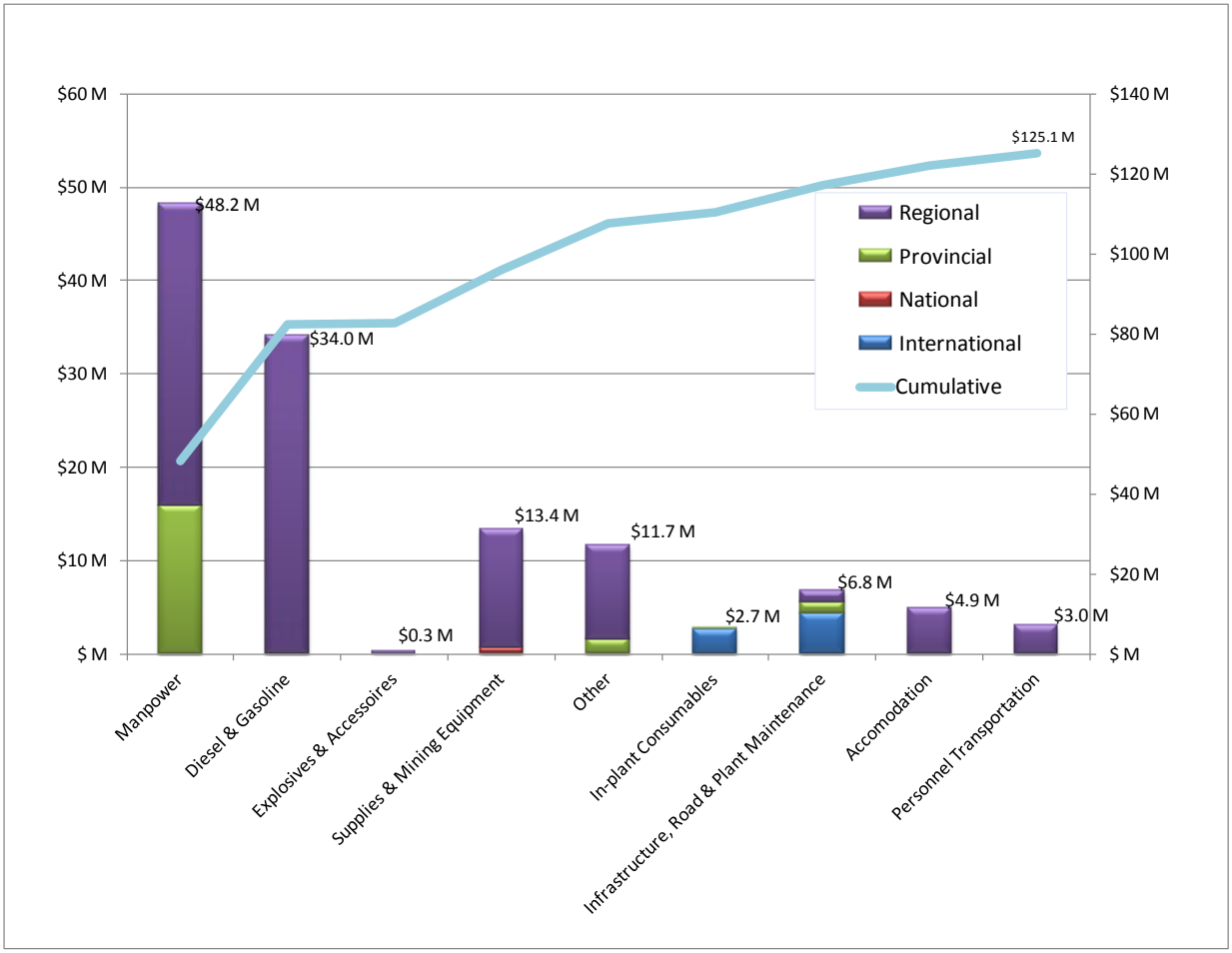
Table 8.4.5 Annual Operation Cost Breakdown

Cost Elements	International	National	Provincial	Regional	Total
Manpower	$3,859	$0	$19 295	$25,083	$**48,236**
Diesel & gasoline	$0	$0	$0	$34,035	$**34,035**
Explosives & accessories	$0	$0	$0	$345	$**345**
Supplies & mining equipment	$0	$634	$0	$12,734	$**13,368**
Other	$0	$0	$1,613	$10,056	$**11,669**
In-plant consumables	$2,661	$0	$82	$0	$**2,744**
Infrastructure, road and plant maintenance	$4,358	$0	$1,171	$1,252	$**6,781**
Accommodation	$0	$0	$0	$4,890	$**4,890**
Personnel transportation	$0	$0	$0	$3,039	$**3,039**
Total	$**10,878**	$**634**	$**22,161**	$**91,434**	$**125,107**
Breakdown	*9 %*	*1 %*	*18 %*	*73 %*	*100 %*

The majority of these expenditures should be made in the region and in the province. These estimates take into account the capacity of regional enterprises to supply these goods, services, and the manpower necessary for the operation of the mine and its ancillary infrastructure (ex. mine camp). Among others, it refers to:

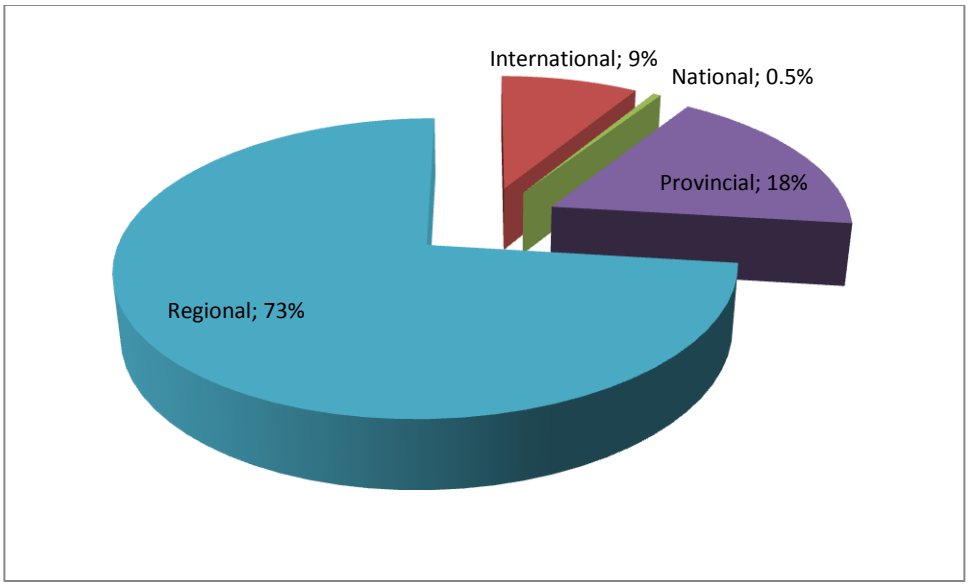
- The supply of diesel and gasoline;
- The supply of mining equipment;

- The maintenance of the infrastructure, the road and the plant;
- The supply of goods and services for the mine camp (ex. food and maintenance);
- Personnel transportation.



Source: Stornoway, December 2011

Figure 8.4.3 Operation costs breakdown by category and according to location



Source: Stornoway, December, 2011.

Figure 8.4.4 Annual operation costs breakdown according to location

- *ECONOMIC SPINOFFS*

Table 8.4.6 shows the annual economic spinoffs arising from the operation expenditures of the Renard mine. The direct effects are broken down as illustrated in Figure 8.4.5. The direct value added that will be generated in the Nord-du-Québec and Abitibi-Témiscamingue regions corresponds to $25.7 M, or 57 % of the total direct value added of the country.

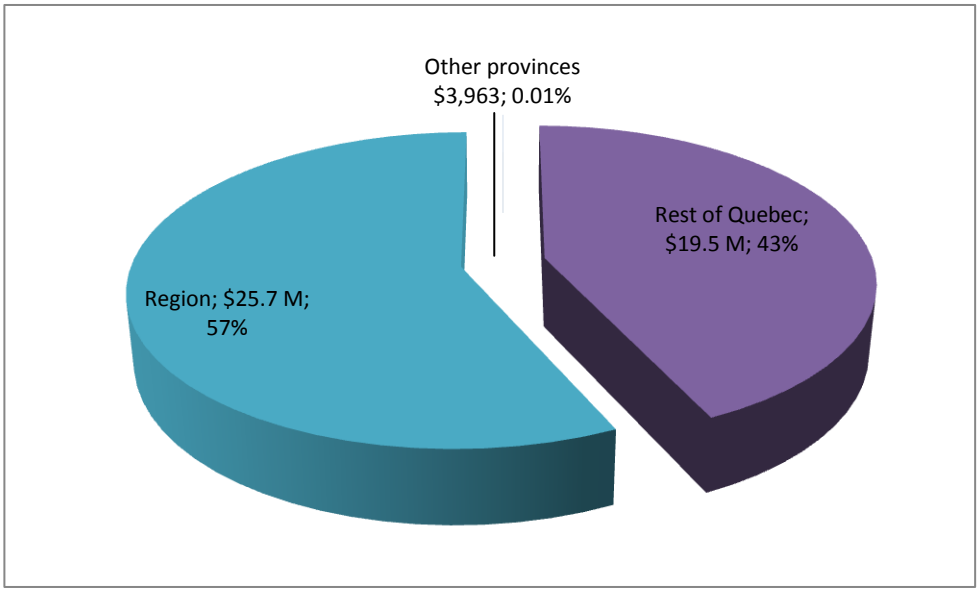


Figure 8.4.5 Distribution of the direct value added according to location

In total, including the direct, indirect, and induced effects, economic spinoffs are estimated at $110.8 M across the country, and break down as follows (Table 8.4.7):

- $37.5 M for economic agents from the region;
- $52.5 M for economic agents from the rest of Quebec;
- $20.8 M for economic agents from the rest of Canada.

This creation of value comes from the salaries paid to workers whose jobs will be created or maintained thanks to the project and other revenues of the economic agents (enterprises, government).

At a regional level, it is close to three quarters of the value added that can be attributed to direct, indirect, and induced worker salaries, totalling more than $27 M (Table 8.4.7). It must be noted that the project will support close to 400 regional jobs in equivalent person-years. A global increase of revenues will most certainly contribute to raising the standard of living of individuals and that of their families. Moreover, the increase in buying power of local communities could help certain individuals start out in business and create new businesses. In addition, a part of the revenues and benefits resulting from the contracts obtained with the regional enterprises could be invested in the communities in order to stimulate the economy, create employment or diversify the sectors of economic activity.

Table 8.4.6 Economic Spinoffs of the Renard Project - Operation Phase

Effects	**Region (M$) (NDQ and A.T.)**	**Rest of Quebec ($M)**	**Other provinces ($M)**	**Canadian total ($M)**	***Importance of impact***
Direct	25.7	19.5	0.0	**45.2**	*41 %*
Indirect	3.4	10.9	9.4	**23.7**	*21 %*
Induced	8.4	22.1	11.4	**41.9**	*38 %*
Total	**37.5**	**52.5**	**20.8**	**110.8**	***100 %***
Geographic Distribution	*34 %*	*47 %*	*19 %*	*100 %*	-

Table 8.4.7 Regional Economic Spinoffs - Operation Phase

Components of the value added	**Direct effects**	**Indirect effects**	**Induced effects**	**Total effects**	*%*
	$M				
Salaries and wages before tax	22.1	2.1	3.0	**27.2**	*73 %*
Other revenues before tax	3.7	1.2	5.4	**10.3**	*27 %*
Total Value Added	**25.8**	**3.4**	**8.4**	**37.5**	*100 %*
%	*69 %*	*9 %*	*22 %*	***100 %***	-
Manpower (person-years)	244	60	87	**391**	-

Beyond the monetary impact, the participation of regional enterprises and manpower in the project will certainly contribute to supporting, solidifying, and developing a core group of businesses and a labour pool that will gain expertise in order to eventually participate in the development of their territory. This increase in capacities will be even more beneficial in the context of the implementation of the *Plan Nord*

over the next few years. Past experiences have demonstrated the positive impacts for regional businesses and manpower from their participation in important projects. These impacts are linked to the development and the valorization of regional expertise. Indeed, several James Bay entrepreneurs who had received contracts on the Eastmain-1 worksite took advantage of the situation and improved their administrative practices and the qualification of their personnel as well as of their equipment, which allowed them to move into a larger market (Hydro-Québec and SEBJ, 2006, cited in Hydro-Québec, 2007). Spinoffs from the Sainte-Marguerite-3 project were also observed in enterprises from Sept-Îsles (Vincent Roquet et Associés, 2002, cited in Hydro-Québec, 2007), and a similar effect from the Toulnustouc Project in enterprises from Baie-Comeau (Hydro-Québec Production, 2006, cited in Hydro-Québec, 2007).

Of course, the importance of this impact depends on several factors, such as the involvement, the support and collaboration of municipal organizations, and the development of the territory in the maximization of regional economic spinoffs. These can have considerable influence on the nature and scope of the economic advantages that become available to their communities. Among the means to reach this goal (RNC, 2006):

- Hire a professional administrator, from the communities or from the outside, in order to obtain maximum benefits from the project;
- Develop their own business and training capabilities;
- Demonstrate creativity and imagination in negotiating agreements;
- Discuss partnerships with companies as soon as possible;
- Determine the advantages of the community;
- Exchange with members of other communities;
- Plan long term (closing, training, and strategic planning of resources).

Local authorities are therefore dependent on the good management of their development. In fact, in a mining industry that is having to deal with a manpower shortage, although the tendency is toward the *fly-in fly out* system, in which workers are transported from the mine to their place of residence, it is nevertheless the proximity between the place of residence and the place of work that makes a difference in the attractiveness of one project or another. Indeed, it is more desirable for workers to be an hour away by transport from work than four hours away. It is from this point of view that new workers and their families can be expected to come and live in the region. In addition, the Chibougamau airport, at the heart of the communities of Chibougamau, Chapais, Oujé-Bougomou, and Mistissini, will become the new drop off point for mining companies that want to exploit the natural resources of Nord-du-Québec. It appears very likely that economic activity will increase markedly in these localities.

➢ *GOVERNMENT AND OTHER REVENUES*

Annual revenues from both levels of government should reach $22.5 M. They are divided between revenues from the provincial government (40 %) and the federal government (60 %) (Table 8.4.8). The Renard Project will notably contribute to the property tax revenues in Eeyou Istchee James Bay.

However, the annual amount remains to be determined. It should be noted that according to Chapter 7 of the *Paix des Braves*, Quebec must pay the Cree royalties annually calculated on the basis of the annual production and the lifespan of the mine.

Table 8.4.8 Government Revenues arising from the Renard Project - Operation Phase

Description *	Direct effects	Indirect effects	Induced effects	Total effects
	$M			
Provincial Revenues	**3.2**	**1.3**	**4.5**	**9.0**
Personal income tax	3.0	0,6	1.0	**4.6**
QST and other indirect taxes	0.2	0.2	2.8	**3.3**
Tax on business profits	0.0	0.5	0.7	**1.2**
Federal Revenues	**3.3**	**2.3**	**8.0**	**13.5**
Personal income tax	2.8	0.7	1.2	**4.7**
GST and other indirect taxes	0.5	0.5	5.2	**6.1**
Tax on business profits	0.0	1.1	1.6	**2.6**
Total provincial and federal revenues	**6.5**	**3.6**	**12.4**	**22.5**

** Does not include Stornoway's property tax, mining rights, and income tax.*

- *TAXES AND ROYALTIES*

Companies exploiting mines in Quebec must pay mining rights to the State. The first objective of a mining duties regime is to allow the State to obtain a fair compensation for the use of a non-renewable resource that belongs to the public. Similar to what generally exists elsewhere, the tax base for Quebec's mining duties regime is based on the notion of mining profits. In regard to the current regime, operators must pay mining rights based on their annual profits, according to a tax scale that will increase in the near future to 16 % (*Finances Québec*, 2010).

In addition to the 16 % mining rights on profits, Stornoway will be taxed at the rate of 26 %. In total, it is almost 43 % that will flow into government coffers. This total percentage is comparable to that which is paid in other foreign fiscal regimes (RNC, 2011). Including mining rights, and provincial and federal taxes on the mine proponent's revenue, Stornoway will pay over the lifespan of the mine a little over $1,174 M that will flow into the coffers of the State (Table 8.4.9).

Table 8.4.9 Taxes and Mining Royalties - Annual Payments

Description	2011	Subsequent years	Total taxation (M$)
Mining rights	15.0%	16.0%	556.1
Provincial income tax	11.9%	11.9%	295.9
Federal income tax	16.5%	15.0%	322.1
Total	**43.4%**	**42.9%**	**1 174.1**

Source: Stornoway, November 2011

8.4.3.2 Enhancement Measures

The enhancement measures for regional economic spinoffs expected for the construction phase will continue in the operation phase (see Section 8.4.2.2). These measures concern, it must be underlined, the set up of a working group with representatives from Chibougamau and Chapais, in conjunction with local and regional organizations working in the economic sectors of employment and training in order to establish mechanisms to monitor economic spinoffs and the application of the Impact and Benefit Agreement (IBA) signed with the Cree Nation.

More specifically, in regard to the contracts of the operation phase (Article 7.6.5), the IBA specifies that, in the 60 days before the expected start up date for commercial production, and in each following year, no later than 45 days after the approval of the enterprise's annual budget, Stornoway will submit the list of goods and services required during the year to the IBA monitoring committee (Renard Committee).

8.4.3.3 Residual Impacts

During the operation phase, the manpower and supply of the project will have a positive impact overall on the regional populations and, in particular, on the Cree and James Bay populations. This impact is considered to be of high intensity, of regional scope, and of moderate duration. The importance of the impact is thus high.

8.4.4 Closure Phase Impacts

8.4.4.1 Impact Description and Assessment

At the end of the mine's lifespan, activities will gradually slow down. Work related to the closure of the site will take around two years. The dismantling of the infrastructure is planned, including the demolition and recycling of materials, as well as the restoration of the site, which includes land rehabilitation, decontamination, securing mine openings, revegetation, etc. The expected budget for this work represents an amount of $9.7 M. The majority of the necessary manpower for the work, as well as the material required, should come from the James Bay territory and Abitibi-Témiscamingue region. These expenses should generate total economic spinoffs in the order of $12.2 M for the country (Table 8.4.10).

Table 8.4.10 Economic Spinoffs from the Renard Project - Closure Phase

Effects	**Region (M$) (NDQ and A.T.)**	***Regional % compared to Canadian total***	**Rest of Quebec (M$)**	**Other provinces (M$)**	**Canadian total (M$)**	***Importance of impact***
Direct	3.9	*92 %*	0.2	0.0	**4.2**	*34 %*
Indirect	0.7	*16 %*	2.2	1.2	**4.1**	*34 %*
Induced	0.8	*21 %*	1.8	1.2	**3.9**	*32 %*
Total	**5.3**	***44 %***	**4.4**	**2.5**	**12.2**	***100 %***
Geographic Distribution	*44 %*	-	*36 %*	*20 %*	*100 %*	-

The value added in the region is divided almost equally between the salaries paid to employees and the other before-tax revenues (Table 8.4.11).

Table 8.4.11 Regional Economic Spinoffs - Closure Phase

Components of the value added	Direct effects	Indirect effects	Induced effects	Total effects	%
	M$				
Salaries and wages before tax	2.0	0.5	0.3	**2.7**	*51 %*
Other revenues before tax	1.9	0.2	0.5	**2.6**	*49 %*
Total Value Added	**3.9**	**0.7**	**0.8**	**5.3**	*100 %*
%	*72 %*	*13 %*	*15 %*	***100 %***	-
Manpower (person-years)	34	9	8	**51**	-

Governmental revenues associated with closure expenses reach $2.6 M, of which $1 M is for the provincial government, and $1.6 M is for the federal government (Table 8.4.12).

Table 8.4.12 Governmental Revenues arising from the Renard Project – Closure Phase

Description *	Direct effects	Indirect effects	Induced effects	Total effects
	M$			
Provincial revenues	**0.3**	**0.02**	**0.4**	**1.0**
Personal income tax	0.2	0.1	0.09	**0.4**
QST and other indirect taxes	0.07	0.01	0.3	**0.3**
Taxes on business profits	0.06	0.07	0.06	**0.2**
Federal revenues	**0.5**	**0.3**	**0.7**	**1.6**
Personal income tax	0.2	0.1	0.1	**0.5**
GST and other indirect taxes	0.1	0.04	0.5	**0.7**
Taxes on business profits	0.1	0.2	0.1	**0.4**
Total provincial et federal revenues	**0.9**	**0.5**	**1.1**	**2.6**

** Does not include Stornoway's property tax, mining rights, and income tax.*

8.4.4.2 Enhancement Measures

As with the other phases of the projects, the proponent will encourage the hiring of regional manpower. This intention is notably expressed in the IBA, which includes the activities related to the mine's closure.

As in the other phases of the project, the proponent will encourage the granting of contracts to businesses of the region, provided that they submit a competitive bid.

8.4.4.3 Residual Impacts

The impact of the closure activities on the purchasing of goods and services is short term. Its intensity is low, and its scope is local. The importance of the impact is therefore low and positive.

8.5 Health and Well-Being

8.5.1 Current Conditions

There is a close link between the health and the well-being of individuals and communities on the one hand, and various health determinants on the other (*Commission d'étude sur les services de santé et les services sociaux du Québec*, 2000; GCC, 2011). Beyond the fundamental aspects of the physical environment, which are essentially linked to the quality of the air and water, as well as to the availability of food and housing, these determinants refer to the socio-demographic particularities of the concerned communities, to the economic characteristics of the milieu, and to the individual and social characteristics of the population. The data related to principle socio-economic characteristics (demography, education, employment, etc.), including the availability of health services, have already been presented in Chapter 2 of the sectoral report on the human environment in the environmental baseline study (Roche, 2011); they are summarized in Section 8.1 of this ESIA. Specifically, in regard to economic aspects, they are presented in Section 8.3.1. It is worth noting that maintaining close ties with nature and traditional hunting, fishing, and trapping is a determining factor as well in the health and well-being of the Cree. This aspect is dealt with in Section 8.2.

This section will expand more particularly on individual and social determinants of health and well-being, i.e. lifestyle, behaviour, social environment, and problems of adaptation. The characterization of these determinants is based principally on studies and analyses performed by regional health organizations, namely the Cree Board of Health and Social Services of James Bay (CBHSSJB), and the *Centre régional de santé et de services sociaux de la Baie-James* (CRSSSBJ), as well as the *Institut national de la santé publique du Québec* (INSPQ).

8.5.1.1 The Cree Context

A study carried out in 2005 by the CBHSSJB on the changes in the state of health of the Crees established that as of 1980s, an increase in psychosocial issues, such as family violence and negligence in regard to children was reported in Cree territory (CBHSSJB, 2005). These issues were variously attributed to the stress resulting from acculturation, unemployment, as well as the consumption of alcohol and other substances, which can influence the capacity of individuals to adjust to different life circumstances.

In this regard, concerns brought up by residents about the alcohol abuse increased over time, and it was the most often reported problem in Cree communities (CBHSSJB, 2005). Incidentally, the most recent assessment of Quebecers' health (INSPQ, 2006a) indicates that along with the Côte-Nord, the Eeyou Istchee territory[12] is in a disadvantageous position compared to other socio-sanitary regions of Quebec regarding the population that excessively consumes alcohol 12 times or more each year

[12] Also called the "Terres-Cries-de-la-Baie-James" socio-sanitary region.

(28.4 %) (INSPQ, 2006b). A perception survey done in the fall of 2008 (Hydro-Québec, 2010) also highlighted the Cree community's concerns on these subjects.

In terms of alcohol consumption, however, the data of the 2003 survey with the Cree population (CBHSSJB and INSPQ, 2008b) showed that the proportion of drinkers is significantly less in Cree territory than elsewhere in Quebec. There are also two times as many people who have never drunk in the region than in the rest of Quebec (17 % as opposed to 8 %). It is worth noting that Mistissini differs from other Cree communities since it includes a lesser proportion of current drinkers (47.8 % as opposed to 53.7 %, for the totality of Eeyou Istchee). Mistissini has also chosen to forbid the consumption and sale of alcohol in public spaces, which is usual practice in Eeyou Istchee territory.

The analysis of the CBHSSJB, produced in the context of the environmental study of the Eastmain-1-A power station (Hydro-Québec, 2004) found for its part that the effects of some of the social issues identified in the Cree territory can be reduced by the high level of social interactions and the support that exists in the Cree population. It was highlighted, therefore, as compared to other Quebecers, that Cree adults dedicate much more time each week to taking care of the elderly. However, there are signs that this social trend is changing. This weakening of community bonds has been associated with better access to roads, which is linked to the development of the Cree territory. On the other hand, an intensification of nuclear family relations has been observed (Vincent, 1998).

The most recent profile of Quebecers' health shows, however, that the Cree community still enjoys a social environment that is favourable to the development of an enviable state of health and well-being. In fact, among the nine indicators used by the INSPQ to explain the social environment that affects an individual's health, it appears that there are no unfavourable situations related to any of these indicators for the Cree territory. Even better, as compared to other Quebec socio-sanitary regions, it is experiencing a favourable situation for three of these indicators: absence of solitude (population that lives alone), the number of people without remuneration who are giving care to the elderly, and the sense of belonging (INSPQ, 2006a).

As indicated in the latest INSPQ profile of Quebecers' health (2006a), two regions, other than the Îles-de-la-Madeleine, stand out from the rest of the province through a significantly lower proportion of people who feel stressed at work: Nord-du-Québec and the Terres-Cries-de-la-Baie-James [Eeyou Istchee]. To differentiate the perception Crees have compared to other Quebecers, the INSPQ underlines that "the strong contrast between the Terres-Cries-de-la-Baie-James inhabitants and other Quebecers is that the former have a negative perception of the state of their mental health, while they are much less inclined to feel a high stress level in general and at work." Despite this generally favourable situation, the data relative to the sources of stress on the Cree (CBHSSJB and INSPQ, 2008b) demonstrate that women identify care, safety, and family responsibilities as main sources, while men place financial security, employment, and school at the top of the list.

Finally, a longitudinal study carried out by the CBHSSJB and the Niskamoon Corporation in 2007 confirms the recent evolution of the situation in regard to eating habits and certain health conditions of the Mistissini population: traditional food is frequently consumed by adults over 40 who consume products from hunting and fishing, as well as berries, two to four times as much as young adults and children. More globally however, the Mistissini population too often consumes products that are un-natural and of little nutritional value. This study clearly establishes that excessive weight and malnutrition are by far the health issues that require preventive action in the short term.

8.5.1.2 The Jamesian Context

The *Centre régional de la santé et des services sociaux de la Baie-James* recently developed a portrait of the health and well-being of Jamesians, which underlined that the life-expectancy of Jamesians does not differ significantly from that of other Quebecers, that Jamesians see themselves in better health, and that they say themselves to be more active physically (CRSSSBJ, 2009). Moreover, the analysis shows that they suffer less from stress in their daily lives and at work than Quebecers overall, and that they have a strong sense of belonging. As such, 76.1% of Jamesians stated having a strong or very strong sense of belonging to their community, whereas this percentage is hardly 54.7 % for all of Quebec.

This portrait corroborates data published earlier by the INSPQ (2006a), and shows that like the Crees, the James Bay population is generally experiencing a more favourable situation than elsewhere in Quebec in terms of the perception of work-related stress and the sense of belonging to the community. Moreover, the latest Quebec study on population health (Traoré et al., 2010) demonstrates that the population of the Nord-du-Québec region has the highest rate of satisfaction in regard to its social life; this rate reaches 95.8 % in the region as compared to 93.5 % for Quebec overall. The level of psychological distress[13] is also lower, since a high level of distress only touches 19.5 % of the population, as compared to 22.2 % for the overall population of Quebec.

A recent analysis by the CRSSSBJ, carried out in the context of the sustainable development of the James Bay population established certain differences among the Jamesian towns, so that in Chibougamau as in Matagami and Lebel-sur-Quévillon, the base for social cohesion is a little wider than elsewhere. Chibougamau benefits from a good level of participation in community life on the part of its citizens. In Chapais, again according to the CRSSSBJ, social cohesiveness is more fragile, and the sense of belonging seems to be mixed (Chakda *et al.,* 2007).

With a view to supporting activities for the promotion of health and well-being of the Chibougamau community, the *Direction de la santé publique* of the CRSSSBJ developed a profile from the results of two discussion groups. As for Chibougamau, this analysis points out the importance of quality of life, and underlines that since the creation of the town, community social relationships have been

[13] Measurement taken using the K6 scale developed by Kessler. This measurement is based on six questions and establishes at which frequency, over the last month, the individuals have felt nervous, desperate, agitated, depressed that nothing can make them smile, had the impression that everything was an effort, or finally, had the feeling of being good for nothing. (Camirand et al., 2010).

characterized by trust, sociability, openness, and mutual aid (CRSSSBJ, 2005). However, the stability of the population is fragile, and this is related in part to women who do not have a family in the region and feel isolated, especially if they are unemployed. Moreover, it is hoped that a renewed mobilization around a shared vision and an increase in volunteerism will occur. Finally, the report regrets the independence in development between the communities of Mistissini and Chibougamau; beyond a simple reconciliation, the authors hope for the development of relationships of trust between these two communities, Cree and Jamesian, with a view toward establishing fruitful partnerships in a win-win situation. We should underline that such a reconciliation has really been felt in the region following the efforts and concrete actions for consultation established since the last municipal election in November 2009. To this end, the mayor of Chibougamau set up the group of 6, which brings together the community chiefs of Oujé-Bougoumou, Mistissini, Nemaska, and Waswanipi, as well as the mayors of Chibougamau and Chapais.

In the case of Chapais (CRSSSBJ, 2003), it is noteworthy that the village or big family spirit that is present contributes to mutual aid and solidarity. We also note the good quality of life in the municipality that is due, in part, to a calm and safe environment. However, there is a waning of volunteer resources involved in the various spheres of social and community life, and a collective effort is desirable to energize the relations with the neighbouring Cree communities, notably in social and economic terms.

Concerning the global social environment of James Bay, it seems, moreover, that on a qualitative level, isolation, uncertainty related to employment, as well as distance from the workplace for the men in certain cases, lead to concern about psychological health by some social players, notably youth drug use (Chadka *et al.,* 2007). At the same time, in regard to social cohesion and participation, the same analysts report that, according to a 2002 study by the *Table régional des aînés du Nord-du-Québec*, concerns by the elderly focus on specialized care (45 %), and isolation (30 %). A recent study carried out by the *Comité de développement social de la Baie-James* (CDSBJ) indicated moreover that “78 % of responders mentioned having a sense of belonging that was very strong or rather strong toward their municipality, while 65% have a sense of belonging that is very strong or rather strong toward the James Bay territory” (Yorn, 2001). The study also shows that the sense of belonging correlates significantly with volunteerism and networking, and that the improvement of the quality of life can, in the long run, encourage retention of people and improve the sense of belonging. The last Quebecers’ health profile confirms the importance of the sense of belonging for residents of Nord-du-Québec (MSSS, 2011).

Finally, in regard to life habits and behaviours, the state of health of Quebecers in 2001 (INSPQ, 2003) indicated that, at that time, the percentage of the population who excessively consumes alcohol at least five times a year was notably superior in Nord-du-Québec compared to the values indicated for Quebecers globally (Hydro-Québec, 2004). In regard this time to the proportion of the population who, in 2003, excessively consumed alcohol 12 times or more a year, the James Bay territory still demonstrates

a problematic situation, with 23.3 % compared to an average of 16.6% for the entirety of Quebec (INSPQ, 2006b).

8.5.2 Construction Phase Impacts

8.5.2.1 Impact Description and Assessment

The impacts on health and well-being during construction are of two types, i.e. on the one hand, impacts on physical health, and on the other, impacts on the overall well-being of individuals and communities. Concerning this second aspect, the source of the impact deals with manpower and involves more specifically working conditions. We will discuss this latter problem in the next section, which covers the entire operation phase of the project.

In regard to physical health, the sources of impact during construction are the usage and upkeep of machinery and power generator sets, road traffic, as well as the storage and management of hazardous materials and fuels.

All of these activities lead to a certain form of nuisance (noise, dust) that, however, do not impact the health of users of the study area, since they are not staying in a camp in the immediate vicinity of the worksite.

Moreover, activity can increase the level of dust and atmospheric emissions since leaks and accidental spills of petroleum products, or of any other chemical product, on the worksite could contaminate the water, vegetation, fish, and the fauna nearby. As shown in Sections 6.3.2 (air quality), 6.6.2 (groundwater), and 6.8.2 (surface water), the impact on these valued environmental components are not likely to have a perceptible impact on the health of M11 trapline users. All appropriate measures will be taken to minimize releases into the environment and a monitoring and surveillance program will be implemented in order to avoid any contamination of the environment.

Finally, it is worth noting that of course there are direct risks to the health and security of workers and visitors to the worksite and the mine during the operation phase. Such an aspect is not taken into consideration here in evaluating the impacts on the natural and social environment. In fact, this is globally considered in the general management of occupational health and safety on the construction and mine site in compliance with the *Occupational Health and Safety Act*. Occupational health and safety management is described in Chapter 12 of this ESIA. This management includes, among others, an emergency response plan in which the roles, responsibilities, and communication links for the managers of the mine, the governmental authorities concerned, as well as for those responsible for civil protection in the Jamesian and Cree communities.

Similarly to what was established for the exploration phase, there will be on-site medical emergency and evacuation services required in the case of illness or accidents. No over-utilization of health services offered in the regions during the construction period is foreseen.

8.5.2.2 Mitigation Measures

The main measures for the mitigation of impacts on the health of users in the study area are those that have already been planned to decrease the impacts on the quality of air (Section 6.3.2), groundwater (Section 6.6.2) and surface water (Section 6.8.2).

In order to alleviate any health or safety problem that could result in a failure or an accident, the emergency response plan (Section 12.5) will cover construction activities. To optimize efficiency, this plan will be the subject of communication and of training of mine personnel and the people responsible for civil protection in the communities. Community residents will also be informed about emergency measures put in place.

Finally, to improve road safety, regular transporters must have satellite telephones.

8.5.2.3 Residual Impacts

During the construction phase, the residual impact on health is negative and of low intensity since the mitigation and monitoring measures are planned to reduce risks to a minimum. This impact is limited to the worksite because there is no resident population in the vicinity, which gives it a limited scope. It is of short duration because it is concentrated during the construction period. The residual impact is therefore low.

8.5.3 Operation Phase Impacts

8.5.3.1 Impact Description and Assessment

- *PHYSICAL HEALTH*

On the mine site, the impacts on physical health will be comparable to those expected during the construction phase regarding the use and maintenance of machinery and power generator sets, road traffic, and storage and management of hazardous materials and fuels. Moreover, the impacts will be associated with the use and presence of various facilities. More specifically, regarding the health of workers and visitors, the new problematic element compared to the construction phase will consist of dust emissions that may arise from different deposits of materials. According to analyses carried out on the quality of air (Section 6.3.3), groundwater (Section 6.6.3) and surface water (Section 6.8.3), no air pollution or environmental contamination is expected, including notably heavy metals, which may have a health impact on land users.

In addition, the health of workers will be guaranteed through the establishment of a management plan for occupational health and safety, including notably, an emergency response plan (see Chapter 12).

In regard to the security of the population outside the mine site, it should also be noted that traffic on Route 167 will be limited because workers will access and leave the site by air. It will be the same for the shipment of finished products (diamonds). In fact, traffic will be limited to the shipment of supplies

and should represent about three vehicles a day, i.e. three incoming and three outgoing trips. It should not impact the traffic flow and the safety of travellers on Route 167 and the regional road network compared to current conditions, since the traffic generated by the mine will be limited in volume and time.

The transportation of various hazardous materials such as hydrocarbons and explosives may also present, in theory, some health risks for residents. These risks are minimal. The transportation of hazardous materials to the Renard mine is indeed controlled by the *Transportation of Dangerous Substances Regulation* which adopts, by reference, the standards of Transport Canada's *Transportation of Dangerous Goods Regulations* (TDGR). These guidelines dictate different standards regarding the safety of vehicles and containers, stipulate the skills required of carriers and provide for the adoption of an Emergency Response Plan (ERP). For some identified subjects (such as explosives and fuels in particular), this plan aims to ensure public safety. It must, among other elements, give a description of the response capability available to the person who imports the dangerous goods or who requires the transport, and must also provide an evaluation of a potential accident, which includes the following information:

- A general analysis of how an accidental release of dangerous goods could occur;
- A general description of the possible consequences of an accidental release;
- A description of measures that the applicant is expected to take in case of accidental release or imminent accidental release.

In regard to the protection of the environment in the case of an accidental spillage, it is provided by *Urgence-Environnement*, an MDDEP organization. Depending on the circumstances, *Urgence-Environnement* may request the cooperation of several organizations such as the *Organisation de la sécurité civile du Québec* and regional civil protection organizations, native and municipal police forces, the *Sûreté du Québec*, fire departments, health services, Environment Canada, Transport Canada, and private companies.

As was observed during the exploration phase, and also as planned during construction, no overuse of health services in the region resulting from the operation of the Renard mine is expected. Overall, we do not think there will be changes in living habits of land users due to fears of possible contamination of the environment in relation with the operation of the project.

➢ *MENTAL AND SOCIAL HEALTH*

Although the impacts on the well-being of individuals and communities are concentrated mainly during the operation phase of the project, it is important to remember that these can be felt throughout the project cycle, including psychosocial impacts associated even with the announcement of the project. According to the literature, these impacts are linked to varying feelings of acceptance or non-acceptance of the project, which may lead in some cases to a systematic opposition fuelled by fear or fear of change. The information collected so far in the activities of communication and consultation

with the affected population (Chapter 4) indicate that the Renard Project causes no particular anxiety in the population; it solicits no significant negative reaction, and therefore has no negative impact in this way. It is certain, however, that the emotional well-being of the regional population observed so far in this regard should be maintained throughout the project by continuing efforts to exchange and communicate in order to ensure that the concerns of the population and cultural characteristics of the Crees and Jamesians are taken into account.

During the operation phase even more so than during construction, manpower and procurement will have an overall positive impact on the social conditions of the Cree and Jamesian populations, given the economic benefits of the project (Section 8.3.3). Rising individual incomes and better employment opportunities will contribute, in effect, to the improvement of living conditions, such as housing, and will contribute as well to better health for individuals and the community, as much physical as mental and social. Such a positive consequence from improving economic conditions is widely recognized by health analysts: *"The Federal/Provincial/Territorial Advisory Committee on Population Health is accumulating more and more data supporting the principle that income and status are the most important social determinants of health. The more income and social status are important, the more they consider themselves healthy. Many studies also show that the more there is an equitable distribution of wealth over the population, the healthier it is, regardless of the amount invested in the health care system. [...] Unemployment is associated with poorer health: the unemployed are much more likely to suffer from psychological distress, anxiety, health problems, hospitalization, etc. than people who have jobs" (Health Canada, 2004).* Such a positive social impact was also observed in Mistissini in the context of the Troilus mine: *"It is also noteworthy that 15% of Cree workers surveyed believe that Troilus had positive effects on their family lives, as it gave them the money to support their families and that by working at the mine, they feel they were providing a good example for their children [...] According to Mistissini representatives, the fact that many Cree workers acquired skills and valuable work experience and that they were proud of their accomplishments at Troilus represents an important social outcome for the community" (*Penn and Roquet, 2008).

In addition to the financial benefits from the project, there are financial advantages that stem from the Impact and Benefit Agreement (IBA) which is negotiated between Stornoway and the Renard-Mistissini Working Group. Among others, this working group brings together the Cree Nation of Mistissini and the Grand Council of the Crees (Eeyou Istchee).

Nevertheless, a number of potential negative impacts are possible, particularly with regard to conditions of employment.

Among them, the experience of other projects in the James Bay territory has particularly highlighted the challenges facing the integration of Native workers into the workplace. The Native population is confronted with developing various adaptations related to language, supervision, work schedules, and cultural habits that can lead to some adjustment problems. Harmonious integration of workers to their

work environment is especially important as it has a significant impact on the very health of workers. Health Canada (2004) indicates, moreover, to this effect: "*The support from the workplace is measured by the frequency and quality of interactions with colleagues. Indeed, it appears that the more people are in contact, the more they are healthy*." Monitoring the integration of Cree workers on projects or major worksites near the Renard Project was recently carried out at the Troilus mine, and at the site of the Eastmain-1-A and Sarcelle power stations, as well as at the Rupert diversion. In the case of the latter study, surveys of over 300 Cree workers have shown that the integration of these workers can be considered positive: "*The vast majority of Cree workers evaluate their work experience positively. They appreciate the nature of their jobs, the experience they have gained, and the work environment. Moreover, the majority of them feel that their relationships with their colleagues and their supervisor are good*" (Hydro-Québec, 2009). Such a result stems from the introduction of several measures to promote the integration of workers. It can also be explained, according to the study, by the usual statement of solidarity among the Crees who do not hesitate to focus on mentoring new Cree workers.

In addition, the study of the Eastmain-1-A highlighted the negative effects of prolonged absences of Native workers on their family lives: "*The job-related difficulty most frequently mentioned is being away from family... This has led to marital or family issues in a quarter of workers or difficulties for children, including boredom, according to a third of employees in couples with young children*." The monitoring study at the Troilus mine also established that the work at the mine had an impact on their family life for half of them and that this impact was particularly felt in families where there were young children (Penn and Roquet, 2008). Such a problem, as with the integration of Cree workers, dictates the implementation of a number of measures to provide the necessary support to workers and their families. The assistance provided to workers must come as much from the mining company as from the local authorities concerned. In the case of Troilus, some Crees indeed complained: "*Lack of support from Troilus when they had personal and family issues: health and social services in the community were also criticized for lack of support*" (El Krekshi, 2009).

Finally, some observers, including the CBHSSJB (2010) as part of the recent analysis of a mining project planned in the territory, underlined the fact that higher incomes for individuals or households in communities can drive a certain number of Crees to spend more money on alcohol, forcing Cree political and health authorities to spend more money on programs for support and building awareness on healthy living. In this regard, it is worth noting that Mistissini, the community most directly affected by the project, includes the fewest current drinkers in Eeyou Istchee. Necessarily, it is also the community that includes the most former drinkers (40.7 % against 29.7 % for the whole territory) (CBHSSJB and INSPQ, 2008a). Given this fact, and further considering that Mistissini is a community where the public consumption and sale of alcohol are prohibited, it can be assumed that the presence of the Renard Project should not cause noticeable consequences.

Also, consumption of alcohol on the mine site will be completely prohibited. At the Troilus mine located near the community of Mistissini, the sale of alcohol was prohibited, but not its consumption. This was viewed positively by those involved and by the Cree health authorities (CBHSSJB, 2010). Helplines were available on the mine site for employees dealing with consumption problems, but it was generally apparent to analysts of the Troilus project (Penn and Roquet, 2008) that drug and alcohol abuse was not a serious problem at the Troilus mine. Moreover, it is to be noted that recent monitoring data on James Bay workers for the construction of the Eastmain-1-A and Sarcelle power stations and the Rupert diversion (Hydro-Québec, 2009) have also demonstrated that camp life neither significantly increases nor reduces the prevalence of alcohol and drug use. On this project's worksite, the consumption and purchase of alcohol are allowed.

Other monitoring studies also suggest that the presence of mines in remote territories is not likely to have notable negative effects on the well-being of the communities concerned. Such monitoring has been done by health and social services of the Northwest Territories Government as part of a socio-economic agreement with the diamond companies BHP Billiton, Diavik and De Beers (Northwest Territories, 2010). This monitoring, which covers 17 indicators reporting on community, family and individual well-being, was conducted over several years to see if the anticipated impacts of the studies prepared by the diamond mining project proponents correspond to field observations[14]. The results tend to suggest that impact studies have generally been more pessimistic than the reality observed during monitoring studies (for five indicators). In the other cases, the indicators observed correspond to the estimates. Government analysts, however, remain generally unable to establish a clear link between changes in indicators observed and the presence of mines. In fact, it is estimated that this link is possible, but unconfirmed, for only two indicators: single-parent families and drug use. In the first case, the phenomenon could be attributed to one spouse working away, while in the second case, the availability of additional income could be an explanation.

Referring to these findings, the Gahcho Kué diamond project proponents argue for their part that the majority of the usual criteria related to family and community cohesion improve or remain stable: "*All standard criteria indicate that the family and community cohesion improves. Incomes rise, economic security improves, divorces are stable or declining, participation in traditional crop harvesting by mine employees seems to be higher than people who are not employed by the mines, and there is an increased access to education in traditional languages in schools*" (De Beers Canada Inc., 2010).

Overall, for the operation phase, it is unlikely that the Renard Project will cause detectable changes in the lifestyle of the Cree and Jamesian communities affected by the project, despite legitimate concerns expressed by a number of Crees around these issues. These changes, if any, should be an extension of

[14] The indicators documented in this study are the following: injuries, suicide, potential lost years of life, communicable disease, teenage births, children benefiting from social services, single parenthood, conjugal violence, all crimes reported to the police, violent crime, property crime, federal crime (in particular related to drugs), traffic violations, other criminal acts, residential upkeep, overpopulation, basic needs.

the known changes in recent years. Moreover, in regard to life habits, behaviour, and the social environment of these communities, there is no evidence that they would not have the ability to manage any change arising from the project that would not have been considered in the context of the environmental and social impact assessment. In addition, these communities are equipped with community organizations that can highlight specific issues arising and provide support as needed.

8.5.3.2 Mitigation Measures

Concerning the community and workers' health, the monitoring of air quality (Section 11.4.2) will cover all forms of contaminants likely to end up in the air, including, where appropriate, metals emitted in particulate form. This will ensure that all current standards for health protection will be respected. The same approach will be followed with regard to liquid effluents (Section 11.4.4), surface water quality (Section 11.4.6) and groundwater quality (Section 11.4.7).

The health and safety of workers will be ensured with the occupational health and safety management plan (Chapter 12). Measures to promote a healthy lifestyle will also be put forward by those responsible for health and safety at the mine in order to have a positive effect both on workers and their families (healthy diet, healthy weight, quitting smoking, etc.).

Stornoway Diamonds (Canada) Inc. will take all measures required to facilitate the coexistence of workers of different origins and to mitigate the negative effects on families related to the remoteness of Cree workers. These measures are:

- Awareness-building about the Cree culture for all staff;
- Hiring Cree personnel to perform various functions of support or services (human resources, health, recreation, security, etc.) which would also facilitate a quick response to any problem situation;
- The identification from among the Cree personnel of those capable of acting as Cree / French-English interpreters when needed;
- The promotion of recreational, social, cultural and sports activities that allow all workers to mingle outside the work context at the camp;
- The establishment of areas at the mine for Cree cultural activities;
- The implementation of measures to facilitate the integration, promotion, and retention of Cree personnel;
- Cooperation with the Mistissini community to deliver programs that promote healthy lifestyles and prevention of drug and alcohol abuse;
- The establishment of a means of communication to keep the community of Mistissini informed about the activities of the mine;
- In consultation with Cree organizations, the implementation of measures to help maintain communication between workers and their families and communities (e.g. facilitating communication by telephone or Internet) and to provide assistance to employees experiencing personal or family issues.

All of these measures will be specified later in conjunction with local organizations responsible for support services to the communities concerned. To this end, Stornoway is committed to holding

planning meetings with the CBHSSJB and CRSSSBJ to identify these organizations and to help them in providing support services to workers and their families.

During the negotiations of the IBA, together with the Crees, Stornoway confirmed its policy on alcohol specifying the formal prohibition of any use at the mine site.

Finally, it should be noted that the impacts on health and well-being are global and long term, and cannot be attributed solely and specifically to a particular development project, such as the Renard Project. In this context, the best way to identify and properly manage such impacts is ultimately the responsibility of regional health organizations, including the CBHSSJB and CRSSSBJ. Such follow-up actions can potentially cause a work overload for such organizations. Aware of this fact and of its responsibilities in this regard, Stornoway is willing to support any monitoring and long-term intervention plan that could include, for example, all development projects related to the *Plan Nord*.

8.5.3.3 Residual Impacts

Regarding impacts on physical health in the operation phase, the absence of population residing in the vicinity and surroundings of the project gives this phase a limited scope. As for the aspects related to general well-being associated with social determinants of health, the scope, however, is local because it involves a certain part of the regional population. Overall, the impact is negative, although several positive effects of improved economic conditions are real. Given the mitigation measures, the intensity is low, but its duration is long because it will be felt throughout the period of the mine's operation. Therefore, the importance of the impact is moderate.

8.5.4 Closure Phase Impacts

8.5.4.1 Impact Description and Assessment

The manpower required during mine closure activities will broadly have the same impacts as during the operation phase, but on a smaller scale and with a much shorter duration.

The rehabilitation and final revegetation of the site will have, from a psychosocial perspective, a positive effect by mitigating the possible negative effect associated with the sense of loss that may emerge from having mining activities in a previously undisturbed environment.

8.5.4.2 Mitigation Measures

See mitigation measures applicable to the manpower during the operation phase (Section 8.5.3.2).

8.5.4.3 Residual Impacts

The positive impact associated with rehabilitation and revegetation will be of moderate intensity as this operation will moderately improve the condition and use of the area affected by the mine. The scope will be local because it is limited to the perimeter of the mine. It will be a permanent impact, so of long duration. The impact will therefore be of moderate importance.

8.6 Archaeological and Cultural Heritage

8.6.1 Current Conditions

8.6.1.1 Background

- *PREHISTORIC PERIOD*

Archaeological studies and research conducted to date in the region indicate that its settlement dates back to the fourth millennium before the present (BP) and that, between 3500 BP and 1650, the Amerindian occupation intensified and still lasts today. From this period, the camps appear numerous and are present as much along rivers as on the shores of major lakes.

The excavation of certain areas in the region indicates that Natives regularly visited them, as evidenced by the discovery of many domestic fireplaces. The great variability in the type of projectile points found further suggests that the Mistissini area was frequented, at the very beginning of this period, by groups of diverse origins. However, closer links with the territories emerged from James Bay to the north and northwest, as well as with Lac-Saint-Jean in the south, and Mauricie in the southwest. Moreover, some of the camps analyzed are centered around large elongated fireplaces full of charred bones, suggesting that the social structure of these people was based in part on the seasonal coming together of several families.

In archaeological contexts dating from the period between 1000 to 1650 AD, small projectile points with notches on the side or in the corner, made out of flakes, were found on several sites. This type of point is found mainly on what is now the Cree territory. From the 18th century and on, European and Euro-Canadian goods were increasingly found in archaeological sites. It is also worth mentioning that there is evidence of stone flaking until 1850 in the Mistissini and Caniapiscau areas.

- *HISTORICAL PERIOD*

During the historical period, the territory located northeast of Mistissini was frequented relatively little by Euro-Canadians. Explorers, fur traders, and missionaries circulated in the region during the 17th century, while geological prospecting campaigns were undertaken in the region as of the 19th century. Moreover, It was during this period that the Misask River, south of the Renard Project, was mapped for the first time. This river is located in the heart of a network of portages that allows north-south movement from the Eastmain River to the Sakami River (Map 8.6.2).

8.6.1.2 Archaeological Potential

To date, no archaeological survey has been conducted within a radius of 50 km of the study area and no archaeological site is known there. An assessment of the archaeological potential was therefore conducted as part of the ESIA. This assessment is based on the progress of archaeological research conducted in the region and results from an assessment of the potential land use of the studied area. It

considers both the prehistoric and historic context and the environmental criteria governing the establishment of human settlements and the practice of various activities by their occupants. Interviews with current M11 trapline users (Section 8.2) also allowed to obtain relevant information on the location of former camps, burial sites, trails and portages, etc. All these elements were considered in the identification of areas of archaeological potential of the project study area.

A total of 51 potential areas have been delineated (Map 8.6.1 in Volume 3). In all cases, the areas are relatively flat, and surface deposits are usually composed of sand and gravel, while elsewhere, tills are dominant. Nine areas of potential refer to the presence of portages. In all other cases, they indicate the presence of areas with a potential for archaeological evidence.

8.6.2 Construction Phase Impacts

8.6.2.1 Impact Description and Assessment

Given the distribution of potential areas, the preparation and development of the project sites will have no impact on the archaeological resources of the territory.

It is always possible, however, that archaeological remains be uncovered incidentally during the various excavations to be made on site. In such circumstances, the archaeological sites discovered will be treated in compliance with the requirements of the *Cultural Property Act* (RSQ, c. B-4, art. 41 and 42), by temporary protective measures, by assessment of findings and, where appropriate, by archaeological excavations.

8.6.2.2 Mitigation Measures

In case of incidental discoveries of archaeological resources during construction, the worksite managers should be informed of their obligation to report promptly to the contractor and must, where appropriate, stop work at the place of discovery until a complete evaluation is made by archaeologists. They must also inform the Cree representatives.

Applicable provisions of the *Quebec Cultural Property Act* will be implemented (temporary protective measures, assessment of the findings, archaeological excavations).

In the case of discovery of a burial site, the police will be called immediately and checks will be made with M11 trapline officials to confirm the identity. Relocation of such a site or any other arrangement agreed upon with the family involved will be the responsibility of Stornoway.

In addition, measures are provided in the IBA in the case of discovery of archaeological or culturally significant sites for the Crees.

8.6.2.3 Residual Impacts

We do not anticipate any impact on archaeological resources during the construction phase.

8.6.3 Operation Phase Impacts

8.6.3.1 Impact Description and Assessment

The excavation work planned during the operation phase (development of pits, quarries and borrow pits) do not touch any area of archaeological potential.

8.6.3.2 Mitigation Measures

In case of incidental findings of an archaeological resource at the mine operations, managers should be informed of their obligation to report promptly to the contractor, and must, if necessary, stop work at the place of discovery until a complete evaluation is made by archaeologists. They must also inform the Cree representatives.

Applicable provisions of the *Quebec Cultural Property Act* will be implemented (temporary protective measures, assessment of the findings, archaeological excavations).

In the case of the discovery of a burial site, the police will be called immediately and checks will be made with M11 trapline users to confirm the identity. Relocation of such a site or any other arrangement agreed upon with the family involved will be the responsibility of Stornoway.

In addition, measures are provided in the IBA in the case of discovery of archaeological or culturally significant sites for the Crees.

8.6.3.3 Residual Impacts

We do not anticipate any impact on archaeological resources during the operation phase.

8.6.4 Closure Phase Impacts

8.6.4.1 Impact Description and Assessment

The mine closure is not likely to impact on archaeological resources.

8.6.4.2 Mitigation Measures

No mitigation measures are required.

8.6.4.3 Residual Impacts

We do not anticipate any impact on archaeological resources during the closure phase.

8.7 Landscape

- *METHODOLOGICAL APPROACH*

The methodology, said "expert," is used to achieve this landscape evaluation and will be based on concepts developed by the *Ministère des Transports du Québec*, as described in the book, “Landscape Study Method for Roads, Highways, and Autoroutes.” The concepts and the nature of the data collected

will be adapted to the receiving environment and the challenges of the Renard Project. The size of the Renard Project study area has also influenced the choice of this method.

Visual analysis has three steps:

- The first step consists in identifying the regional landscape where the project lies in order to provide an overview of the surroundings. The regional landscape corresponds to spatial units bounded by strong bioclimatic discontinuities. Physiographic criteria, such as topography and major geological areas, play a primary role in the identification of these units;
- The second step consists in identifying the different types of landscapes encountered in the studied viewshed, as well as to delineate and characterize the landscape units that compose it. A landscape unit is defined as a separate portion of space bounded by the land topography, vegetation cover, land use, and types of views with visual features and an atmosphere of its own;
- The third step of the analysis consists in identifying constraints and an appreciation of the unit and subunit visual components previously defined, taking into account various criteria such as visual accessibility, visual interest and the assigned value. These criteria allow assessing the value of each landscape unit, and rank them according to their value of visual assessment, and therefore, their visual resistance.

The inventory of the viewshed landscape units in the study is based on the interpretation of aerial photographs and on the assessment of thematic maps. A photographic survey of the site and a field visit helped to complete and validate information. This study of the visual environment helps to define the conditions existing prior to the Renard Project. Technical terms used in landscape analysis are defined in Appendix 8.7.1.

8.7.1 Current Conditions

8.7.1.1 Regional Landscape[15]

The viewshed under consideration is located over 240 km north of the regional landscape unit of Lake Témiscamie. The physiography of the region is a vast peneplain whose low topography is marked by a gently rolling terrain, dotted with a multitude of lakes and rivers, wetlands, and rounded hills rarely exceeding 100 m in elevation. The land is predominantly covered by forest, though there are some places showing the presence of former burns that occurred at different periods, as well as areas of mining exploration. These lands are mostly visited by the Crees for traditional hunting, fishing, and trapping activities.

There is no permanent establishment in the land under consideration. Temporary and permanent Cree camps are scattered around the country and they are mainly visited coming from the village of Mistissini.

[15] The information contained in this section is taken from the following work: *Robitaille André et Saucier Jean-Pierre, Paysages régionaux du Québec méridional, 1998.*

8.7.1.2 Physical Components

- *CLIMATE AND VEGETATION*

The study area is located in the boreal vegetation zone and belongs to the spruce-lichen bioclimatic domain, which occupies the entire **taiga subzone**. It is especially distinguished from that of the spruce-moss, further south, by the low density of forest cover. Lichen and shrubs dominate. The burns are still abundant (nearly 10 %) and the tundra begins to grow in importance. Black spruce, whose vegetative reproduction is favoured by the harsh climate and low rainfall, punctuates the lichen mat. As for balsam fir and jack pine, they reach the northern limit of their distribution range.

The study area is characterized by a subpolar climate, with distinct seasons: short summers alternating with long winters. Forest fires are common in the territory in the spring and summer (Photo 8.7.1).



Source: David Thomassin, Roche Ltd, July 6, 2010.

Photo 8.7.1 Example of a burn

- *GEOLOGY AND TOPOGRAPHY*

The study area lies within the Superior Province, which is the oldest and largest geological province of Quebec. The Foxtrot Property in turn is part of the Opinaca meta-sedimentary Sub-province, located in the center of the Superior Province, i.e. between the Opatica and the La Grande Sub-provinces. Buttes and rounded hills form the periphery of the central depression. The relief is characterized by low rolling hills, covered with glacial and postglacial deposits. Indeed, the thick glacial deposits are the hallmark of this natural province, mainly Rogen moraines, which, combined with a multitude of small lakes, form a very particular landscape (Photo 8.7.2).



Source: David Thomassin, Roche Ltd, July 6, 2010.

Photo 8.7.2 Example of Rogen moraines and the landscape they create

The general topography of the study area varies from flat to hilly where the average altitude of the hills is from 450 to 550 metres. South of the project, the Otish Mountains' massif rises to over 1,000 metres and the sides of these hills appear rather steep.

- *HYDROLOGY*

The natural Superior Province presents a radial type hydrographical network, which is to say that the water flows in all directions.

The study area lies within the La Grande River watershed, and within two of its subwatersheds, which are that of the Sakami River and Eastmain River. They form the major rivers in the immediate area. The Renard Project site is located in the Misask River watershed, a tributary of the Eastmain River.

8.7.1.3 Landscape Unit Description

As a whole, the site offers a landscape dominated by a bare dry vegetation type where the low density of black spruce offers filtered views of the rolling countryside surrounding the mine site. The hydrographical network of Lake Misask and Lake Lagopede offers large flat areas that open the view towards the mountains that surround them (Photo 8.7.3).



Source: Vital Boulé, Roche Ltd, September, 2010.

Photo 8.7.3 View of Lake Lagopede and from Camp Lagopede (September 2010)

These waterways also allow travel by canoe in summer and snowmobile in the winter. This Cree hunting, trapping and fishing territory is crisscrossed by several trails that allow the tallyman to cover his territory and access his camps.

Within the studied viewshed, mine site users and the tallyman and his family share five distinct landscape units (Map 8.7.1 in Volume 3). These units are delineated on the basis of land uses, the presence of vegetation and the topography. The main elements of the units are presented in the following descriptions.

It is first important to define the Cree concept of the landscape in order to better understand the description of the following landscape units. This concept was described in *Eastmain-1-A and Rupert Diversion: Environmental Impact Assessment (Volume 4: Chapters 16-25 - December 2004, Hydro-Quebec Production).*

Chapter 18 of the Hydro-Québec impact assessment states: “It should be noted that the notion of landscape has rarely been documented in studies conducted in the Cree Nation. It was therefore impossible to rely on existing documents or data on the subject.

Among the James Bay Crees, a variety of experiences exist with respect to cultural knowledge and their use of, and relationship with, the land. This is particularly discernable from one generation to the next, and is displayed in aesthetic and spiritual values connected to the landscape, such as the overall understanding of the territory, which is more abstract. Accordingly, the concept of landscape for the

Crees is based on appreciation criteria that vary according to generation and the individuals interviewed."

The author finds that the tallymen speak of the landscape in pragmatic and descriptive terms, even to describe valued sites such as a camp or a lake. For him, the Cree notion of landscape is based on the idea of territory and the feeling of being an essential part of it. He also mentions that the appreciation of landscape holds a sacred or spiritual dimension for many Crees. This observation will guide us in analyzing the value assigned to the landscape.

- *VOCABULARY*[16]

The visual accessibility of the landscape corresponds to the actual visibility of the elements of a landscape; its relative value is assigned depending on the absorptive capacity of the landscape, the number and type of observers, and the distance and time of perception. The absorption capacity of a landscape is an indication of the complexity of the viewshed of a landscape unit. This index is determined by landform, view types, density, and type of land use. Assessing the visual accessibility of the project study area is provided in Appendix 8.7.2.

The visual interest of the landscape is reflected in the complementary visual objects therein. First and foremost, it is by assessing whether these landscapes are harmonious, i.e. those that are visually interesting do not contain major discrepancies. It is also by assessing the degree of landscape animation (diversity in components of a view) that we highlight those that have the most interest. This is called the change, continuity, and orientation of anticipated visual sequences. The sequence resulting from the change and renewal of the landscape, sustains the interest. This is an ordered sequence of visual events that allows the land user to assess his time and movements. The evaluation of landscapes of visual interest is provided in Appendix 8.7.3.

The assigned value, or cultural value, is defined as the value assigned by the populations concerned. The landscapes have traits that are their own and that distinguish them from one another. We then say that they have a character whose quality is reflected in the organization of their components. This organization and its components are analyzed according to the presentation of landscape elements in terms of what is recognized by land users as being more or less useful and well structured. The character is manifested by the presence of elements with historical or symbolic significance. The value assigned to the landscape also depends on its current and anticipated purpose. Assessment of the value assigned to the landscape is provided in Appendix 8.7.4.

The environmental value is the index of resistance of users and shoreline residents. Resistance to change caused by the construction of infrastructure is determined by the cumulative result of the three criteria defined above, that is visual accessibility, interest, and the value assigned to the visual

[16] The definitions of technical terms used for analysing landscape come from the following work: *Gaudreau, Richard, 1986. Méthode d'analyse visuelle pour l'intégration des infrastructures de transport, Ministère des Transports du Québec, Service de l'environnement.*

environment. The environmental value determines the degree of compatibility of the proposed infrastructure with a landscape unit.

- *DS-1 – WOODED DRY BARRENS*

The DS-1 landscape unit has moderate visual accessibility with its rolling landform and vegetation of moderate density (Photo 8.7.4).



Source: David Thomassin, Roche Ltd, July 6, 2010.

Photo 8.7.4 Landscape unit as seen from the south of Camp Lagopede (July 6, 2010)

It contains one of the anthropogenic landmarks of the region, i.e. Camp Lagopede, the mining exploration camp. This landscape unit is occupied by exploration infrastructure, namely the camp and the workers who stay there, which increases the visual accessibility of this unit, despite the low density of occupation. The trails that go through this landscape unit are not regularly used because they are part of a hunting, trapping, and fishing territory that goes far beyond the study area. Several months may go by without the tallyman or his family members visiting the trails found in the study area. For this reason, the visual accessibility index is minimal.

The harmony and continuity of this wooded unit qualify the visual interest as moderate. The mine camp allows observation of the *LC-1 Lake Lagopede* unit, but it is the only feature in this landscape to guide users other than Natives.

The value assigned by land users is considered moderate. As explained in the definition of the concept of landscape for James Bay Crees, the trapping territory may hold a more or less important symbolism

that is not accessible in the eyes of the outside observer. There are few historical and symbolic sites according to a usual definition.

The environmental value in visual terms is described as moderate.

- *LC-1 – LAKE LAGOPEDE*

The landscape unit "LC-1" is located in the heart of the study area. The visual accessibility of this unit is strong due to the lack of vegetation cover and the opening of the landscape created by the water body (Photo 8.7.5).



Source: David Thomassin, Roche Ltd, July 6, 2010.

Photo 8.7.5 View of Lake Lagopede and Mount Lagopede in the background (July 6, 2010)

Lake Lagopede has a moderately strong index of visual interest because of the harmony of its lake scenery and the atmosphere that prevails.

The value assigned by land users is considered high due to the presence of several former camp sites, net-fishing sites, and a spawning ground. Therefore, most of the symbolic and historical sites are present here.

The environmental value in visual terms is described as high.

- *LC-2 - SWALLOW CAMP LAKE*

The "LC-2" landscape unit is located 3.5 km south of Camp Lagopede and continues to the north-east of the future airstrip. The visual accessibility of this unit is the highest of the study area due to the land use by the Swallow camp (Photo 8.7.6).



Photo 8.7.6 Tallyman's camp at the edge of the lake (April 2011)

The lack of vegetation cover and the opening of the landscape created by the lake also contribute to this accessibility. The Swallow camp is the only anthropogenic landmark in this landscape unit. Despite the low density of this occupation, it proves to be important in the context of the study area. This explains the high index of visual accessibility given to this unit.

Swallow Camp Lake has the strongest visual interest of this landscape due to the importance of the presence of the Swallow camp. The lake offers a beautiful setting and an ambiance that fits in well with the surrounding nature.

The index value assigned to this unit is considered strong because of the presence of the camp, which is the only native building in the study area of the viewshed. We therefore find here most of the historic and symbolic sites in this visual unit, but not necessarily in the M11 trapline area.

This unit has the strongest environmental value in the study area in visual terms.

➢ *MT-1 - MOUNT LAGOPEDE*

The "MT-1" landscape unit is located at the eastern boundary of the study area. The visual accessibility of this unit is moderate due to the moderate density of vegetation and its mountainous terrain (Photo 8.7.7).

The mountain offers a far-off view of Camp Lagopede facilities from the snowmobile trail that crosses it (Photo 8.7.8).

Mount Lagopede serves as a landmark for all land users, whether they circulate by snowmobile, motor boat, helicopter or floatplane.

The visual interest index of Mount MT-1 is strong due to the importance of its vantage point. The harmony and continuity of its barren landscape reinforce this index. However, there are no historic and symbolic sites according to a usual definition.

The value assigned to this unit is considered moderate due to the presence of a site for moose-hunting and a snowmobile trail.

The environmental value in visual terms is described as moderate, but this value is higher than that assigned to the DS-1 unit.

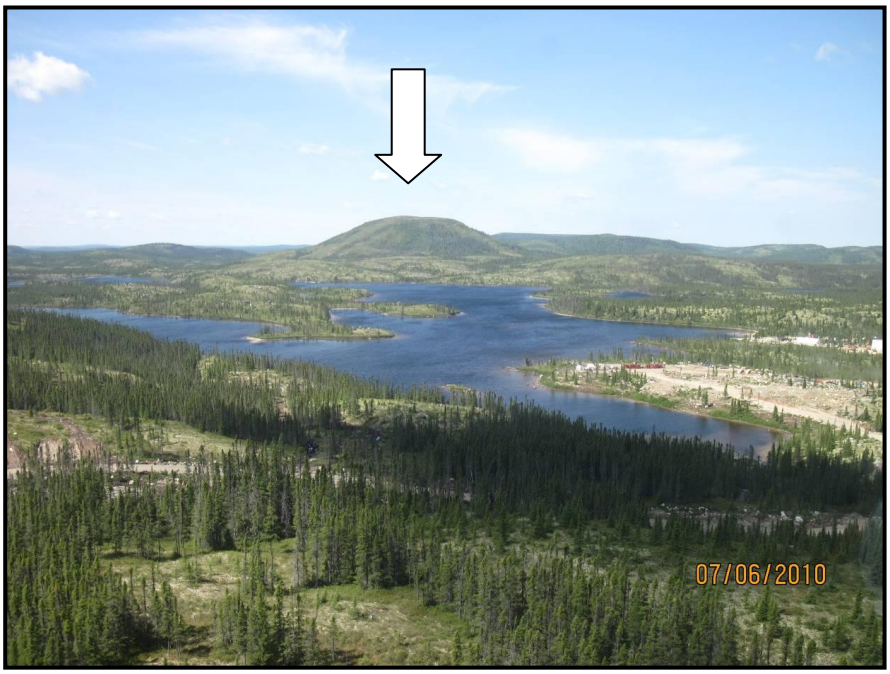


Photo 8.7.7 View of Mount Lagopede and Lake Lagopede

Source: David Thomassin, Roche Ltd, July 6, 2010.



Photo 8.7.8 View of Camp Lagopede from Mount Lagopede

Source: Mary-Lou Coulombe, Roche Ltd, March 24, 2011.

- *MT-2 – UNNAMED MOUNTAIN (LOCATED 3 KM SOUTHEAST OF CAMP LAGOPEDE)*

The "MT-2" landscape unit is located in the western sector of the study area. The visual accessibility of this unit is moderate due to the moderate vegetation density and its mountainous terrain (Photo 8.7.9).



Photo 8.7.9 Unnamed mountain (located 3 km southeast of Camp Lagopede (March 2011))

There are no paths or snowmobile trails on this mountain, which lends this landscape unit the weakest index of visual accessibility.

Mount MT-2 has a moderate visual interest index since it offers no easily accessible observation point. There is no landmark in the landscape to help in location.

The value assigned to the unit is considered low due to the absence of historic or symbolic sites in this unit.

In visual terms, this unit has the weakest environmental value in the study area.

8.7.1.4 Assessment of Visual Components

The appreciation of visual components is based on the criteria for visual accessibility, visual interest and the assigned value. Visual accessibility takes into account the opening of the landscape and the presence of observers and land users. Visual interest reflects the harmony of the landscape unit, the atmosphere that it emanates and the presence of landmarks and points of interest. Finally, the assigned value is based on the organization, the history and symbolic landscapes, as well as the vocation of the unit. Table 8.7.1 summarizes the parameters considered in the environmental value of each landscape unit and subunit. This environmental value also corresponds to the resistance of the landscape. The stronger the value, the stronger the resistance.

Table 8.7.1 Visual Environmental Value Index

				Landscape Unit				
	Intensity	Landscape	SimpleI Index	DS-1	LC-1	LC-2	MT-1	MT-2
Visual Accessibility	High Moderate Low	Visible Hidden	2 1 0	1	1	2	1	1
Visual Interest	High Moderate Low	Concordant Discordant	2 1 0	1	2	2	2	1
Assigned Value	High Moderate Low	Valued Ordinary	2 1 0	1	2	2	1	0
Visual environmental value Index (maximum of 6)				3	5	6	4	2

Index > 4: ***High*** *environmental value*

Index of 3-4: ***Moderate*** *environmental value*

Index < 3: ***Low*** *environmental value*

8.7.1.5 Visual Environment Analysis Summary

The LK-2 Swallow Camp Lake landscape unit has a very strong environmental value closely followed by the LK-1 Lake Lagopede unit. This result reflects the importance that was assigned to Cree traditional activities such as hunting, trapping, and fishing, and to spaces occupied by a camp.

8.7.2 Construction Phase Impacts

The main sources of impact on the landscape in the construction phase are related to the following project components:

- Site preparation and development;
- Dewatering of lakes and streams;
- Construction of mine facilities.

➢ *SITE PREPARATION AND DEVELOPMENT*

During construction, the preparation and development of sites, including land clearing, backfilling of confinement areas and storage of bulk materials, may affect the quality of the landscape and alter its natural character. Clearing activities will expose soil and will be responsible for the deterioration of the visual quality, as much for the mine site as for the airstrip. These visual impacts of high intensity will be synergistic, while at the same time being circumscribed. The construction phase includes several constructions spread over the entire site and will be built in parallel over a period of approximately two years. It should be noted that few people will see the work because the site is far from human settlement, with the exception of the Swallow camp which is located near airstrip site (unit LC-2, which is visited occasionally). The visual impact will be noticeable from the surface of Lake Lagopede (unit LC-1) because of the sparse natural vegetation, as well as from the top of the nearby hill (unit MT-1) on which is found a snowmobile trail used in winter.

➢ *CONSTRUCTION OF MINE FACILITIES AND DEWATERING OF LAKES AND STREAMS*

During the construction of mine facilities (the ore processing plant, the accommodation complex, the airstrip, the power generating sets, and ancillary facilities), the landscape quality and its natural character are likely to be affected.

The establishment of facilities in the landscape has a direct negative impact due to the visual contrast between the existing natural character and man-made constructions. Buildings and their surfaces, as well as roads around the site, will contrast significantly with the existing natural landscape. Although there are many water bodies in the area, the dewatering of small lakes F3302 and F3303 will also take away a part of the natural character of the environment. Few people will see these new facilities since no dwelling that could have a view on the site is close by, except for the Swallow camp, which is located 1.6 km northeast from the end of the airstrip. The views most affected will be from Lake Lagopede and the surrounding hilltops.

➢ *MITIGATION MEASURES*

- No infrastructure will be installed less than 30 metres from Lake Lagopede;
- The accommodation complex will be built on two floors in order to take up less ground space;
- The Swallow camp, which is located near the airstrip, will be relocated. An agreement is in the process of being negotiated with the tallyman to relocate the camp to another area suitable for its use.

➢ *RESIDUAL IMPACT*

During the construction phase, the residual impact can be considered negative because it will be visible from Lake Lagopede and the surrounding hilltops.

The intensity of the impact is considered moderate because it will limit the use of the landscape by a regional community. The spatial extent is considered limited because it will only be noticeable by a few individuals given the security perimeter that will be established around the facilities. The duration of the impact is considered long because it will most likely exceed 20 years until the site is revegetated. Therefore, the importance of the impact is considered moderate.

8.7.3 Operation Phase Impacts

The main sources of impact on the landscape during the operation phase are related to the following project components:

- Development of pits, quarries, and borrow pits;
- Extraction, handling and storage of ore;
- Management of materials resulting from mining operations;
- Operation of the airstrip;
- Progressive rehabilitation of the site;
- Presence of facilities.

➢ *DEVELOPMENT OF PITS, QUARRIES, AND BORROW PITS*

Clearing activities, backfilling, and excavation of overburden from the pits, quarries and borrow pits will have the effect of baring the soil and exposing the mineral layer beneath.

The more formal and circular contours of pits R-65, and particularly R-2/R-3, will stand out in the landscape. The layer of overburden will be transported to the overburden stockpile.

➢ *EXTRACTION, HANDLING AND STORAGE OF ORE*

The ore extracted from pits and the underground mine will be kept in the ore stockpile area to the east of the plant. This storage area is temporary and should disappear after 19 years. The accumulation of ore that will rise in height will have a negative impact; it will be partially visible from Lake Lagopede, but mainly from the surrounding hilltops. Its base consisting in granular material will be reused to backfill the underground mine during the closure phase.

➢ *MANAGEMENT MATERIALS RESULTNG FROM MINING OPERATIONS*

The management of materials resulting from the mining operations, that is the overburden derived mainly from pits, waste rock, and processed kimberlite, consists in transporting these materials to stockpiles or respective confinement and storage areas. The ground space and the final height of the stockpile storage area (20 metres), the waste rock stockpile (52 metres), and the processed kimberlite confinement area (maximum height of 90 metres) will have an ongoing high intensity negative impact. The rigid forms, their imposing size and the covering of the slopes with gravel will contrast significantly with the surrounding natural landscape. These elements will be visible from Lake Lagopede and the high tops of nearby mountains.

➢ *OPERATION OF THE AIRSTRIP*

The operation of the airstrip will have no impact related to landscape quality except for the presence of the airstrip.

➢ *PRESENCE OF FACILITIES*

The presence of facilities on the mine site will have a negative impact on the landscape. This is due among others to their size, colour and shape that will contrast with the natural surroundings. The impact related to the presence of facilities will be visible to only a very few number of people, as no dwellings are found near the mine site. In addition, a security perimeter will be established around the facilities. The views which may be affected are those from Lake Lagopede and the surrounding hilltops.

➢ *PROGRESSIVE REHABILITATION OF THE SITE*

The progressive rehabilitation of the site will have a positive effect on the landscape. This will allow the revegetation of the horizontal surfaces of the processed kimberlite confinement area and the overburden stockpile. The surfaces will gradually become available to revegetation once a bench is completed.

➢ *MITIGATION MEASURES*

- Use the overburden and waste rock excavated from the pits as a material for civil engineering works;
- Jointly operate a sand pit located near the airstrip with the MTQ to minimize the footprint on the surrounding landscape;
- Minimise the ground space and the maximum height of the overburden and the waste rock stockpile, and the processed kimberlite confinement area so that they are not higher than the hilltop to the east, on the other side of the lake F2606 access road, thereby reducing impact on the environment;
- Minimize the footprint of all facilities so that their impact on the landscape is reduced;
- Gradually revegetate the flat surfaces of the kimberlite confinement area during the operation phase.

➢ *RESIDUAL IMPACT*

In the operation phase, the residual impact of the Renard Project on the landscape can be considered negative. The processed kimberlite confinement area and the overburden stockpile will always remain visible in the landscape due to their size and shape.

Visual simulations of the site as it exists now and of the facilities in the operation phase are presented in Appendix 8.7.5. The intensity of the impact is considered moderate, since the presence and operation of the facilities and the security perimeter around them will limit the possibility to admire the landscape. The spatial extent is considered limited since the impact will be perceived only by a restricted number of people. The facilities will remain visible throughout the life of the mine up until its dismantling during the rehabilitation phase. The duration of impact is considered long because it will be felt over a period of more than 20 years until the revegetation of the site is completed. The importance of the impact is considered moderate.

8.7.4 Closure Phase Impacts

The main sources of impact on the landscape during the closure phase are related to the following project components:

- Dismantling and recovery of facilities;
- Final rehabilitation and revegetation of the site;
- Presence of remnants of the site.

➢ *DISMANTLING AND RECOVERY OF FACILITIES*

The dismantling and recovery of facilities will have a positive impact on the landscape. As described in the closure and rehabilitation plan, no building will remain on site. All secondary roads will be scarified and revegetated. The airstrip will also be scarified and revegetated.

➢ *FINAL REHABILITATION AND REVEGETATION OF THE SITE*

The final rehabilitation and revegetation of the site will have a positive effect on the landscape. This will allow the revegetation of areas impacted by the various facilities (treatment plant, power station, vertical mine shafts, accommodation and service complex, and fuel storage area), roadways, inclined access ramps, the former ore storage area, the waste rock stockpile, the overburden stockpile and the processed kimberlite confinement area. The flooding of mine pits will have a positive impact on the landscape by largely offsetting the dewatering of the two small lakes in the construction phase. The impact will have a direct effect on the visual quality of the landscape and will enhance the views from Lake Lagopede and the surrounding hills.

➢ *PRESENCE OF REMNANTS OF THE SITE*

The presence of remnants of the site will have a low intensity negative impact on the landscape since its effect will be gradually reduced over time as vegetation planted on the site takes over. The slopes of the processed kimberlite confinement area and the overburden stockpile will remain visible for some time as they will be covered with blocks.

➢ *MITIGATION MEASURES*

- Cover the former ore stockpile surface with a 0.5 m layer of overburden and a 0.3 to 0.5 m layer of organic matter, followed by revegetation;
- Reuse the stored overburden for rehabilitation purposes;
- Return waste rock and their granular base to pits or use them for underground backfill or various constructions;
- Cover the former waste rock stockpile area with a 0.5 m layer of overburden and a 0.3 to 0.5 m layer of Topsoil for revegetation;
- Collect the granular base from the ore storage area for purposes of site rehabilitation;
- Scarify and revegetate the airstrip following its use;
- Dismantle all buildings and other facilities adjacent to the airstrip;
- Progressively rehabilitate the sites for the management of materials resulting from mining operations in order to mitigate their visual impact.

➢ *RESIDUAL IMPACT*

During the closure phase, the residual impact of the Renard Project on the landscape can be considered positive because of the rehabilitation of the site in general. The site facilities at this point are presented in Appendix 8.7.5. The dismantling work will allow the environment to regain a natural aspect in the short and long term. However, the footprint of the mine area will be visible until the vegetation has completely taken over. The processed kimberlite confinement area as well as the overburden stockpile will remain noticeable because their slopes will be covered with blocks. The footprint of the mine area will remain visible until the vegetation has taken hold and surfaces will remain visible until the plantings mature and hide the slopes located behind.

In the short term, the surfaces that have been revegetated with young trees will stand out from the surrounding natural environment. As the trees mature, this difference in the landscape should be lessened.

Once the perimeter of open pits is revegetated and lakes are formed in the pits following the closure, it will be possible to distinguish their circular shape. Indigenous vegetation will spontaneously take over part of the mineral surfaces several years after closure. A footprint will remain in the natural character of the landscape.

Following the operation of the mine, the rehabilitation of the airstrip, if it is not reused, will allow the environment to regain a natural aspect over the long term, with the growth of vegetation that will be planted there.

8.8 Summary of the Environmental Assessment on the Human Environment

Figure 8.8.1 summarizes the assessment of residual impacts of the Renard Project on the valued components of the human environment.

8.8.1 Construction Phase

During the construction phase, the project components that constitute the main sources of impact are divided into three major groups. The first refers to the very footprint of the project and is characterized by site preparation and development as well as the dewatering of lakes and streams, the second group relates to the construction activities, while the third refers to the manpower and procurement.

The site preparation and development interfere primarily with land use and the landscape. They first have the effect of removing 300 ha of land from any use of natural resources by M11 trapline users. Moreover, construction work will change the natural landscape. Clearing of the sites where mine facilities will be established and the exposure of the soil will be responsible for the deterioration of visual quality of the landscape.

Project Phase	Valued components of the human environment					
	Land use	Socio-economic context	Economic environment	Health and well-being	Archaeological heritage	Landscape
Construction	▼	▲	▲	▽	•	▼
Operation	▼	▲	▲	▼	•	▼
Closure	▲	△	△	▲	•	▲

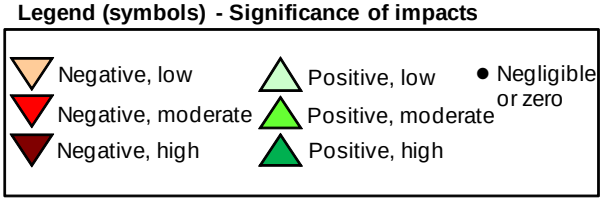


Figure 8.8.1 Summary of residual impacts on the human environment by project phase

Concerning the construction activities, the use and maintenance of machinery and power generator sets, road traffic, air transport, and the construction of mine facilities will cause various nuisances that may lead a number of animals to move away from the construction worksite, while at the same time causing inconvenience to land users. Moreover, the base camp of one of the two trapline holders happens to be located 2.1 km east of the airstrip. Aircraft takeoffs and landings will inevitably cause some inconvenience to this land user. It should also be noted that there are some direct risks to the health and safety of staff and visitors on the worksite and in the mine during the operation phase. Such an impact is taken into account globally in the ongoing management of occupational health and safety at the construction and the mine site in compliance with the *Occupational Health and Safety Act*.

Overall, the impacts of the construction phase on land use and landscape are of moderate importance. Mitigation measures implemented will mainly focus on reducing the negative effects on the activities of M11 trapline users.

The manpower required for construction will, for its part, have a positive socio-economic effect. The Nord-du-Québec and Abitibi-Témiscamingue regions should provide more than a quarter of the manpower required during the construction phase of the Renard Project with nearly 400 jobs in equivalent person-years. In total, also taking into account indirect and induced employment, this phase should support 6,642 jobs in equivalent person-years. Nearly 70 % of these jobs will be located in Quebec. In the three years of the construction phase, the initial investment of $801.8 M should generate economic benefits of about $733 million nationwide, including 14 % in the region and 55 % in the rest of the Quebec province. Across Canada, the induced effect is as important as the direct effect, meaning that workers' incomes represent a very important component of the total spinoffs, and the business retail sector will benefit greatly during the construction phase.

Stornoway plans to develop a recruitment policy that favours regional hiring in order to maximize its impact on the socio-economic context of the region.

8.8.2 Operation Phase

Disruptions of land use experienced during construction activities will continue throughout the operation phase. This time, the sources of impact will be road traffic and machinery maintenance, ore extraction, handling and storage, management of materials resulting from mining, activities at the airstrip, the presence of facilities and manpower, and the gradual rehabilitation of the site. These project components will lead to a general disruption of hunting, fishing, and trapping activities in the mine area. Considering the area occupied by mine facilities and a security perimeter of about one kilometre around the mine site, the area where the project will have an impact on land use and exploitation of natural resources covers an area of approximately 1,500 ha. In addition, the surrounding area will experience a series of disturbances that will cause a number of animals to avoid the mine site (in a < 6 km radius around the mine site), and will impair the practice of traditional hunting and trapping activities. Given these disturbances, M11 trapline users will have to relocate some of their activities. Potential new sites

for hunting and trapping are located near the southeastern border of the trapline and in the central part, to the northwest of the Renard Project.

It should be further emphasized that the Renard Project will likely bring increased employment or business income for M11 trapline users, while encouraging, depending on their availability and interest, the use of the land and the practice of traditional activities. Considering all these facts, the impact of the Renard mining operations on land use is considered negative, but of moderate importance, especially considering that only a small part of M11 trapline will be affected.

Concerning the health of workers and visitors, a new element to be considered relative to the construction phase will consist of dust emissions that may arise from different material deposits. According to analyses carried out on air quality, groundwater, and surface water, no air pollution or environmental contamination that could have a health impact on land users is foreseen.

As regards to the security of the population outside the mine site, it should also be noted that traffic on Route 167 will be limited because workers will access the site and leave by air. It will be the same for the shipment of finished products (diamonds). In fact, traffic will be limited to supplies and should represent about three vehicles per day. Therefore, there should be no impact on traffic flow as compared to current conditions, nor on the safety of Route 167 users and the regional road network, since the traffic generated by the mine will be limited in volume and time.

Transportation of various hazardous materials, such as hydrocarbons and explosives, may also present, in theory, some health risks for residents. These risks are minimal, however, because the transportation of such materials to the Renard mine is governed by the *Ministère des Transports du Québec*'s *Transportation of Dangerous Substances Regulation.* Stornoway will also have more than one emergency response plan.

Concerning the health and well-being of the population, the sources of impact will be mainly related to manpower and procurement, and the very presence of the project. During the operation phase, and even more so in the construction phase, manpower and procurement for the project will have a generally positive impact on overall social conditions of Cree and Jamesian populations, given the economic benefits of the project.

Mining operations for the Renard Project should lead to the direct employment of 244 workers in the regions of Nord-du-Québec and Abitibi-Témiscamingue in equivalent person-years, or 52 % of the total manpower. In total, the Renard Project would support 432 direct jobs dedicated to mining and ancillary facilities in Quebec per year. In addition to these direct jobs, the project would maintain 275 jobs with suppliers (mainly Quebecers) and 465 jobs with merchants who would see their activities increased due to stabilized or additional earnings on the part of direct and indirect workers. The annual economic benefits arising from Renard's mining operation expenses are for their part estimated at $110.8 million, with 34 % distributed to Nord-du-Québec and Abitibi-Témiscamingue, 47 % to the rest of the province,

and 19% to the rest of Canada. Finally, to these benefits are added government and public revenues, including personal income tax, consumption taxes, business profit taxes, payments to the Crees under the Paix des Braves, the mining company taxes paid to the Quebec and Canada governments, as well as mining royalties. The economic spinoffs of the project during the operation phase is positive and of high importance.

In addition to the economic spinoffs of the project, there are financial benefits stemming from the Impact and Benefit Agreement (IBA) that is negotiated between Stornoway and the Crees. It is noteworthy that under this agreement, Stornoway aims to ensure that the Crees will benefit from a number of jobs proportional to their demographic weight within the Eeyou Istchee James Bay territory, i.e. around 50 % currently. In addition, the IBA provides for various measures concerning the training of Crees and the optimization of spinoffs for Cree businesses.

A number of potential negative impacts, however, can be foreseen for the well-being of the Crees, particularly with regard to conditions of employment. Among them, the experience of other projects in the James Bay territory in particular, has highlighted the challenges facing the integration of Native workers within work teams. With some support measures and awareness raising on the part of Stornoway, however, such integration should be positive.

At the same time, the study of the Eastmain-1-A-Sarcelle-Rupert highlighted the negative effects of prolonged absences of Native workers on their family lives. Finally, some observers, notably the CBHSSJB (2010), as part of the recent analysis of a mining project planned in the territory, highlighted the fact that higher incomes for individuals or households in communities can drive a number of Crees to spend more money on alcohol, forcing Cree political and health authorities to dedicate more money to support programs and awareness raising on healthy lifestyles.

Other monitoring studies for their part lead to the belief that the presence of mines in remote territories is unlikely to have marked negative impacts on the well-being of communities. Overall, during the operation phase, it is doubtful that the Renard Project will bring any detectable change in the lifestyles of the Cree and Jamesian communities affected by the project.

It should also be underlined that the presence of facilities on the mine site will have a negative impact on the landscape. This is due in part to their size, colour, and shape, which will contrast with the natural character of the surroundings. This impact is considered of moderate importance.

8.8.3 Closure Phase

During closure, the project components that are the main sources of impacts are generally the same as during the operation phase, but on a smaller scale and of a much shorter duration. These negative impacts will be largely offset by the final rehabilitation and revegetation of the site that, beyond the visual improvement of the sector, will enable flora and fauna to gradually recolonize the environment. From a psychosocial standpoint, this will have a positive effect by mitigating as much as possible the

negative impact associated with the feelings of loss that may emerge from the mining operations in of a previously undisturbed environment.

In terms of jobs, it is estimated that the direct employment of the closure phase will be 34 person-years from the region. In total, closure activities would support some 135 jobs across the country.

Chapter 9

Impact Assessment by Project Component

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9 Impact Assessment by Project Component

The present section describes the main residual impacts of the Renard Project, i.e. those that will last regardless of the mitigation measures adopted. These residual impacts are presented by project component for each of the project phases. It should be recalled that construction is scheduled to continue for about 2 to 3 years (2013 to 2015), that the deposit will be mined for approximately 20 years (2015 to 2033), and that the closure of the mine and final rehabilitation of the site should last about 2 years (2033-2036). Lastly, the post-closure period, referring to a permanent state of the site once it is completely closed, has been set at over 25 years, i.e. the longest period of time during which it would appear possible and reasonable to anticipate long-term impacts of the mine after closure work and the final rehabilitation of the site have been completed.

Appendices 9.1.1, 9.2.1 and 9.3.1 present, respectively, the summary of impacts and of mitigation and enhancement measures by valued component, for the construction, operation and closure phases.

9.1 Construction Phase

During the construction phase, the project components generating the most impacts are the preparation and development of the sites and water management on the construction site due to dewatering of small lakes F3302 and F3303 and the diversion of stream F3298V, north of pit R-65. The main impacts to apprehend include terrestrial and aquatic habitat loss, along with water quality degradation. It should be noted that 90 % of losses in terrestrial environments and wetlands, and 100 % of losses in aquatic environments will occur during this phase of the project.

- *SITE PREPARATION AND DEVELOPMENT*

The clearing of trees required for site preparation and development will result in the loss of 254 ha of forest environments (2.5 % of their initial extent in the study area), of 20.3 ha of barren (9.1 % of their initial extent in the study area), and 4.8 ha of wetlands (1.8% of their initial extent in the study area). As regards forest environments, nearly 68 % of all losses will be incurred by the young black spruce-lichen stand, the most extensive stand in the study area. The old black spruce-sphagnum and old jack pine-lichen stands will absorb, respectively, 15 % and 14 % of the losses. Based on the initial area of each stand in the study area, the latter two stands will be proportionally the most affected by the project. For example, the old black spruce-sphagnum stand will lose 9.6 % of its initial area and the old jack pine-lichen stand, 12 %, compared to only 2.6 % for the young black spruce-lichen stand. The wetlands that will be destroyed are small in extent and consist of open bogs (61 % of losses) and riparian fens (39% of losses). The affected forest environments and wetlands are neither rare nor unique at the regional level. They do nevertheless constitute habitats for terrestrial flora and fauna (amphibians, birds and mammals), as well as territories for natural resource harvesting by users of Trapline M11. Regarging special status species observed in the mine site, two bird species will lose nesting and

feeding habitats as a result of site preparation and development, namely the olive-sided flycatcher (a threatened species according to the federal government and likely to be designated as threatened or vulnerable at the provincial level) and the rusty blackbird (of special concern at the federal level and likely to be designated as threatened or vulnerable at the provincial level). Lastly, site preparation and development will result in the development of bare areas (secondary roads, storage areas, etc.) that will constitute physical barriers limiting the movement of amphibians between habitats.

Site preparation and development will also involve other types of work, including topsoil stripping, leveling, backfilling, drill cutting, as well as the installation of culverts. As a result of this work, topsoil will be exposed to bad weather and reworked, thus becoming susceptible to wind and water erosion. The relative importance of fine particles resulting from this work will be limited. Consequently, most particles raised by earthworks will tend to settle close to their source. In addition, the earthwork will modify subwatershed limits, runoff coefficients, and groundwater recharge rates. In fact, the combined effect of tree clearing and sealing of certain surfaces will, upon occasion, increase peak flows at the outlets of the subwatersheds concerned, which could lead to even greater erosion.

Erosion could potentially affect surface water quality by increasing suspended solids and contaminant loads in streams and lakes. Any deterioration in surface water quality would necessarily impact the quality of sediment and of aquatic life habitat. In order to prevent and limit sediment and contaminant transport in the water, erosion control at the source and an integrated water management plan were developed as part of the project design and will be implemented as soon as construction work begins. Thus, the impacts of site preparation and development during the construction phase should be slight and contained. The water quality monitoring (Section 11.4) and environmental surveillance program (Section 11.3) for the construction site will ensure that the impacts are limited in this way.

Site preparation and development work (including the airstrip and terminal) will require the use of machinery that emits combustion gas and raises suspended particulate matter. The proportion of fine particles generated by such work will be limited; therefore most of the particles thus raised will tend to settle close to their source.

Archaeological remains may be uncovered fortuitously during the various excavations to be carried out at the site. Should this occur, work will be interrupted at the place of discovery to allow archaeologists to carry out a complete assessment of the discovery in question.

Site preparation and development will prevent the M11 trapline users to carry out their natural resource harvesting in some 300 ha of land. In the meantime, construction activities will result in various nuisances that would normally lead a certain number of animals to avoid the mine site while causing inconveniences for land users. Aircraft landings and takeoffs are also likely to cause a few inconveniences. In order to minimize these impacts, Stornoway will remain in constant communication with M11 trapline users so as to ensure that their activities are not hindered in any significant way and to reach the necessary agreements to compensate them for any observed or predicted disturbances.

Lastly, in order to minimize the impact on the natural character of the landscape, no infrastructure will be built within 30 m of Lake Lagopede or streams, and the height of the processed kimberlite confinement area will remain below that of neighbouring hills.

- *CONSTRUCTION OF MINE FACILITIES / QUARRY AND BORROW PIT OPERATIONS*

The most significant impact of the construction of mine facilities and of the quarry and borrow pit operations will be the noise emission. Based on simulations, the sound levels during the construction phase are anticipated to be $LA_{eq,1h}$ 50 to 60 dBA in the temporary dormitory area located south of the mine site. These levels correspond to the values measured on residential streets. In zones outside the project's footprint area, noise levels in the order of 60 dBA are to be expected during work, depending on the site in question. To contextualize the predicted disturbance, a noise level of 60 dBA is the equivalent of a conversation between two people situated one metre apart. The noise generated by the construction of mine facilities could affect the activities of wildlife around the mine site within a maximum radius of six km, beyond which residual noise levels will be similar to those of the boreal forest. Nevertheless, depending on where one is located, the topography of the site may help reduce the extent of this potential impact zone.

Certain species that are more likely to be disturbed will avoid the mine area. Cree land users will have to modify their hunting, fishing and trapping habits by avoiding the mine area since there will be a one-km security perimeter surrounding the facilities.

Although most animal species will be disturbed by the construction activities, others may be attracted by the mine facilities. Some animals, such as wolves, foxes, black bears and common ravens, may come in search of food, and may become a nuisance. An awareness program will be implemented to encourage employees to avoid feeding animals or leaving out food that they can reach to prevent animal from being attracted in the first place. Other species may find suitable sites to build their nests (common ravens and tree swallows), or perching spots (electricity poles) for hunting (red-tailed hawk) on the mine site.

- *DEWATERING OF LAKES AND WATER AND SEDIMENT MANAGEMENT*

This work includes the dewatering of small lakes (F3302 and F3303) and the diverting of stream F3298V to the north of pit R-65, the pumping of water toward the sedimentation pond of pit R-65, and the management of sediment excavated at the bottom of lakes. The water pumped will be treated at the mine wastewater treatment plant prior to being discharged into Lake Lagopede. The volume of pumped water represents 0.2 % of Lake Lagopede's volume, thus resulting in an estimated temporary maximum increase of the lake's water level of 8.5 mm. The excavated sediment will be incorporated into the overburden stockpile and used during the progressive rehabilitation work on the site as a means of topsoil nutrient enrichment.

In addition to modifying the sector's hydrological regime (disappearance of outflow streams) and the pattern of groundwater recharge and discharge, the dewatering of lakes F3302 and F3303 will cause minimal aquatic habitat losses for benthos, fish, amphibians and waterfowl. In fact, these two small lakes, taken together, represent only 0.17 % (3.75 ha) of the area of all bodies of water in the study area. Brook trout use lake F3303 for feeding and resting. Pearl dace and white sucker have also been observed in this lake. Only pearl dace and an unidentified species of cyprinid were caught during the fishing campaign carried out at lake F3302. Concerning amphibians, the loss of these two small lakes will especially affect the mink frog, which seeks permanent aquatic environments for reproduction.

- *WATER MANAGEMENT ON THE CONSTRUCTION SITE*

In addition to modifying the sector's hydrological regime, the diversion of stream F3298V and of all waters of subwatershed SBVR2 upstream from pit R-65, by way of a ditch toward lake F3295, will cause aquatic habitat loss for benthos, fish and amphibians. Brook trout are known to use the downstream waters of stream F3298V.

A peripheral system of runoff water collection made up of drainage ditches will be built at the outset of construction work. This system will channel runoffs from the construction site toward pit R-65, which will be built at the current outflow of subwatershed SBVR2 and will cover an area of 21.5 ha. The water collected in pit R-65 will be treated before being discharged into Lake Lagopede. It should be noted that water from the accommodation complex will be collected by its own drainage system and directed toward a sedimentation pond whose water will, in turn, be monitored before being discharged into Lake Lagopede.

Effluents treated by domestic and mine wastewater treatment plants will discharge a certain quantity of contaminants into Lake Lagopede (TSS, nutrients, metals, fecal coliforms, organic matter, etc.). By complying with the Effluent Discharge Objectives set by the *Ministère du Développement durable, de l'Environnement et des Parcs* (MDDEP), the surface water quality criteria for the protection of aquatic life (at the boundary of the mixing zone), Directive 019, and the provisions of the *Metal Mining Effluent Regulation* (MMER), it will be possible to limit the impacts of these effluents on water and sediment quality and restrict the impacts to within their mixing zone. Moreover, contaminant concentrations measured at the boundary of the plumes should fall within the concentration range measured before the beginning of the project, during the environmental baseline study. The results of the plume dispersion model of treated domestic effluent (Appendix 3.10.1) indicate that the initial concentration of treated effluent will reach a dilution of 1:100 at a distance of 52 to 130 m from the discharge point, depending on whether an estimated average flow or a peak flow is being taken into account. At the boundary of the plume, contaminant concentrations will be within the same range as concentrations currently measured in the receiving environment. According to the results of dilution limit calculations and of model CE-QUAL-W2, the domestic effluent will not have a significant impact on the water quality of the lake; its influence being limited to the zone adjacent to the discharge point.

The additional loads of organic matter introduced by the treated domestic effluent could lead to a local increase in bacterial activity and result in a decline in the dissolved oxygen rate in the vicinity of the discharge point. For fish, the main impact linked to effluent discharge is an avoidance effect. In fact, certain so-called specialist fish species, such as lake trout, may well avoid the effluent mixing zone.

Lastly, the setting up of ponds for the domestic wastewater treatment station may well benefit certain waterfowl species by serving as places for rest and reproduction.

- *USE AND MAINTENANCE OF MACHINERY, POWER GENERATING SETS, TRAFFIC, AND STORAGE AND MANAGEMENT OF HAZARDOUS MATERIALS AND FUELS*

Given the risks of leakage and accidental spills of hydrocarbon products (which are in themselves hazardous materials), the use and maintenance of machinery and of power generating sets, along with the storage and management of other hazardous materials and fuel, threaten the quality of topsoil, sediment, groundwater and surface water, as well as aquatic biotic communities (benthos, fish, amphibians, etc.). Seepage of contaminants into the soil toward the groundwater could even be facilitated by the stripping and reworking of topsoil carried out by machinery. Contaminated groundwater could resurface and thus affect Lake Lagopede. The contamination of water, plants, fish and wildlife by hydrocarbons, or other chemical products, could eventually affect the Crees who consume them. However, a management plan for hazardous materials and fuels, as well as an emergency response plan have been developed in order to prevent leaks and spills and to intervene as effectively as possible to contain contamination in cases of accidental events. The implementation of these plans will minimize the risk of contamination of the project's environment by hydrocarbon products and others of an equally hazardous nature.

The use of machinery will result in emissions of combustion gas and suspended particulate matter. Given that the exhaust pipes of the machinery to be used are low to the ground, the maximum concentration of combustion gas that they generate will be observed at distances of less than 100 m from the facilities and consequently will not affect areas outside the mine site. The concentrations of nitrogen oxides and particulate matter generated by machinery will be below the limits set by the *Regulation respecting occupational health and safety*. However, as a precautionary measure, the appropriate personal protection equipment should be provided for those assigned this sort of work.

During the construction phase, the main sources of noise will be linked to on-site mobile equipment, namely drillers, graders, loaders, etc. Taken as a whole, this equipment will generate sound levels of roughly 95 dBA at a distance of 15 m. In zones outside the project's footprint area, noise levels of approximately 60 dBA should be expected during work, depending on the site in question. The noise generated by the construction of mine facilities could affect the activities of wildlife within a maximum radius of six km of the mine site, beyond which residual noise levels will be similar to those of the boreal forest. Certain species that are more susceptible to disturbance will avoid the mine site. Cree land users

will have to modify their hunting, fishing and trapping habits by avoiding the mine site since a one km security perimeter will surround the facilities.

During construction, on-site machinery traffic may cause wildlife mortality, especially among amphibians and small mammals, as a result of crushings and collisions. However, the on-site speed limits to be applied will considerably reduce the probability of collisions with wildlife.

- *STORAGE AND SOLID WASTE MANAGEMENT SYSTEM AND TRENCH LANDFILL SITE (TLS)*

The seepage of precipitation by percolation into the solid waste of the trench landfill site (TLS) has the potential to transport various contaminants (nutrients, metals, organic matter) toward the groundwater table. As a means of limiting these impacts, the TLS has been designed to meet the specifications of the *Regulation respecting the landfilling and incineration of residual materials* (RLIRM, R.S.Q., c. Q-2, r. 19). Moreover, the ground of the TLS will be raised so that waste may be landfilled above the water table, i.e. in an unsaturated zone. As such, the leachate will be diluted and treated in a natural manner by the processes of soil infiltration (filtration, capillary retention), biodegradation, and other chemical processes (precipitation, ion exchange and absorption). In order to ensure a successful treatment of leachate in the soil, a system of observation wells will be put in place on the periphery of the TLS, designed for the specific needs of the Renard Project in accordance with the provisions of section 65 of the *Regulation respecting the landfilling and incineration of residual materials* (RLIRM).

- *MANPOWER AND PROCUREMENT*

Since the mine's employees and contractors will not be allowed to pursue any on-site hunting and/or fishing activities, no additional pressure from such activities on the wildlife resources of the sector is anticipated. The application of the one km security perimeter surrounding the facilities will also ease the pressure of hunting and trapping around them, as well as the fishing pressure on Lake Lagopede.

During construction, and especially during the operation phase, the project's manpower and procurement activities will, generally speaking, have a positive impact on the overall social conditions of the Cree and Jamesian populations given the project's economic spinoffs. The manpower required for construction work will have a positive effect on the socio-economic context. As such, the Nord-du-Québec and Abitibi-Témiscamingue regions should provide over 25 % of the manpower required during the construction phase of the Renard Project, which will generate nearly 400 person-years equivalent jobs.

The impacts of other project components are proportionally less important and are summarized in Appendix 9.1.1, along with their respective mitigation measures.

9.2 Operation Phase

The operation phase will extend over a period of approximately 20 years. Project components having the greatest impact during this phase are most likely to be those also producing jobs, stimulating the economy, and providing business opportunities in the region.

This is especially the case as regards the project's manpower and procurement activities, which will support all other mining activities of this phase of the project.

Concerning impacts on the natural environment, project components which are most likely to cause an impact include mining extraction activities and the management of materials resulting from mining operations; water management; the physical presence of the facilities themselves; the development of quarries, borrow pits and other pits; the use and maintenance of machinery; and road traffic. Other project components will have a lesser impact on the valued environmental components.

- *MANPOWER AND PROCUREMENT*

Given its economic spinoffs, the project's manpower and procurement activities will, generally speaking, have a positive impact on the overall social conditions of the Cree and Jamesian populations.

Higher individual incomes and better employment opportunities will lead to improved living conditions, especially in the area of housing, and will also result in better individual and community health, including physical, mental and social health.

The Renard Project mining operation should result in the direct hiring of 244 person-years equivalent workers from the Nord-du-Québec and Abitibi-Témiscamingue regions, i.e. 52 % of the total manpower. Overall, the Renard Project should sustain some 432 jobs per year in Quebec, all directly dedicated to mining activities and related facilities. In addition to these direct jobs, the project would help maintain 275 jobs among suppliers (mainly from Quebec), and 465 jobs among merchants whose activities will increase due to the sustained or additional income of the direct and indirect workers. For their part, the yearly economic spinoffs from expenditures related to the Renard mine are predicted to be $110.8Mand distributed as follows: 34 % for the Nord-du-Québec and Abitibi-Témiscamingue regions, 47 % for the rest of the province, and 19 % for the rest of Canada. To be added to these spinoffs are government and public revenues, especially from personal income taxes, consumption taxes, capital gains taxes paid by businesses, payments to the Cree in accordance with the *Agreement Respecting a New Relationship Between the Cree Nation and the Government of Quebec* (the so-called "Peace of the Brave"), taxes collected by the governments of Quebec and Canada from the mining company, and mining royalties. The expected economic spinoffs of the project during the operation phase constitute a very powerful positive impact.

Added to the benefits related to the project's economic spinoffs are the financial advantages arising from the Impact and Benefit Agreement (IBA) negotiated between Stornoway and the Cree. It should be

noted that, in accordance with the agreement, Stornoway has established a Cree employment target: the number of Cree hired should be proportionate to their demographic weight within the Eeyou Istchee Baie-James region, i.e. approximately 50 % at the present time. In addition, the IBA provides for various measures concerning the training of Cree and the optimizing of spinoffs for Cree businesses.

A certain number of potentially negative impacts may, however, be anticipated as regards the well-being of the Cree, especially with respect to working conditions. Included among them are challenges concerning the integration of Native workers within work teams, as the experience of other projects across the James Bay territory serves to highlight. However, certain facilitation and awareness measures that Stornoway is expected to implement should ensure a successful integration of Native workers.

Other monitoring studies, for their part, suggest that the arrival of mining industries in a remote area will not normally have pronounced negative impacts on the well-being of the communities concerned. Overall, as regards the operation phase, it may be concluded that the Renard Project will not result in any detectable transformation of the life styles of the Cree and Jamesian communities concerned by the project.

- *PIT DEVELOPMENT AND THE EXTRACTION, HANDLING AND STORAGE OF ORE*

Pit development will especially contribute to modifying the topography of the site, as well as the hydrological and hydrogeological regime of certain subwatersheds of Lake Lagopede. Additional losses of forest environment will overall be very modest, involving an additional loss of 28.6 ha of forest environment and 1.2 ha of wetlands, i.e. only 0.2 % and 0.5 % of their initial respective areas in the study area. However, excavation and ore and tailings handling and storage activities will contribute to a local modification of the surface water and groundwater flow pattern, cause a drawdown of the water table around the pits, and generate annoyances such as dust, exhaust gases and noise at the extraction site and in its vicinity.

The noise generated by the construction of mine facilities could affect the activities of wildlife within a maximum six-km radius of the mine site, beyond which residual noise levels will be similar to those of the boreal forest. Certain species that are more susceptible to disturbance will avoid the mine area. Cree land users will have to modify their hunting, fishing and trapping habits by avoiding the mine area since the facilities will be surrounded by a one km security perimeter.

- *MANAGEMENT OF MATERIALS PRODUCED BY MINING OPERATIONS (OVERBURDEN STOCKPILE, WASTE ROCK STOCKPILE AND PROCESSED KIMBERLITE)*

Approximately 44.3 Mt of processed kimberlite will have to be stored. The total area of the processed kimberlite confinement (PKC) area along with the waste rock and overburden stockpiles will be nearly 114.9 ha.

These tailing confinement and storage areas will obviously have an impact on the landscape, with the processed kimberlite confinement area (a maximum height of 90 m), the waste rock stockpile (52 m high) and the overburden stockpile (20 m high) having the greatest impact. The aforementioned confinement and storage areas will bring about a significant modification of the landscape and of the drainage pattern and may modify the quality of the water that percolates through them. Nevertheless, according to the results of static and kinetic testing, waste rock, kimberlite and processed kimberlite constitute low-risk mine tailings, as Directive 019 indicates. In other words, these materials do not present any risk of acid mine drainage and are not likely to leach metals at a concentration that could represent a risk for aquatic life, water consumption, or the consumption of aquatic organisms.

Three forms of processed kimberlite will be stored: coarse fractions, grit fractions and slime fractions. The expertise acquired by other Canadian diamond mines and the results generated by atmospheric emissions modeling have led us to conclude that problems related to wind erosion and airborne particle transport are unlikely to arise given the size of the particles and the position of buildings and neighbouring hills.

- *WATER MANAGEMENT*

With the implementation of the water management plan, all surface runoff that comes in contact with the mine site and its materials will be collected and directed to a sedimentation pond in pit R-65 for treatment. The quality of this water will be controlled before being discharged into Lake Lagopede. The water management plan will result in a modification of the hydrological regime of certain small subwatersheds that feed Lake Lagopede (diversion of certain streams, increased peak flow and changes in timing of peak flow)

Mine-pit dewatering will have a significant impact on the sector's groundwater. According to simulation test results, a 10-m groundwater level drawdown could occur and may extent as far as 500 m or so from the pit walls.

Modeling results of the treated mine effluent plume (see Appendix 3.10.1) indicate that in a condition of minimum flow the initial concentration of treated effluent will reach a dilution of 1:10 at a distance of 750 m from the discharge point, and 300 m during fall overturn. For the northern basin of Lake Lagopede, the phosphorus in the mine effluent could lead to a temporary and local increase in total phosphorus concentration, around the month of August, corresponding to that of an oligo-mesotrophic lake (typically between 0.007 and 0.013 mg/l of total phosphorus; MDDEP, 2007). Depending on the proportion of this total phosphorus that will be bioavailable in the form of orthophosphates, the phosphate inflow could contribute to an occasional and temporary increase in the productivity of this sector of Lake Lagopede and of its fish productivity. Considering the residence time of water in Lake Lagopede, i.e. approximately 50 days, and the drop in temperature generally occurring in September, this effect will not last long and will perhaps be limited to the month of August. In order to validate the

impact assessment, a water quality monitoring program for Lake Lagopede and the various effluents has been developed (see Chapter 11).

- *PRESENCE OF FACILITIES*

The physical presence of facilities will have a direct impact on landscape quality by affecting its natural character. Hunting, fishing and trapping will not be allowed within a security perimeter established around the mine site and airstrip. When including the area with the mine facilities and a security zone encompassing approximately one km on the periphery of the mine site, the area where the project will impact land use and natural resource harvesting covers some 1,500 ha. This represents approximately 4 % of the vast and valued land used by the M11 trapline users. The surrounding area will experience a series of disturbances that will probably put a certain number of animals to flight and undermine the peaceful pursuit of traditional hunting and trapping activities. In spite of the project's relatively limited impact on the main wildlife resources of M11 trapline's hunting and trapping grounds, users have expressed concerns that must be highlighted, and it should also be stressed that the presence of the mine will force them to abandon certain sectors where wildlife will be affected, and re-establish their harvesting activities on the basis of the new distribution pattern of species of interest.

- *USE AND MAINTENANCE OF MACHINERY, POWER GENERATING SETS, TRAFFIC AND STORAGE AND MANAGEMENT OF FUEL AND HAZARDOUS MATERIALS*

The impacts linked to these components are addressed in the section concerning the construction phase. The operation of power generating sets over a 20-year period may cause significant greenhouse gas emissions. Overall, the project will produce an estimated 75,000 or so tons of CO_2 equivalent in GHG on an annual basis, including 35,000 tons by the power generating sets alone. However, if the economic context is such that fuel prices increase before project implementation, or if a context favouring the development of the Nikamo-Renard line emerges, the project could decide to invest in the construction of the line.

- *OPERATION OF THE AIRSTRIP*

Airstrip operations and road traffic will open up the region to a significant extent and facilitate procurement and exchange activities. Given that there will be only three flights per week, the takeoff and landing of Dash 8 aircraft will constitute occasional and infrequent sources of noise. The noise will temporarily disturb birds, amphibians and mammals that use the sector. The sound level could increase by 50 to 60 dBA for one to ten minutes during takeoff and landing. Given that flights will be few and far between, these disturbances will not last long and may be comparable to, or even less significant than, the disturbances currently caused by hydroplanes and helicopters that generate higher noise levels than a Dash 8.

An annual use of approximately 1,000 L of propylene glycol is anticipated for purposes of aircraft deicing. Although not considered toxic, propylene glycol can affect aquatic organisms in concentrations exceeding 500 mg/l (CCME, 2007), mainly by increasing biological oxygen demand (BOD_5). In order to limit propylene glycol dispersal, all deicing activities will be restricted to a single site. Considering that aircraft will remain on the ground for a very short time only and that flights will be few and far between, deicing needs will be considerably less pressing than at a commercial airport. Given propylene glycol's low toxicity and the small amount to be used, there is no cause for concern as regards toxicity or BOD_5 increase linked to propylene glycol degradation in the aquatic environment. The residual propylene glycol that could remain in springtime will be rapidly dissolved by the spring thaw and rains and carried toward streams during freshet period. Moreover, surface water quality monitoring downstream from the airstrip site will be implemented in order to ensure that the use of propylene glycol does not cause any contamination of streams and lakes.

- *WATER SUPPLY*

The only water uptake done from Lake Lagopede will be for purposes of drinking water production, fire protection and dust control. Given the significant volume of water available from Lake Lagopede (21 Mm^3) and the low quantities used during the operation phase, the water uptake should not have any impact on Lake Lagopede.

- *PROGRESSIVE REHABILITATION OF THE SITE*

The progressive rehabilitation of the site will help prevent erosion and sediment transport and will also serve to restore a small proportion of the habitats lost during site preparation and development. In fact, during the operation phase, the temporary storage area for construction materials, the temporary campsite, and part of the processed kimberlite confinement area will be covered by a layer of overburden and topsoil before being hydroseeded and planted with black spruce. These first on-site revegetation trials will serve as pilot tests for the final on-site revegetation work, and lessons will be drawn from them. The habitats restored in this way may gradually be recolonized by amphibians, forest birds, micromammals, small wildlife, and fur-bearing animals.

Moreover, the revegetation of horizontal surfaces of the processed kimberlite confinement area and the overburden storage area will have a beneficial impact on the landscape.

The impacts of other project components are proportionally less important and are summarized in Appendix 9.2.1, along with their respective mitigation measures.

9.3 Closure Phase

Mine closure and final site rehabilitation activities should stretch over a period of approximately two years. Initially, for the closure phase, road traffic and the use of machinery will cause localized disturbances on the work sites (localized dust emissions, machinery noise and sediment transport).

However, the project components that will result in the most significant environmental transformations are the dismantling of mine facilities, the final rehabilitation and revegetation of the site and water management by pit flooding.

- *WATER MANAGEMENT*

Water management facilities, i.e. the ditches, retention ponds, and the wastewater treatment plant, will remain in operation until closure activities have been completed and monitoring demonstrates that the quality of the water that came into contact with the mine site complies with the environmental quality objectives (Directive 019, MDDEP 2005) and does not require further treatment (Golder, 2011e). From that point on, the drainage pattern of streams and lakes located on the periphery of the mine site will be restored, as much as possible, to conditions similar to those observed before the beginning of operations.

During closure, two new lakes will be created north of Lake Lagopede through the flooding of pits R-65 and R-2/R-3. Pit R-2/R-3 is slated to be filled by net precipitation, surface runoff and groundwater inflow.

- *DISMANTLING OF MINE FACILITIES AND THE FINAL REHABILITATION AND REVEGETATION OF THE SITE*

The industrial mine site will be transformed and will return to natural conditions somewhat different from what they were prior to implementation of the project. The dismantling of mine facilities will include the removal of buildings and industrial facilities that will have been part of the landscape for about twenty years. The final rehabilitation work will aim to restore the topography so that it is well integrated with the natural landscape, to stabilize soils, to restore vegetation as a means of controlling erosion, and to restore the forest cover. By the end of production activities, revegetation of most (75 %) of the impacted areas will be initiated in order to gradually restore the forest cover. The flooded pit and the slopes of the processed kimberlite confinement area and overburden stockpile will not be revegetated after the mine is closed and will cover an area of 76.8 ha (25 % of the impacted area).

Industrial buildings will give way to grass prairies generated by hydroseeding and dotted with young spruce trees planted at a density of 2,000 plants per hectare. This new habitat on the edge of Lake Lagopede will initially attract geese, certain forest birds and raptors, small mammals and micromammals, and possibly herpetofauna in wet lowland areas. Most of the area impacted by the mine will become once again suitable for wildlife. Certain species that may have been attracted by the mine facilities during the operation phase (foxes, wolves, bears, common ravens, tree swallows, etc.) may disperse across the land while other opportunistic species will profit from the new environmental conditions. The processed kimberlite confinement area and overburden stockpile will initially take on the appearance of barren hills that will gradually become covered with vegetation, as they were in the past. Initially, the structure of the plant communities will mainly include herbaceous and shrub strata along with a sparse covering of spruce.

As much as possible, surface drainage will be re-established to conditions similar to those in place prior to the implementation of the project. Pits R-2/R-3 and R-65 will cease to be dewatered and will gradually become 'lakes.' The outlet of lake F3298, which will have been diverted toward lake F3295, will be redirected toward pit R-65 in order to speed up the filling process. A surface hydraulic link will be established between this new lake and the bay northeast of Lake Lagopede in order to ensure free movement of fish between the two bodies of water. A link will be established between R-2/R-3 and the site's drainage network to ensure that the pits are filled.

If they wish, regional communities will be able to take over the airstrip and terminal as facilities to promote regional development. Alternatively, facilities can be dismantled, the soil scarified and the site revegetated. Materials and equipment salvaged from the mine site may be upgraded or recovered in the region, and in this way, slightly mitigate the loss of business opportunities related to the end of project operations. Mine closure will obviously result in job losses, both direct and indirect. However, given the mine's long life span, workers will have acquired mining or industrial expertise that can be put to good use in other upcoming projects in the region.

All things considered, the impact of this phase will essentially be positive and long lasting, and will enable Crees and Jamesians to re-appropriate the territory and its resources while providing greater access to it.

The impacts of other project components are proportionally less important and are summarized in Appendix 9.3.1, along with their respective mitigation measures.

9.4 Post-Closure Phase

The post-closure phase refers to a permanent state of the site once the closure phase has been completed. This phase is expected to stretch over a 25-year period, i.e. the longest period during which it is possible and reasonable to anticipate long-term impacts of the mine following closure work and the final rehabilitation of the site. A gradual return to pre-project conditions should be observed during this period.

- *WATER MANAGEMENT*

Two new lakes that will be created north of Lake Lagopede by the flooding of pits R-65 and R-2/R-3 will normally fill up within seven years (Itasca, 2011). Pit R-2/R-3 is expected to fill up by way of net precipitation, surface runoff and groundwater inflow. As opposed to the hydrographical network, which is mainly fed by groundwater from surface deposits, the deep pit lakes will also be fed by groundwater from rock. Results generated by the model suggest that the piezometric surface will not totally return to its initial conditions, but instead will be slightly lower due to the presence of lakes (Itasca, 2011). Over 222,000 m² of fish habitat will be recreated by the flooding of the pits. These lakes will have a large surface area and will, on average, be deeper than all the lakes of the study area; as such they will

provide a favourable habitat for species prioritized by the Cree, such as lake trout, lake whitefish, and burbot. In addition, the new lakes could be used by benthos and as a migratory staging area for waterfowl. These modifications could lead to an increase in productivity for the Lake Lagopede region, and enhance its halieutic and hunting potential.

- *FINAL REHABILITATION AND REVEGETATION OF THE SITE*

Over the years, the revegetated areas will be colonized by neighbouring vegetation, and trees will slowly grow. The vegetation cover will normally regain a natural appearance structure and begin to provide habitats for large wildlife and fur-bearing animals within a 10 to 15-year period, which could be extended further depending on growth conditions.

- *PRESENCE OF SITE REMAINS*

Following the definitive closure of the mine, the sound environment will return to pre-project conditions.

Post-closure monitoring will be established for the following environmental components: surface water quality, groundwater quality, and vegetation. These monitoring plans will be designed to ensure that the site remains (processed kimberlite confinement area, overburden stockpile and TLS) left by mining operations do not have significant environmental impacts, or conversely, that corrective measures are implemented if sources of contamination are identified.

Following the elimination of mine facilities, the general rehabilitation of the project's footprint area, and pit-flooding procedures, the space encompassed by the Renard Project should, on the whole, recover its appearance, tranquility and productivity of former times. As such, it will once again be available as part of the heritage of the Mistissini community and of M11 trapline tallymen.

From a long-term perspective, the Renard Project will also have contributed to the building of Route 167 North, and thus lead to an opening of the Eeyou Istchee Baie-James region, to the benefit of all concerned. Stornoway is also prepared to transfer airstrip facilities to regional authorities, depending on their interest. Both regional facilities (the highway and the regional airport) may eventually prove advantageous when it comes to diversifying the regional economy (for instance, as regards hunting and fishing outfitters, eco-tourism activities, the future Albanel-Témiscamie-Otish National Park, etc.)

- *MANPOWER*

Like other mine facilities, the Renard mine will cease to operate when the resource is exhausted, i.e. approximately 20 years after its opening, according to current knowledge. This will involve the loss of a number of jobs at the mine. Stornoway will offer severance pay, varying from one group of jobs to another, and will participate in measures stipulated in the *Act respecting labour standards* concerning the establishment of a manpower reclassification assessment committee. Throughout the operation period, Stornoway will pay a great deal of attention to improving the skills and competencies of its

employees, especially its Cree personnel. In so doing, and based on what has been experienced and confirmed in the immediate area of the Renard Project, i.e. the Troilus mine and the Eastmain-1 and Eastmain-1-A-Sarcelle-Rupert hydroelectric projects, it is hoped that a number of Crees will have become more employable and will easily find new work. In order to ensure that this situation is properly addressed following its departure from the area, Stornoway will set aside appropriate funding for post-closure monitoring of its ex-employees' employment conditions. The sums required for such monitoring will be identified in conjunction with the Renard Committee and registered in a fund associated with the financial securities deposited for site rehabilitation and closure of the mine. This monitoring should ideally be carried out by an organization from the Eeyou Istchee Baie-James region involved in employment development and training.

Chapter 10

Cumulative Effects Assessment

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10 Cumulative Effects Assessment

10.1 Introduction

The environmental impacts of the Renard Project have been considered and discussed in previous sections. In recent years, the environmental assessment process has highlighted the importance of assessing the cumulative environmental effects of a given project at the same time as analyzing the impacts themselves. There is a recognition that the environmental effects of various human activities may combine, causing a series of interactions that will produce cumulative effects whose nature and scope may be different from the individual effects of each activity alone. Consequently, it is now common practice for an environmental assessment process to consider the cumulative effects that may result from the interactions between the environmental effects of the project itself and those of other current, past and future activities and projects.

The *Canadian Environmental Assessment Act* (CEAA) defines cumulative effects as changes sustained by the environment due to a given action, combined with other past, present and future human actions. Cumulative effects may be biophysical, but may also be of a social, cultural and/or economic nature. Certain cumulative effects may result from human-related activities, such as an increase in mining activity, or may be linked to natural phenomena, such as very intensive rainfall or forest fires. They represent the combined effect of all natural and anthropic influences on physical, biological, social, cultural, economic and environmental elements across time and space. The goal of a cumulative effects assessment is to estimate the degree to which each type of effect contributes to the final impact of these effects on valued environmental and socio-economic components (VESC[1]).

The methodology for assessing cumulative effects is therefore based on taking effects attributable to other projects into full account (Hegmann *et al.,* 1999). With this approach, it is possible to consider effects that were not brought up during the environmental assessment of a specific project. The cumulative effects assessment is a useful tool in the following cases (based on Hegmann *et al.,* 1999, and modified here), as a means of:

- Assessing effects across a large area;
- Assessing past and future effects over a long period of time;
- Considering effects on valued environmental and socio-economic components (VESC) attributable to interactions with other projects and/or activities, and not only the effects of the project or activities specifically targeted by the study;
- Including other reasonably predictable past, present or future activities; and
- Assessing relative importance by considering effects other than those of a local and direct nature.

[1] Valued environmental and socio-economic components (VESC) represent the elements of the natural and human environment considered important by the general public, as well as by experts, professionals and environmental organizations.

The Renard Project brings together a number of these conditions. It is to unfold in a vast area of Quebec's middle north, the James Bay region, where it is likely that various environmental, social, economic and cultural problems will interact due to other project undertakings.

It should however be pointed out that it is not the VESC, taken as a whole, that must be analyzed for their cumulative effects. In fact, it is necessary to determine whether or not the potential effects on a given component of the project under study (in this case, the Renard Project) and one or several parallel or additional activities actually overlap, or interact, with the project in space and time. For certain VESC, there are few or no cumulative effects, for there is very little or no overlap with other projects in time or space (for instance, the effects on the aquatic environment for projects in various watersheds). In the case of other VESC distributed across large areas (for example, woodland caribou or employment), these elements may indeed be influenced, and a cumulative effects analysis may then prove to be necessary and important.

In conclusion, the approach adopted for the cumulative environmental and socio-economic effects assessment takes into account current knowledge of the immediate environment in question and the availability of information concerning the projects. A number of potential projects that may be undertaken in the region are currently in an early development stage and include information of a confidential nature that could not be consulted for the present study. In addition, the primary purpose of the analysis presented in this chapter is to enlighten lawmakers concerning the potential cumulative effects of the Renard Project, without usurping the role of various levels of government as regards the development of territorial planning initiatives and strategic guidelines for purposes of environmental protection.

10.2 Scope of the Assessment

10.2.1 Identifying the Environmental Issues and Valued Environmental and Socio-economic Components

The methodology used to assess the cumulative environmental and socio-economic effects within the framework of the Renard Project is in accordance with the procedures of the Canadian Environmental Assessment Agency (CEAA, 1999) and the World Bank (World Bank, 2004). The factors considered are of a human and biophysical nature, and a number of the environmental and socio-economic issues identified are associated with these factors. Only issues likely to present effects when combined with other projects were selected for the purpose of assessing anticipated cumulative effects. The factors considered during the cumulative effects assessment are presented in Table 10.2.1.

Table 10.2.1 Factors considered for the cumulative effects assessment

Environmental and socio-economic issues	Issues raised			Valued environmental and socio-economic components	Potential environmental indicators
	Public consultation stage of the ESIA	Environmental Baseline Study (EBS) (2011)	Environmental and Social Impact Assessment		
Biophysical environment					
Air quality conservation					
Atmospheric emissions resulting from mining operations (dust)	X		X	**Air quality and noise**	Air quality parameters (meteorological and hydro-meteorological measurements, total suspended particulate matter, PM_{10} and $PM_{2.5}$; settling of dust; and NO_2 and SO_2).
Gas emissions and resulting odours			X		
Soil conservation (erosion, contamination)					
Impacts of site and infrastructure preparation and development (deforestation, backfill/excavated material, drainage, etc.)	X		X	**Soil quality and integrity**	Soil-quality parameters (pH, metals, etc.); and surface areas of affected soils.
Impacts of mining activities (extraction, storage and confinement areas, quarry and borrow pit operation, storage of hazardous materials and fuel, etc.)	X		X		
Water resource conservation with respect to drinking water supply					
Impact of mining operations on water resource quality conservation	X		X	**Quality and quantity of surface water and groundwater**	Drinking water quality parameters (suspended solids, metals, nutrients, DBO_5, coliforms, etc.) and quality of wastewater effluents (annual volumes), concerned watersheds.
Impact of mining operations on water resource quantity conservation			X		Freshwater intake for various projects and needs (annual volumes), concerned watersheds.
Protection of freshwater ecosystems and of their aquatic organisms					
Impact of wastewater on aquatic organisms	X	X	X	**Freshwater fish and benthos**	Effluent volumes and quality parameters (suspended solids, metals, nutrients, DBO_5, coliforms, toxicity, etc.), fish populations, biotic index, presence of protected species, concerned watersheds, number of stream crossings.
Impact on fish habitat	X	X	X		
Conservation of protected species	X	X	X		
Terrestrial wildlife protection					
Specia status birds		X	X	**Birds**	Surface area of boreal forest and wetlands, additional pressure on the forest and wetlands (ha).
Amphibians	X			**Reptiles**	
Mammals	X	X	X	**Mammals**	
Protection of terrestrial ecosystems and conservation of endemic plants and special status species					
Boreal forest		X	X	**Vegetation**	Surface area of the plant community, additional pressure on indigenous vegetation (ha) by forest fires and logging.
Wetlands		X	X		
Forest conservation for the use of its biological resources, particularly with respect to hunting	X	X	X	**Caribou and moose habitats**	Surface area of boreal forest and wetlands, additional pressure on the forest and wetlands (ha).
Land and natural resource conservation for traditional and recreational activities	X	X	X	**Traplines, campgrounds, hiking, etc.**	Surface area of boreal forest and wetlands, additional pressure on the forest and wetlands (ha).
River conservation for recreational and subsistence fishing activities	X	X	X	**Outfitters, canoe camping**	Aquatic contaminants generated by project activities (suspended solids, metals, nutrients, DBO_5, pathogenic agents) before treatment, number of outfitters/campgrounds.
Human environment					
Social and cultural context cohesion					
Health problems related to atmospheric emissions (risks of cancer and respiratory problems due to exposure to pollutants)			X	**Conservation of public health and security**	Atmospheric-dust emissions, NOx and SOx; number, location and population of communities; **hospital and clinic frequentation rate**
Tailing-site security (berm stability)	X		X		
Noise linked to construction and operation activities	X		X	**Conservation of rural living conditions**	Zone of noise levels generated by project activities (perceptible or imperceptible from the inhabited area), number, location and population of communities.
Pressure on public services					
Development of sanitation and social services in response to an anticipated increase in demand (resulting from an increase in population)			X	**Facilities, infrastructures and public services**	Number of additional workers and residents, number of businesses and new industries.
Increased risk of accidents and roadway degradation as a result of an increased use of regional road infrastructures			X		
Higher regional energy demand			X		
Conservation of archeological, historical and cultural heritage		X	X	**Archeological, historical and cultural resources**	Land surface area affected by the project and archeological potential of the site.
Conservation of the visual environment					
Visual impact of facilities	X		X	**Visual and aesthetic resources**	Land surface area affected by the project, project visible or invisible from inhabited areas.
Development of economic and employment activities					
Efficient use of regional mineral resources	X		X	**Economy, employment and training**	Number and value of contracts attributed to the region; average regional salary; number of direct and indirect jobs created for local communities and Native people (in general, men-women and young people); number of new economic activities in the zone; and number of potential mining projects.
Impact of the project on other potential mining projects (use of human and financial resources)			X		
Competition for specialized mining workers			X		
Competion for the workforce required concerning the environment			X		
Local employment vs. workforce from other regions (construction and operation phases)	X	X	X		
Training youth for work in related activities		X	X		
Training the Native workforce for work in related activities	X	X	X		
Links with the local economy and activity	X	X	X		
Direct and indirect community benefits	X		X		
Survival and/or development of traditional economic activities	X	X	X		
Spinoffs for local markets	X		X		

Sources: Roche, 2011

The VESC are the focus of the environmental assessment for each project component (Chapters 4 to 9), as well as for the entire project. The various VESC were identified during the gathering and analysis of information put together as part of the Environmental Baseline Study of the Renard Project (Roche, 2011), during the information panels and environmental exchange groups organized by Stornoway, and as part of a press review. The environmental impacts are described by way of the VESC, which are grouped together according to specific issues. A number of environmental indicators were specified for each VESC. The relevance of these indicators for the cumulative effects assessment is discussed in the sections that follow.

10.2.2 Spatial and Temporal Boundaries

The cumulative environmental, biophysical and socio-economic effects analysis must be carried out within a very specific framework. The physical boundaries of the territory to be examined and the period of time during which the activities are to be identified must be clearly established. These spatial and temporal limits have to reflect the cumulative potential of the anticipated effects.

- *SPATIAL BOUNDARIES*

The zone selected for the cumulative effects assessment encompasses all areas directly or indirectly influenced by the Renard Project wherein a combination of effects could be produced. The spatial limits for the cumulative effects assessment will vary according to the VESC considered and the type of effect anticipated. For certain VESC to be considered, it will therefore be possible to establish the limits within the vicinity of the site, whereas a more regional approach will be necessary for others.

For instance, the actual physical presence of the future Renard mine, along with the on-site activities scheduled to unfold therein, will constitute the main source of influence on the immediate biophysical environment (soil, water, wildlife and vegetation) of the area around the site. The effects (loss of habitat and daily activities) should however be limited since the project's footprint is relatively compact. Given the nature of Renard Project activities, the impacts on water and the aquatic environment (sediment transport, fish habitat, water quality, etc.) should, for their part, be limited *a priori* to the sub-watersheds where the project is located. In the same vein, although certain activities may be carried out close to the site (fishing, hunting, trapping, etc.), there are no permanent dwellings or communities in the vicinity, thus limiting a number of potential impacts on the activities of neighbouring populations (noise, transformation of the landscape, atmospheric emissions, etc.).

Hence, since the territory where the Renard Project is to be established is sparsely populated and underdeveloped, the potential anticipated impacts resulting from certain on-site mining operation activities (deforestation, noise, habitat loss, etc.) may engender only a small number of cumulative effects. For a number of VESC, there may well be few cumulative effects linked with other projects, for there is no overlap of activities within the confines of the site itself. In fact other current and future mining activities, as well as the communities closest to the Renard Project, are located over 50 km from

it, for instance the Eastmain Mine, which is 59 km away. These conditions therefore reduce the risk of cumulative effects for a number of VESC.

Currently, certain preliminary mineral-exploration work is being carried out in the region by other companies. This typically consists of very small camps or temporary tents around which drilling operations are undertaken. People usually travel from one place to another across this territory by helicopter, since there is practically no road network. The opening of the site with the help of a permanent road (Route 167 extension) will no doubt pave the way for more exploration work in the region, as well as for other commercial and recreational activities, by making the area more accessible.

As a result, it would appear that certain project components may well trigger cumulative effects on a more regional scale. In fact, even though they are far from the site, regional communities may be affected, in the context of an increased need for the delivery of goods and services, as well as for workforce personnel, all of which elements could enter into competition with existing activities. Moreover, the Route 167 extension work could induce habitat fragmentation for large mammals that normally travel great distances across the study area. These additional pressures may therefore generate cumulative effects impacting infrastructures, the socio-economic context, and certain typical natural habitats of the region. This explains why certain VESC have to be examined using a different scale.

As such, four (4) spatial study limits were selected for the project's cumulative effects assessment so as to take the various VESC into account:

- The first zone ("immediate study area") encompasses the study area (127 km^2) of the environmental and social impact assessment for the Renard Project. A strip approximately one kilometre wide was also added on either side of the Route 167 extension and another 250 metre-wide strip (right-of-way) along the preliminary alignment of the electric power line linking Camp Lagopede to the Nikamo station near LG4. These strips will cover an additional total extent of approximately 521 km^2 which allow to address certain impacts that could occur outside the actual infrastructure-footprint area (visual effect, noise, etc.). All of the direct and indirect impacts of the Renard Project on biophysical components and on land use will be experienced within the confines of this zone. It also encompasses various activities and development projects to be carried out within and in vicinity of the project footprint; i.e. a mine area of approximately 100 km^2, along with a 27 km^2 area in the airstrip sector. Few cumulative effects are anticipated in this "immediate study area."
- The second study zone ("local study area") represents the spatial limits of the project's potential impacts, as well as of other industrial and commercial activities (mining, forestry, outfitting, etc.) and recreation and tourism activities (future parks and wildlife reserves), including those already existing or likely to be established close to the site, especially as a result of easier access to the area. In addition to including components of the aforementioned immediate study area, as it is spatially defined, this local study area will include within its confines activities that may be undertaken within the project's watershed area (upper Eastmain), as well as within a strip approximately 100 km wide on both sides of the planned infrastructure routes (Route 167 and the power line toward LG4, providing easier and more economical access to the area), as well as within possible trans-territorial movement areas for large mammals, such as caribou and moose. Cumulative effects of a biophysical nature are of most concern in the local study area, as it has been defined, i.e. a rectangular area encompassing roughly 94,695 km^2 (9,469,500 ha).

- The last study zone ("regional study area") includes the area where the potential cumulative effects of the project and of other activities could emerge, especially in their socio-economic aspects. As opposed to the biophysical-component study area, the socio-economic-component impact analysis will extend well beyond the limits as previously defined, in particular to include the James Bay region, considered here as an "expanded regional area," as well as a "immediate regional area" corresponding to the urban communities of Mistissini, Chibougamau and Chapais. A few other problems linked to the economy, employment and training could also result in cumulative effects even further afield. This is why, by intention, the zone has been assigned no clearly defined boundaries.

The limits of the respective cumulative effects study zones and the location of the development projects and activities identified therein are presented in Map 10.2.1.

➢ *TEMPORAL BOUNDARIES*

Determining temporal boundaries is a more complex process, which must take the following factors into account (Hegmann *et al.,* 1999):

- The first occurence of impacts associated with the anticipated project or activities;
- Current conditions;
- The moment when a given land-use designation is submitted;
- The first occurrence of effects similar to those anticipated for the project or activities; and/or
- A period representative of the desired conditions for regional land use, or pre-disruption conditions (for instance, "the initial historic state").

The territory on which the Renard Project is located is endowed with immense natural resources that have scarcely been tapped or developed (basic, precious and industrial metals; industrial minerals; forest resources; etc.). Notwithstanding the existence of economic cycles, the current climate, characterized by an increasing, or at the very least sustained, demand for mineral resources, suggests that interest in territorial development could be maintained over a relatively long horizon (World Bank, 2010), especially with the implementation of the Quebec government's Plan Nord, presented in 2011. Moreover, the operating lifetime at the Renard mine (approximately 20 years) is significantly greater than any other potential mining operation.

For all these reasons, the lower maximum temporal limit to be considered would be 25 years at the very least, i.e. the period covered by operations and including the post-closure and restoration phases of the Renard mine; and the higher maximum limit could be in the neighbourhood of 30 to 50 years, i.e. a period often cited in the literature for the complete rehabilitation of mine sites, or a more or less return to initial conditions.

As regards the minimum temporal limit, the territory under study was explored in the 19th century for purposes of the fur trade, especially by the Hudson Bay Company. Although mining-exploration activities were reported in northern Quebec as early as 1903, northwestern Quebec was mainly opened up for mining development between 1920 and 1930[2]. For their part, the first forestry operations in

[2] MRNF du Québec, Gros plan sur les mines – quelques dates marquantes: http://www.mrnf.gouv.qc.ca/mines/industrie/industrie-diamant-hier-dates.jsp

Quebec's middle north date back to the colonization of the James Bay region (1930-1940) and the building of the first forest roads (MRNF, 2010), whereas the hydroelectric development of the region greatly intensified as of the 1970s with the electrical development of James Bay. The minimum temporal limit has been established as 1920, notwithstanding the scarce historical data available for this period.

For purposes of the present study, the temporal limit of the cumulative effects study would normally include the main development projects and activities undertaken between 1920 and 2050 within the spatial limits of the various established study zones, considering the start-up date for the Renard Project to be 2013. This period takes into account the fact that the Renard Project will be partially rehabilitated during its operation phase and that it is rather risky to extrapolate land use over too long a period of time.

400 000 mE
600 000 mE
800 000 mE
6 000 000 mN
5 800 000 mN
5 600 000 mN

Zone d'étude régionale rapprochée / Near Field Regional Study Area
Zone d'étude locale / Local Study Area
Projet Renard / Renard project

Cours supérieur de la Grande rivière de la Baleine
Denys
Roggan
Kanaaupscow
Cours inférieur de la rivière La Grande
Cours moyen de la rivière La Grande
Cours supérieur de la rivière La Grande
Réservoir Laforge 2
Réservoir Laforge 1
Réservoir La Grande 4
Réservoir La Grande 3
Réservoir Robert-Bourassa
Réservoir Caniapiscau
Cours supérieur de la Caniapiscau
Eaux d'amont de la Caniapiscau
LaForge-2
LaForge-1
Brisay
Nikamo
LG-1
LG-2-A
LG-3
LG-4
Robert-Bourassa
Chisasibi
Radisson
Castor
Route Transtaïga
Cours inférieur de la Sakami
Cours supérieur de la Sakami
Réserve de biodiversité projetée Hirondelle
Wemindji
Vieux Comptoir
Cours supérieur de la Opinaca
Réservoir Opinaca
Cours inférieur de la Opinaca
Parc national projeté Albanel-Témiscamie-Otish
Cours supérieur de la Eastmain
Mouchalagane
Eastmain
Baie James
Cours inférieur de la Eastmain
Eastmain-1
Réservoir de l'Eastmain 1
Cours moyen de la Eastmain
Jolicoeur
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Pontax
Nemaska
Route du Nord
Lac Mistassini
Cours supérieur de la Péribonka
Cours supérieur de la rivière aux Outardes
Waskaganish
Route de la Baie-James
Cours inférieur de la Rupert
Cours supérieur de la Rupert
Lac Albanel
Cours inférieur de la Broadback
Réserve faunique Assinica
Cours supérieur de la Broadback
Lac Mistassini
Cours inférieur de la Harricana
Cours inférieur de la Nottaway
Mistissini
Oujé-Bougoumou
Matagami
Waswanipi
Chapais
Chibougamau
Lac Saint-Jean
Saguenay

Aire d'étude de l'EIES du projet Renard / Renard Project ESIA Study Area
Secteur de la mine / Mine area
Secteur de la piste d'atterrissage / Airstrip area
Lac Emmanuel
Lac Lagopède
Rivière Misask
Rivière Nerveuse
0 5 km

0 50 100 km
Échelle / Scale 1: 2 850 000
UTM, zone 18 (NAD 83)

Localisation générale / General location
Projet diamantifère Renard / Renard diamond mine project
0 500 km

- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Poste de transformation Nikamo / Nikamo substation
- Pourvoiries sans droit exclusif / outfitter without exclusive rights
- Aéroport / Airport
- Hydrobase / Hydrobase
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique potentielle d'Hydro-Québec / Hydro-Québec potential electric power lines
- Ligne électrique d'Hydro-Québec / Hydro-Québec electric power lines
- Réseau routier principal / Main road network
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Mine active / Mine in operation
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Projet minier en phase de développement avancé / Mining project in advanced stage of development
- Ancienne mine / Old mine
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique / Wildlife reserve
- Bassin versant / Watershed
- Aire d'étude du projet Renard / Renard Project Study Area
- Zone d'étude de l'étude d'impact du prolongement de la route 167 / Road 167 extension project atudy area

les diamants stornoway (canada) inc

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Zones d'étude pour l'évaluation des effets cumulatifs / Cumulative effects assessment study areas

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_EC_ZE_111216.WOR
Source : - Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010*
Pourvoiries / Outfitter, MRNF, 2010
** Bassin versant: Ressources naturelles Canada, Données-cadres nationales de l'atlas du Canada, Hydrologie - Aire de drainage, 2008*

Carte / Map 10.2.1

Décembre 2011 / December 2011

10.3 Development Projects and Activities

The previously discussed development activities include other mining projects, outfitters, forestry activities, road and power line infrastructures, protected areas, and wildlife reserves, among others. Information concerning past (historic) and current development activities in the study area were obtained, in part, from government sources. Information concerning future development projects was obtained from the websites of the respective project proponents.

The main projects or activities that have taken place in the area since 1920, as well as possible projects for the 2011 to 2050 period in the Renard Project's local and immediate regional study areas for cumulative effects, are briefly presented in the present section, while those likely to trigger cumulative effects in conjunction with the Renard Project are described in more details in the following sections. The development projects and activities identified, along with a certain number of their characteristics, are described in tables 10.3.1 to 10.3.3.

These projects and activities have affected, are affecting, and will affect wildlife, vegetation, soil, and surface water and groundwater resources, among other elements, to varying degrees, depending on their characteristics. It is, on the other hand, very difficult to determine the exact scale of the effects, or to quantify them, for there is, generally speaking, little information available concerning other projects, since a number of them are at a very preliminary stage of development, and details concerning these projects are confidential or non-existent. It is, nevertheless, possible to provide a qualitative assessment of the most likely effects on the environment and on society based on the experiences of similar projects and activities undertaken in other regions.

10.3.1 Past Projects and Activities

A few previous projects and activities likely to have cumulative effects in the study areas even today have been identified within the temporal limit established in the previous section. First of all, large-scale mining projects that were in operation in the past in the region of the Renard Project include:

- The former Troïlus (Inmet Mining) located southwest of Lake Mistassini. Operations were closed down in mid June 2010, and the mine is now in the restoration phase;
- The Chibougamau mining camp, along with the former Copper Rand and Principale mines (Campbell Resources), which were closed down in 2008; and the Joe Mann, Portage and Cook mines, closed down in 2000, 1997, and 1989 respectively;
- The Springer and Perry (Opemiska) mines in the Chapais mining camp sector that were in operation until 1991; and
- The former Eastmain gold mine that operated during the 1990s and led to the building of the winter road in the Renard Project sector.

Around 28 abandoned mine sites have been identified in the Abitibi-Témiscamingue and Nord-du-Québec regions. For the most part, the latter are, however, too far from the local study zone to become possible triggers for cumulative environmental effects.

In the same vein, traces of past forest fires, registered since the 1930s, have been identified in the Renard Project region, particularly in the local study area. It would appear that such fires occurred around 1935, 1952, 1970 and 1979. Two others also happened more recently, in 2010 to be exact, to the east of Lake Mistissini and about 10 kilometres from the Matoush mine0 project site.

10.3.2 Current Projects and Activities

- Advanced mining exploration work:
  - the Renard Project (Stornoway Diamonds (Canada) Inc.), with construction scheduled to begin in 2013 and production, in mid 2015 (press release of November 16, 2011);
  - the Eleonore Project (gold, Goldcorp Inc.), with production scheduled to begin in 2014 (press release of November 14, 2011);
  - the Blackrock Project (iron, titanium and vanadium; Blackrock Metals Inc.), with production scheduled for 2014 at the earliest;
  - the MacLeod Lake Project (copper-molybdenum, Western Troy Capital Resources), with construction scheduled for 2013, and production, for 2015 (press release of October 24, 2011);
  - the Matoush Project (uranium, Strateco Resources), scheduled to begin operations in 2013, with production activities to begin in 2016 (website visited on December 2, 2011); and
  - the Whabouchi Project (lithium, Nemaska Exploration), with operations scheduled to begin in 2013.
- Preliminary mining exploration work:
  - a number of mining projects in the exploration phase for various metals (U, Au, Ag, Cu, etc.) are located within the established cumulative effects assessment limits (for the complete list, see Table 10.3.1).
- Logging and forest development work:
  - UAF 026-61: Beneficial owners: Barette-Chapais Ltd., Bois K.M.S. (GMI) Ltd., Eanatuk Forestry Corporation, Les Chantiers de Chibougamau Ltd., and Kruger Publication Papers Inc.; and
  - UAF 026-62: Beneficial owners: Bois K.M.S. (GMI) Ltd., Eanatuk Forestry Corporation, Les Chantiers de Chibougamau Ltd., and Entreprises Alain Maltais Inc.
- Road work:
  - winter road to the Eastmain mine site and proposed extension of Route 167 North toward the Otish Mountains.
- Recreation & tourism and conservation:
  - The Albanel-Mistissini-and-Waconichi-Lakes Wildlife Reserve.
- Others:
  - natural phenomena: forest fires;
  - outfitters (37, including 1 located in the upper Eastmain watershed); and
  - traditional Native activities (hunting, fishing, trapping, gathering, etc.).

Table 10.3.1 Various mining projects identified in the cumulative effects study areas

#MNRF 2010*	Company	Project	Mineral	Exploration activity[1]	Location		Watershed	Source of electricity	Power (kW)	Number of claims	Area ha	Sources
					Latitude (North)	Longitude (West)					Claims	
107	Stornoway Diamond Corporation	Renard	Diamonds	Er, EF, Env, S (91:7830)	-72.1945	52.8253	Upper Eastmain (also part of the Misask watershed)	•Generator set •Hydro-Québec	•10 MW	n.av.	68 158	http://www.stornowaydiamonds.com/development/le_projet_renard/
108	Dios Exploration Inc.	33 Carats	Diamonds-Au	G, Gc(t), Pr	-72.0576	52.7604	Upper Eastmain	n.av.	n.av.	877	46 000	http://www.diosexplo.com/33carats.php
109	Eastmain Resources Inc.	Eastmain Mine	Au-Ag-Cu	E, G, Gc(ro,s), Pr, S (46:14584)	-72.1532	52.3096	Upper Eastmain	n.av.	n.av.	152	8	http://www.eastmain.com/projects/q-rubyhill.php
110	Cameco Corporation	Otish South	U	GpEm(A), GpMa(A), GpGr(S), S (11:3400)	-72.1395	51.8143	Lake Mistassini	n.av.	n.av.	n.av.	n.av.	
111	Ditem Explorations Inc.	Otish Uranium	U	GpEm(S), GpRa(S), S (4:479)	-72.2389	51.8318	Lake Mistassini	n.av.	n.av.	486	25 800	http://www.ditem.com/fr-otish.php
112	Strateco Resources Inc.	Matoush	U	Gp(A), S (18:10268)	-72.1619	51.9529	Middle Eastmain	Thermal power plant	3 300	590	31 213	http://www.stratecoinc.com/en/our-properties/matoush-matoush-extension-eclat-and-pacific-bay-matoush-properties.php
113	Strateco Resources Inc.	Matoush Extension	U	Gp(A), Pg	-72.0813	51.9688	Lake Mistassini	n.av.	n.av.	198	10 504	
114	Strateco Resources Inc.	Éclat	U	Gp(A), S (47:27589)	-72.3587	51.9572	Middle Eastmain	n.av.	n.av.	90	4 787	
115	Strateco Resources Inc. / Pacific Bay Minerals Ltd.	Pacific Bay	U	Gp(A), Pr, S (3:1989)	-72.4545	51.8693	Middle Eastmain	n.av.	n.av.	277	14 576	http://www.stratecoinc.com/2010/fr/proprietes-de-strateco/20100314-0746-proprietes-matoush-matoush-extension-eclat-et-pacific-bay-matoush.php#4
116	Dios Exploration Inc.	Hotish	U-Diamonds	Pg	-72.6347	51.8159	Middle Eastmain	n.av.	n.av.		49 199	http://www.diosexplo.com/hotish.php
117	Western Troy Capital Resources Inc.	MacLeod Lake	Cu-Mo-Ag-Au	EF, Env, Sci(20:65)	-72.9613	52.2497	Upper Eastmain	• Hydro-electric dam • Electricity line •Thermal power plant	n.av.	604	15	http://www.westerntroy.com/project.html http://www.westerntroy.com/files/5-16-11.pdf
118	Virginia Energy Resources Inc.	Magneron Lake	U	E, T	-70.6211	52.2181	Upper Outardes River	n.av.	n.av.	n.av.	n.av.	
119	Virginia Energy Resources Inc.	Redgreen	U	E, T	-71.9757	52.1516	Middle Eastmain	n.av.	n.av.	n.av.	n.d.	
120	Abitex Resources Inc.	Epsilon	U-Au-Ag-Pb	E, G, GpMa(S), GpRa(S), Pr, S (21:1159), T	-71.1659	52.1642	Upper Eastmain	n.av.	n.av.	102	5 352	http://www.cbr.ca/CompanyProfile.aspx?CompanyID=27623&Language=en#3
121	Abitex Resources Inc. / Areva NC Inc. / SOQUEM INC.	Lavoie	U-Au-Ag-Pb	Er, ET, Gc	-71.2225	52.1935	Upper Eastmain	n.av.	n.av.	15	780	http://www.abitex.ca/
122	Majescor Resources Inc. / Virginia Energy Resources Inc.	Laparre Lake	U	E, T	-71.9391	52.2443	Upper Eastmain	n.av.	n.av.	317	14 700	http://www.majescor.com/en/projects/laclaparre.aspx
123	Globestar Mining Corporation / SOQUEM INC.	Moblan Lithium	Li-Nafeldspath K	Er, S (99:13456), TM	-74.888	50.7349	Upper Broadback	n.av.	n.av.	14	235	http://www.globestarmining.com/SiteResources/ViewContent.asp?DocID=235&v1ID=&RevID=625&lang=1
124	Beaufield Resources Inc. / Melkior Resources Inc.	Troilus JV	Cu-Zn-Au-Ag	GpGr(A), S (22:7132)	-74.7958	50.7228	Upper Broadback	n.av..	n.av.	869	31 289	http://www.beaufield.com/properties/troilus-tortigny.aspx
125	Western Troy Capital Resources Inc.	Troilus	Cu-Mo	Pg	-74.6624	50.7604	Upper Broadback	n.av.	n.av.	n.av.	n.d.	
129	Nemaska Exploration Inc.	Whabouchi	Li-Rb-Be	E, Er, ET, G, Pr, S (82:15670), T	-75.9794	51.6804	Pontax	• Electricity line	n.av..	n.av.	1 716	http://www.nemaskaexploration.com/fr/Nos-proprietes/Whabouchi
130	Nemaska Exploration Inc.	Levac Lake	Cu-Ni-CoEGP-Au-Ag-Zn	G, Pr, S (2:1200)	-75.4591	51.7671	Lower Rupert	n.av.	n.av.	n.av.	9 200	http://www.nemaskaexploration.com/fr/Nos-proprietes/Lac-Levac
131	Nemaska Exploration Inc.	Arques Lake (Bouvier, Rupert Complex)	Cu-Ni-CoEGP-Au-Ag-Zn	E, G, Gc(s), GpEm(A), GpMa(A), Pr, S (2:400), T	-75.6357	51.7171	Lower Rupert	n.av.	n.av.	n.av.	39 470	http://www.nemaskaexploration.com/fr/Nos-proprietes/Lac-Arques
132	Nemaska Exploration Inc..	Des Montagnes Lake (Duval)	Cu-Ni-CoEGP-Au-Ag-Zn	E, G, GpEl(S), Pr, T	-75.8841	51.6425	Lower Rupert	n.av.	n.av..	n.av..	12 740	http://www.nemaskaexploration.com/fr/Nos-proprietes/Lac-des-Montagnes
133	Virginia Mines Inc.	Auclair	Au	S (13:4033)	-75.0943	52.0539	Lower Rupert	n.av.	n.av.	318	16 700	http://www.virginia.qc.ca/fr/Projet/Auclair/index.asp
134	Goldcorp Inc. / Azimut Exploration Inc.	Wabamisk	Au-Ag-Cu-Zn-Pb-Mo	E, G, Pr, S (8:1976), T	-75.4198	52.0875	Middle Eastmain	n.av.	n.av.	755	39 950	http://www.azimut-exploration.com/fr-prop-wabamisk.html
135	Eastmain Resources Inc.	Clearwater	Au-Bi-Te	E, Er, G, Gc(s), S (39:9255), T, TM	-75.6727	52.2241	Middle Eastmain	n.av.	n.av.	n.av.	20 600	http://www.eastmain.com/projects/q-clearwater.php
136	Nemaska Exploration Inc.	Sirmac	Li	Pg	-75.4724	50.6167	Upper Broadback	n.av.	n.av.	n.av.	n.av.	
138	Dios Exploration Inc.	PAM	U-Au	Pg	-74.3832	52.7215	Upper Opinaca	n.av.	n.av.	n.av.	n.av.	
139	Dios Exploration Inc.	AU33	Au-Ag-Pb-Zn-Diamonds	G, Gc(t), GpEl(S), GpMa(A), Pr	-76.0024	52.2719	Lower Eastmain	n.av.	n.av.	1 000	50 000	http://diosexplo.com/french/projects.php
141	Jourdan Resources Inc.	Pivert East / Stairs	Li-ETR	E, GpMa(A), GpRa(A), Pg,	-76.108	52.0624	Middle Eastmain	n.av.	n.av.	n.av.	n.av.	
142	Exploration First Gold Inc.	Pivert / Rose Lithium	Li-Ta-Rb-Cs-Be	E, Er, G, Pg, S (139:17000), T	-76.1673	52.0347	Pontax	n.av.	n.av.	636	33 307	http://www.cecorp.ca/en/projects/rose-tantalum-lithium.html
151	Goldcorp Inc. (Opinaca Mines Ltd.)	Eleonore	Au	E, Er, G, S (50:24000), T	-76.0603	52.6464	Lower Opinaca	• Electrical substation	120 (kV)	n.av.	n.av.	http://www.goldcorp.com/Unrivalled-Assets/Mines-and-Projects/Canada-and-US/Development-Projects/Eleonore/Overview-and-Development-Highlights/default.aspx
152	Golden Valley Mines Ltd. / Sirios Resources Inc.	Cheechoo B	Au	E, G, Gc(s), GpMa(S), Pr	-75.7483	52.6452	Lower Opinaca	n.av.	n.av.	306	15 300	http://sirios.com/fr/cheechoo
153	Eastmain Resources Inc. / Goldcorp Inc. (Opinaca Mines Ltd.) / Azimut Exploration Inc.	Eleonore South JV	Au	G, Gc(ro), Pr, S (17:3622), T	-76.0764	52.5896	Lower Opinaca	n.av.	n.av.	282	14 760	http://www.azimut-exploration.com/fr-prop-eleonoresouth.html
154	Midland Exploration Inc.	Eleonore James Bay	Au	E, Gc(ro), Pr	-75.2641	52.3268	Middle Eastmain	n.av.	n.av.	121	6 500	http://www.midlandexploration.com/projets.aspx?i=39
155	Beaufield Resources Inc.	Opinaca	Cu-Au-Ag-Mo	E, GpEl(S), Pg	-76.1918	52.6183	Lower Opinaca	n.av..	n.av.	192	10 050	http://www.beaufield.com/properties/opinaca.aspx
161	Sirios Resources Inc. / Dios Exploration Inc.	Upinor	U	E, Pr	-75.4166	53.0102	Upper Opinaca	n.av.	n.av.	871	45 000	http://sirios.com/fr/upinor
162	Virginia Mines Inc.	Lemoyne Station Extension	Au	Gc(t), GpEl(S), GpMa(S), Pg, S (x:1043), T	-75.1156	53.456	Upper Sakami	n.av.	n.av.	n.av.	5 600	http://www.virginia.qc.ca/fr/Projet/Poste-Lemoyne/index.asp
163	Virginia Mines Inc. / Goldcorp Inc.	Corvet East	Au	S (7:3361)	-74.1436	53.3337	Upper Sakami	n.av.	n.av.	n.av.	37 000	http://www.virginia.qc.ca/fr/Projet/Corvet-Est/index.asp
164	Virginia Mines Inc.	FCI	Au	G, S (11:3035)	-74.1198	53.5262	Upper Sakami	n.av.	n.av.	412	21 100	
165	Sirios Resources Inc.	Tilly	Mo-Cu-Au	Emi, G, Gc(ro)	-74.1086	53.9095	Middle Grande River	n.av.	n.av.	101	5 000	http://sirios.com/fr/tilly
166	Midland Exploration Inc. / Agnico-Eagle Mines Ltd.	James Bay Gold	Au	Gc(ro), S (10:1520)	-72.4411	53.1942	Upper Sakami	n.av.	n.av.	1 033	56 200	http://www.midlandexploration.com/projets.aspx?i=12
167	Virginia Mines Inc.	Nichicun-Escale	Au	E, Pr, T	-72.1613	53.4705	Upper Grande River	n.av.	n.av.	n.av.	n.av.	
168	Sirios Resources Inc. / Virginia Mines Inc.	Escale	Au-Zn	Gc, Gp	-72.254	53.5629	Upper Grande River	n.av.	n.av.	31	2 700	
169	Somdra Inc.	Duhesme Lake	Au-Cu-Ag	E, T	-72.0552	53.5548	Upper Grande River	n.av.	n.av.	n.av.	n.av.	
170	Golden Tag Resources Ltd. / Sirios Resources Inc.	Aquilon Main	Au	S (x:1400), TM	-72.5391	54.0556	Middle Grande River	n.av.	n.av.	104	5 000	http://sirios.com/fr/aquilon
171	Stornoway Diamond Corporation / Virginia Mines Inc. / SOQUEM INC. / Aurizon Mines Ltd.	LG-4 Diamonds Consorem	Diamonds	Gc(t), GpMa(S), Pg	-72.8222	54.157	Middle Grande River	n.av.	n.av.	236	29 500	http://www.stornowaydiamonds.com/grassroots/consorem/
172	BlackRock Metals Inc.	Blackrock	Fer-Ti-Va	n.av.	-74.4167	49.8333	South region	• Electricity line	n.av.	n.av.	n.av.	http://www.ceaa.gc.ca/050/documents/50411/50411E.pdf

*Source: MRNF, 2010c

Notes: n.av.: not available

1: Geological and prospecting work

E	Sampling
Eb	Block sampling for architectural stone
Emi	Mineralogical study
Ep	Polishing test
Ev (tm:g/t)	Bulk sampling including tonnage or (mt: % Xx) and concentration (metric ton: gram per ton) or (metric ton: % Xx)
G	Geological survey
Int. Sat.	Interpretation of satellite images
Pg	Undefined geological and prospecting work
P	Prospecting
S (nb:m)	Diamond drilling (number: total metres)
Sci (nb:m)	Reverse circulation survey
T	Trench excavation and stripping
Tc	Characterization tests and analysis (peat)

Geochemical surveys

Gc	Undefined geochemical survey
Gc(e)	Esker geochemical survey
Gc(h)	Humus geochemical survey
Gc(l)	Lake-bottom geochemical survey
Gc(ro)	Rock geochemical survey
Gc(ru)	Stream geochemical survey
Gc(s)	Soil geochemical survey
Gc(t)	Till geochemical survey

Geophysical surveys

Gp	Undefined geophysical survey
GpEl	Electrical survey
GpEm	Electro-magnetic survey
GpGr	Gravimetric survey
GpMa	Magnetic survey
GpMt	Magnetotelluric survey
GpRa	Radiometric survey
GpSi	Aerial (A), drilling (F), and soil (S) seismic survey

Other types of work

EF	Feasability and/or market study
Env	Environmental study
Er	Reserve and resource estimate
ET	Technical assessment study
R	Mine-site restoration work
TM	Metallurgical test

Table 10.3.2 Outfitters identified in the cumulative effects study areas

Reference number	Outfitter	Number of camps	Nearby zone	Watershed
10525-1	Dream Catcher Adventures S.E.N.C.	1	Lake Théodat	Upper Broadback
10526-2	Pourvoirie Mirage Inc.	2	Lake Rosée	Upper Sakami
10526-3	Pourvoirie Mirage Inc.	3	Lake Rossignol	Upper Sakami
10526-5	Pourvoirie Mirage Inc.	5	Lake Pluto	Upper Eastmain
10526-6	Pourvoirie Mirage Inc.	6	Grande River	Upper Grande River
10526-7	Pourvoirie Mirage Inc.	7	Lake Roz	Kanaaupscow
10536-1	Nouchimi Tourism Inc.	1	Km 509 Trans-Taïga Road	Middle Grande River
10536-2	Nouchimi Tourism Inc.	2	Km 395 Trans-Taïga Road	Upper Grande River
10536-3	Nouchimi Tourism Inc.	3	Km 516 Trans-Taïga Road	Upper Grande River
10537-1	Nouchimi Tourism Inc.	1	Km 305 Trans-Taïga Road	Middle Grande River
10537-2	Nouchimi Tourism Inc.	2	Km 440 Trans-Taïga Road	Middle Grande River
10549-1	Oujé-Bougoumou Enterprises Inc.	1	Lake Assinica	Upper Broadback
10552-1	Robert D. White (Pavillon Square-Tail Lodge)	1	Lake Frotet	Upper Broadback
10552-2	Robert D. White (Pavillon Square-Tail Lodge)	2	Lake Troilus	Upper Broadback
10553-1	Pourvoirie J.C.-Bou. (2003) Inc.	1	Lake Chibougamau	Upper Waswanipi
10554-1	Association de Pourvoirie Du Lac Mistassini	1	Rupert River (Ls-Jolliet)	Upper Rupert
10554-2	Association de Pourvoirie Du Lac Mistassini	2	Lake Mistassini (Vieux P.)	Lake Mistassini
10554-3	Association de Pourvoirie Du Lac Mistassini	3	Lake Woollett	Upper Rupert
10554-4	Association de Pourvoirie Du Lac Mistassini	4	Pépeshquasati River (1)	Lake Mistassini
10554-5	Association de Pourvoirie Du Lac Mistassini	5	Pépeshquasati River (2)	Lake Mistassini
10554-6	Association de Pourvoirie Du Lac Mistassini	6	Chéno River	Lake Mistassini
10554-7	Association de Pourvoirie Du Lac Mistassini	7	Takwa River (Toqueco)	Lake Mistassini
10554-8	Association de Pourvoirie Du Lac Mistassini	8	Pépeshquasati River (3)	Lake Mistassini
10554-9	Association de Pourvoirie Du Lac Mistassini	9	Témiscamie River	Lake Mistassini
10554-10	Association de Pourvoirie Du Lac Mistassini	10	Birch Island	Upper Rupert
10554-11	Association de Pourvoirie Du Lac Mistassini	11	Lake Cocomenhani	Upper Rupert
10565-1	Camp de pêche Pomerleau Inc.	1	Lake Chibougamau	Upper Waswanipi
10580-3	Americree Ltd	3	Lake Weakwaten	Upper Rupert
10605-1	Tourisme Nouchimi Inc.	1	Lake Katatipawasakakamaw (Bottine)	Middle Grande River
10609-1	Pourvoirie Donat Asselin	1	Km 382 Trans-Taïga Road	Middle Grande River
10610-0	Pourvoirie Caniapiscau Inc.	0	No accommodations	Upper Caniapiscau
10612-1	Pourvoirie Manicouagan Inc.	1	Lake Sureau	Upper Grande River
10613-1	Wabannutao Eeyou development corporation	1	Lake Kamwakuskach	Lower Opinaca
10616-1	Jimmie Neacappo	1	Tilly Lake	Middle Grande River
10619-1	Awashish Outdoor Adventures Inc.	1	Rupert River	Upper Rupert
10620-1	Les Camps Kiskimaastakin Inc.	1	LA 1 Road	Middle Grande River
10621-1	Pourvoirie Aigle Pêcheur	1	Lake Mistassini	Lake Mistassini

Table 10.3.3 Regional infrastructures, recreation-and-tourism and forestry activities in the cumulative effects study areas

Parameters	Total surface area (ha)	Linear infrastructure length (km)	Characteristics	Sources
Otish Mountain Route 167: with or without borrow pits	3450 / 840	240	Estimated width up to 35 m	EIES - Route 167 extension
MacLeod Lake Road to future Route 167	140	70	Estimated width 20 m	EIES - Route 167 extension
Possible road for Matoush to future Route 167	2	1	Estimated width 20 m; direct distance	-
Possible road for the Eastmain mine to future Route 167	0.6	0.3	Estimated width 20 m; direct distance	-
Possible road for the Lavoie mine to future Route 167	124	62	Estimated width 20 m; direct distance	-
Trans-Taïga Road	8 439 000	582	Estimated width 35 m	-
Power line (Renard-LG4)	1 200	150	Estimated width up to 80 m	Hydro-Québec Communications
Corridor for the hydroelectric generating station at MacLeod Lake	31.5	7	Indefinite outline, estimated width 45 m	EIES - Route 167 extension
Hydroelectic dam (LG4)	n.a.	0.246	-	-
La Grande 4 Reservoir	70 700	n.a.	9 turbines (2779 MW)	http://fr.wikipedia.org/wiki/Centrale_La_Grande-4
Albanel-Témiscamie-Otish National Park (proposed)	1 100 000	n.a.	Project phase	EIES - Matoush Project
Hirondelle Biodiversity Reserve (proposed)	32 200	n.a.	Project phase	http://www.mddep.gouv.qc.ca/biodiversite/reserves-bio/hirondel/PSC_Hirondel.pdf
Albanel-Mistissini-and-Waconichi-Lakes Wildlife Reserve	2 528 500	n.a.	Existing	http://www.sepaq.com/dotAsset/585615.pdf
UAF-026-61 forestry zone	684 776	n.a.	Possible	MRNF
UAF-026-62 forestry zone	320 403	n.a.	Possible	MRNF
Forest-fire affected area (regional study area only)	2 770 226	n.a.	Existing	MRNF

Note:
n.a.: not applicable

10.3.3 Future Projects and Activities

- Mining operation work (in advanced stage of development):
  - Renard Project (diamonds, Stornoway Diamonds (Canada) Inc.);
  - Eleonore Project (gold, Goldcorp Inc.);
  - Blackrock Project (iron, titanium, and vanadium; Blackrock Metals Inc.);
  - MacLeod Lake Project (copper-molybdenum, Western Troy Capital Resources);
  - Ruby Hill/Eastmain Project (gold, Eastmain Resources);
  - Matoush Project (uranium, Strateco Resources);
  - Whabouchi Project (lithium, Nemaska Exploration); and
  - Lavoie Project (uranium, Abitex Resources Inc.).
- Logging and forest development work in UAF 026-61 and 026-62 should continue over the next few years;
- Road work:
  - the extension of Route 167 North toward the Otish Mountains and up to the Renard Project;
  - the building of an access road between Route 167 North and MacLeod Lake Camp; and
  - the building of access roads between the Route 167 extension and other mining projects (Eastmain, Matoush and Lavoie mines).
- The building of a power line between LA-1 (Nikamo station) and the Renard Project site;
- The building of a small generating station on the Eastmain River as part of the MacLeod Lake Project;
- Recreation, tourism and conservation:
  - existing wildlife reserve (Albanel-Mistassini-and-Waconichi-Lakes);
  - Albanel-Témiscamie-Otish National Park project; and
  - Hirondelle biodiversity reserve project.
- Other possible activities:
  - natural phenomena (for instance, forest fires);
  - other outfitters; and
  - traditional Native activities (hunting, fishing, trapping, gathering, etc.).

10.3.4 Justifying the Selection of Projects and Activities Considered for the Cumulative Effects Assessment

It has already been established that a number of the projects and activities listed above will have no cumulative effects in relation to the Renard Project. In fact, some of the aforementioned projects are too far away, are located in other watersheds, or are characterized by very different activities from those of the Renard Project. Moreover, a number of the above-listed projects that are in the exploration phase will not be undertaken for various reasons, particularly those of a financial, economic, political, social and/or environmental nature.

Consequently, as specified in the *Cumulative Effects Assessment Practioners' Guide* of the *Background Paper concerning the Canadian Environmental Assessment Act*, only projects likely to be undertaken at a certain point in time within the spatial and temporal limits established herein are to be considered, with

the same applying to previous and already existing projects. A detailed description of these projects and activities is presented in sections 10.4 to 10.6, below.

10.4 Mining Projects in Advanced Stage of Development

This section will briefly describe projects in a sufficiently advanced stage of development to suggest that mining operations will eventually emerge, including:

- The Renard Diamond Project;
- The Eleonore Gold Project;
- The Blackrock Iron, Titanium and Vanadium Project;
- The MacLeod Lake Copper-Molybdenum Project;
- The Eastmain and Ruby Hill Gold Mine Project;
- The Matoush Uranium Project;
- The Whabouchi Project; and
- The Lavoie Uranium Project.

Although information is available concerning each of these projects, the final design and details of the various facilities are in the development phase and are therefore not yet definitive (footprints, infrastructures, wastes/emissions, etc.). Map 10.4.1 shows where these projects are located compared to the Renard Project site and a few other mining exploration sites (potential impacts on the longer term).

200 000 mE
400 000 mE
600 000 mE
800 000 mE
6 000 000 mN
5 800 000 mN
5 600 000 mN
5 400 000 mN

Zone d'étude régionale rapprochée / Near Field Regional Study Area
Zone d'étude locale / Local Study Area

Cours supérieur de la Grande rivière de la Baleine
Cours supérieur de la Caniapiscau
Réservoir Laforge 2
Réservoir Laforge 1
Réservoir Caniapiscau
Eaux d'amont de la Caniapiscau
Denys
Roggan
Kanaaupscow
LaForge-2
Brisay
LaForge-1
Réservoir La Grande 4
Cours inférieur de la rivière La Grande
Cours moyen de la rivière La Grande
Réservoir La Grande 3
Chisasibi
LG-1
Robert-Bourassa
LG-4
LG-3
Radisson
LG-2-A
Réservoir Robert-Bourassa
Castor
Route Transtaïga
Cours supérieur de la rivière La Grande
Cours inférieur de la Sakami
Cours supérieur de la Sakami
Réserve de biodiversité projetée Hirondelle
Wemindji
Projet Éléonore / Eleonore project
Projet Renard / Renard project
Vieux Comptoir
Cours supérieur de la Opinaca
Réservoir Opinaca
Cours inférieur de la Opinaca
Cours supérieur de la Eastmain
Parc national projeté Albanel-Témiscamie-Otish
Projet mine Eastmain / Eastmain mine project
Projet Lac Macleod / Macleod lake project
Projet Lavoie / Lavoie project
Eastmain
Baie James
Cours inférieur de la Eastmain
Eastmain-1
Cours moyen de la Eastmain
Mouchalagane
Projet Matoush / Matoush project
Projet Ruby Hill / Ruby Hill project
Jolicoeur
Réservoir de l'Eastmain 1
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Pontax
Nemaska
Route du Nord
Whabouchi
Waskaganish
Cours inférieur de la Rupert
Lac Mistassini
Cours supérieur de la Péribonka
Cours supérieur de la rivière aux Outardes
Route de la Baie-James
Cours supérieur de la Rupert
Lac Albanel
Cours inférieur de la Broadback
Réserve faunique Assinica
Cours supérieur de la Broadback
Cours inférieur de la Harricana
Mistissini
Cours inférieur de la Nottaway
Oujé-Bougoumou
Matagami
Waswanipi
Chapais
Chibougamau
Projet Blackrock / Blackrock Metals inc.
Lebel-sur-Quévillon
Amos
Lac Saint-Jean
Saguenay

0 50 100 km
Échelle / Scale 1: 2 850 000
UTM, zone 18 (NAD 83)

Localisation générale / General location
Projet diamantifère Renard / Renard diamond mine project
0 500 km

- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec electricity power lines
- Réseau routier principal / Main road network
- Réseau routier secondaire / Road network
- Prolongement de la route 167 Nord vers les monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Mine active / Mine in operation
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Projets miniers en phase de développement avancé / Mining projects in advanced stage of development
- Ancienne mine / Old mine
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Bassin versant / Watershed
- Aire d'étude du projet Renard / Renard Project Study Area

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Projets miniers en phase de développement avancé / Mining projects in advanced stage of development

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_EC_PM_111216.WOR
Source : -* Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010

* Bassin versant: Ressources naturelles Canada, Données-cadres nationales de l'atlas du Canada, Hydrologie - Aire de drainage, 2008

Décembre 2011 / December 2011

Carte / Map 10.4.1

10.4.1 Renard Diamond Project

The Renard Project involves Stornoway's development and mining of the Renard kimberlite pipes and the network of Lynx/Hibou kimberlite dykes. The company currently owns 54,550 ha of claims in the area north of the Otish Mountains. The Foxtrot Property is located some 350 km from Chibougamau and can only be accessed by plane or helicopter for the time being. All the exploration activities are conducted in the surroundings of Camp Lagopede, north of Lake Lagopede (*Kaakus Kaanipaahaapisk*). The project is described in detail in Chapter 3.

Resources valued at 24 million carats will allow the Renard Project to produce between 1.6 million and 2.1 million carats every year for over twenty years. This is the longest production period for potential mining projects. The resources will be mined using small open pits and an underground mine.

10.4.2 Eleonore Project

Developed by Goldcorp Inc., the Eleonore Gold Project is located some 350 km north of Matagami. The property was purchased from the Virginia company at the end of March 2006, to be later incorporated into the assets of Les Mines Opinaca Ltée ("Opinaca"). Despite being outside the local study area of cumulative effects, the project is considered in this assessment because it is located in the immediate regional study area and it shares a pool of labour force and equipment.

The feasibility study phase of the mining project was completed in 2011, allowing the project to go forward. Mining infrastructures will include two vertical access shafts, one ore processing plant with a 7,000-tonnes/day production capacity, a 63 km access road, and a 120 kV power sub-station. The project obtained its global certificate of authorization on November 14, 2011.

Results showed in December 2010 that the deposit contained 3.03 million ounces of proven and probable gold resources and 4.17 million ounces of inferred gold resources. The company now expects to produce up to 600,000 ounces of gold every year by operating an underground mine scheduled to open by the end of 2014. The mine will be in operation for 15 years.

10.4.3 Blackrock Iron, Titanium and Vanadium Project

The Blackrock Iron, Titanium and Vanadium Project is being developed by Blackrock Metals Inc. in the Doré Lake area, 30 km southeast of Chibougamau. Since the Blackrock Project is located in the immediate regional study area, but outside the local study area of cumulative effects, like the Eleonore Project, it is also considered in this assessment because it involves a shared pool of labour force and equipment.

The mining project is in a quite advanced stage of development. The proponent plans to submit an impact assessment by the end of 2011. The project will include the operation of an open pit mine. The mining site will cover an area of about 2.5 km long, 100 m to 400 m wide and 200 m deep. A processing plant will be built on the project site. Concentrates will be first carried by truck to Chibougamau to be

then carried on the existing railroad to the Port of Quebec. The project also includes a 25 km access road and a power line to supply the project with electricity.

Construction should start in the summer of 2012, with production to begin at the end of 2012. The project is expected to produce about 20,000 tonnes of ore per day during the first year, and the proponent plans to increase production up to 50,000 tonnes per day over a period of two to three years.

10.4.4 Macleod Lake Copper-Molybdenum Project

The MacLeod Lake Copper-Molybdenum Project is being developed by Western Troy Capital Resources Inc. The MacLeod Property is located about 275 km northeast of Chibougamau in the local study area of cumulative effects. The property includes 604 claims divided up in four clusters, for an overall surface area of 18,628 ha.

At the end of a preliminary economic study released in April 2008, the company concluded that only an open-pit mine would provide maximum economic opportunity (Scott Wilson RPA, 2008). The mine infrastructures would also include an ore processing plant and would eventually be supplied by a power line. The existing winter road ends a few tens of kilometres east of the property. As part of the preliminary studies, Western Troy has planned to build an all-weather, controlled-access road with a single lane from the existing road leading northwest of the project site. Approximately 70 km long, this access road would join the existing road at about 103 km north of Témiscamie. The access road is to join the future Route 167.

A feasibility study should be completed in early 2012 and the company expects to obtain environmental authorizations in early 2013. Construction would start in 2013, with production to begin in 2015 or 2016. The mine could eventually produce in the long run close to 98,430 tonnes of copper, 14,515 tonnes of molybdenum, 800,000 ounces of silver and 7,000 ounces of gold. At an annual rate of 2.1 Mt, the deposit is estimated to be mined over a period of about 9 years.

10.4.5 Eastmain and Ruby Hill Gold Mine Project

The Eastmain Property, which includes the closed-down Eastmain gold mine and two blocks known as “East” and “West” Ruby Hill, is located at about 320 km northeast of Chibougamau in the local study area of cumulative effects. The project is under development by Eastmain Resources Inc. and is currently in the exploration phase to increase the resources of the former mine, closed down during the previous decade.

The property includes 224 claims covering an overall surface area of 11,667 ha divided up into two clusters. The property can be accessed by a 160 km winter road from Témiscamie and by air with a hydroplane or a plane using a landing strip next to the former mine.

As indicated in the 2004 Ressources Campbell annual report, the Eastmain gold deposit could contains 255,750 ounces of gold and 4.1 Mlb of copper, including 91,500 t of measured resources in gold

grading 0.268 oz/t and 786,600 t of indicated resources in gold grading 0.294 oz/t (Eastmain Resources, 2010). The resources are historic estimates and should not be considered. Further exploration has been conducted since 2005 to better define the reserves.

10.4.6 Matoush Uranium Project

The Matoush Uranium Project is under development by Strateco Resources Inc. The project is located in the Otish Mountains at about 275 km northeast of Chibougamau within the local study area of cumulative effects. The project includes the Matoush, Matoush Extension, Eclat and Pacific Bay properties. The Matoush project includes 590 claims for an overall surface area of 31,213 ha. The site can currently be accessed by air with a helicopter or hydroplane from the Témiscamie hydroplane base and, in winter, by the winter road that ends 7 km west of the property.

The project is only at the approval request phase for the construction of an access ramp for underground exploration. The purpose of excavating is to explore and define the mineral resources in order to determine the feasibility of a large-scale mining project. Not much information is available about the future mining facilities, but the mine might be operated through underground drifts. The project is located only one kilometre or so from the future Route 167.

The goal of Strateco Resources is to sufficiently define the extent of the resources to allow an annual minimum production of 2,000,000 pounds of U_3O_8 for at least 10 years. A recent September 2009 estimate established the mineral resources to the indicated category at 436,000 tonnes of 0.78 % grade U_3O_8 containing 7.46 million pounds of U_3O_8. The inferred mineral resources are estimated at 1.16 million tonnes of 0.50 % grade U_3O_8 containing 12.78 million pounds of U_3O_8. Strateco plans to begin construction at the end of 2013, with commercial production to begin early 2016. Based on the current resource estimate and an extraction rate between 500 t/d and 750 t/d, the lifetime of the mine was established at 7 years.

10.4.7 Whabouchi Project

The Whabouchi Lithium Project is under development by Nemaska Exploration. The project is located in the immediate regional study area of cumulative effects, at about 280 km northwest of Chibougamau. The project is also considered in this assessment, because it shares the same pool of labour force and equipment with the Renard Project. The mining property covers a surface area of about 1,716 ha.

Nemaska Exploration submitted a project notification to the COMEV (Evaluating Committee) conveying its intention to open and operate a mine likely to produce 1,000,000 tonnes per year from initial mineable reserves of 20,000,000 tonnes and 202,000 tonnes per year of spodumene concentrate during a mining life cycle of 20 years. A feasibility study for the project was to be completed by the end of 2011 and requests for several regulatory authorizations were made during the summer of 2011. All-year access to the site is by the existing road. An open pit mine of about 1.3 km long and 320 m deep will be operated. Building a secondary processing plant is discussed for the production of lithium

carbonate and lithium hydroxide, particularly in Chibougamau. Power lines are also present near the site.

According to the latest estimate, the resources stand at 25 million tonnes of spodumene containing 1.54 % grade Li_2O. Construction should begin in 2012, with production to begin in 2013.

10.4.8 Lavoie Project

Abitex Resources Inc. has undertaken exploration of the Lavoie Property located at about 350 km northeast of Chibougamau in the local study area of cumulative effects. The Lavoie Property is subject to an acquisition and co-partnership agreement between Abitex and equal owners Areva Resources Canada and SOQUEM Inc. Abitex could acquire a 50% share in the property if it completes a pre-feasibility study by the end of 2011. The property includes 15 adjoining claims covering an overall surface area of 780 ha. For the time being, the property can only be accessed by plane. The winter road leading to the former Eastmain gold mine stretches to about 75 km west of the property, while the closest permanent forestry road ends at about 135 km from the property. The Lavoie deposit is one of the three major indicators of uranium located in the Otish Mountains region.

To speed up the ongoing development of the project by increasing and enhancing the definition of the resource, Abitex planned to put emphasis on the required additional drilling in 2010 for the purpose of preparing an opportunity study.

10.5 Regional Infrastructure

Major infrastructure projects are being studied within the region of the Renard Project, particularly in the local study area of cumulative effects. It concerns the extension of Route 167 to the Otish Mountains and the installation of electric power lines. The location of the main projects is shown on Map 10.5.1.

200 000 mE
400 000 mE
600 000 mE
800 000 mE
6 000 000 mN
5 800 000 mN
5 600 000 mN
5 400 000 mN

Zone d'étude régionale rapprochée /
Near Field Regional Study Area

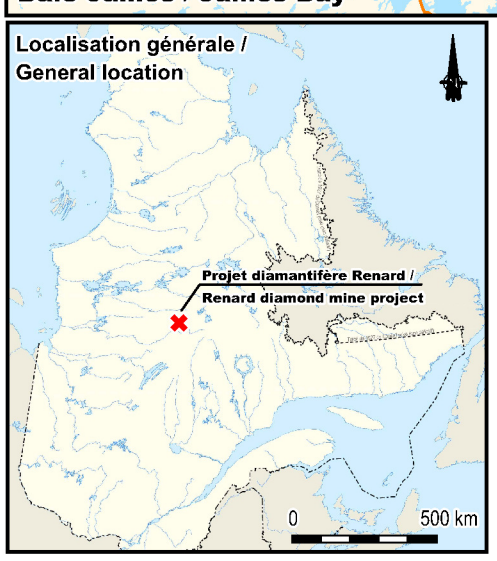
Zone d'étude locale /
Local Study Area

Chisasibi
LG-1
Robert-Bourassa
Radisson
LG-2-A
Réservoir Robert-Bourassa
LG-3
Réservoir La Grande 3
Route Transtaïga
LaForge-1
Nikamo
Réservoir La Grande 4
LG-4
LaForge-2
Réservoir Laforge 2
Brisay
Réservoir Laforge 1
Réservoir Caniapiscau
Wemindji
Réservoir Opinaca
Eastmain
Baie James
Eastmain-1
Réservoir de l'Eastmain 1
Nemaska
Waskaganish
Route de la Baie-James
Route du Nord
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Réserve faunique Assinica
Lac Albanel
Lac Mistassini
Mistissini
Réserve de biodiversité projetée Hirondelle
Projet Renard /
Renard project
Parc national projeté Albanel-Témiscamie-Otish
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Oujé-Bougoumou
Waswanipi
Chapais
Chibougamau
Matagami
Lebel-sur-Quévillon
Amos
Lac Saint-Jean
Saguenay
167
113
109

0 50 100 km
Échelle / Scale 1: 2 850 000
UTM, zone 18 (NAD 83)

Baie-James / James Bay

Localisation générale /
General location



- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Poste de transformation Nikamo / Nikamo substation
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique potentielle d'Hydro-Québec / Hydro-Québec potential electric power line
- Ligne électrique d'Hydro-Québec / Hydro-Québec electric power line
- Réseau routier principal / Main road network
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Mine active / Operating mine
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Projet minier en phase de développement avancé / Mining project in advanced stage of development
- Ancienne mine / Old mine
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Bassin versant / Watershed
- Aire d'étude du projet Renard / Renard Project Study Area

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Projets d'infrastructures régionales / Regional infrastructure projects

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_EC_IR_111216.WOR
Source: - Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010*
Pourvoiries / Outfitter, MRNF, 2010
** Bassin versant: Ressources naturelles Canada, Données-cadres nationales de l'atlas du Canada, Hydrologie - Aire de drainage, 2008*
Décembre 2011 / December 2011

Carte / Map 10.5.1

10.5.1 Extension of Route 167 and Other Roads

The most significant infrastructure project within the region of the Renard Project is the opening of the territory for Plan Nord, with the extension of the existing Route 167. The new layout will start from the area east of Lake Albanel up to the Renard Project site. About 240 km of new road will be built with a right-of-way between 30 m and 35 m. This route will also facilitate access to other particular mining projects (Matoush, Macleod Lake, etc.), logging sites, and recreational, tourist and traditional activity sites in the James Bay region. Additional stretches of road to join the other mining sites to Route 167 will be relatively short: 1 km to the Matoush project; 70 km to MacLeod Lake; 0.3 km to the Eastmain mine; and 62 km to the Lavoie project.

The extension of Route 167 will allow access to the territory and the realization of activities that would otherwise not be possible without this new stretch of road. Therefore, the cumulative effects of this new access road will not be limited to the footprint of Route 167. They will extend to the secondary branch roads to be eventually developed in order to provide access to the projects to be completed on the land. Increasing road traffic on the existing, already busy southern portion of the road taken by Mistissini residents, will also add to the impacts.

10.5.2 Power Lines

Another project of potential significance is power supply in the region. The Renard Project was initially meant to be powered by diesel generators, like all the other mining projects in the region. The 12 generators planned to supply the Renard mine would have a combined power capacity of over 22,600 kW.

However, the construction of a power line between Laforge 1 (Nikamo station) and the Renard mining site is also under review as part of a pre-feasibility study and an impact assessment. The line would have a minimum capacity of 161 kW and cover close to 165 km. The power line would have a right-of-way between 65 m and 80 m along its entire length. The grid would be designed to eventually supply two to three other sites of the same capacity as the Renard Project.

The MacLeod Lake mining facilities will potentially be supplied by a small power station on Eastmain River. A corridor of at least 7 km is being studied to transmit this backup energy (Western Troy Capital Resources press release, May 2011)[3].

[3] http://www.westerntroy.com/files/5-16-11.pdf

10.6 Recreational and Tourism Activities and Forestry Development

10.6.1 Natural Development and Conservation Areas

The recreational and tourist potential of local and regional study areas is chiefly based on the development of commercial activities such as hunting, fishing, ecotourism and Native tourism. For the time being, the supply of services in that area is limited to the services offered by the Albanel-Mistassini-and-Waconichi-Lakes Wildlife Reserve and a few outfitters operating in the Lake Mistassini area, and Grande Rivière region north of the study area. However, the Québec Governementproposed to create the Albanel-Témiscamie-Otish National Park in partnership with the Cree Nation of Mistissini, and the Hirondelle biodiversity reserve located east of the Renard Project. Map 10.6.1 shows the location of those projects and activities in relation with the Renard Project site.

- *Assinica and Albanel-Mistassini-and-Waconichi-Lakes Wildlife Reserves*

The Middle North of Quebec features a grandiose expanse of land practically untouched and unexplored. The largest water bodies of Quebec are also found within this vast territory covering 25,285 km^2. Hunting is reserved to Natives only, as well as fishing of particular species of fish like whitefish and sturgeon. The Lake Albanel and Lake Mistassini, aside from those of Assinica reserve, are dream venues for great outdoors and sport fishing enthusiasts.

In times past, the territory was very important for fur trade when Natives traded their beaver pelts for firearms or food. Those vast wild spaces were declared a reserve in 1948 to ensure their conservation. They are now part of a wider beaver reserve to benefit the Natives, particularly the Crees of Mistissini. The *Société des établissements de plein air du Québec* (Sépaq), a society of outdoor recreation establishments in Quebec, manages those wildlife reserves and involves the Natives living on the land in the management and exploitation of the resources.

- *Planned Albanel-Témiscamie-Otish Biodiversity Reserve*

The planned Albanel-Témiscasmie-Otish biodiversity reserve covers 11,874 km^2 mainly within the James Bay territory. The status of this reserve is provisional and should become permanent as a national park. The park will be managed under the *Parks Act* (R.S.Q., c. P-9). This reserve is proposed to ensure the protection of nine vascular plants likely to be identified as threatened or vulnerable.

Several roads allow access to the territory. From Chibougamau, Route 167 allows to reach the village of Mistissini and the southeastern shore of Lake Albanel and the mouth of the Temiscamie River, both located within the planned reserve. A winter road also provides access to the northernmost portion of the present biodiversity reserve.

The southern part of the planned biodiversity reserve is the habitat of three animal species likely to be identified as threatened or vulnerable: caribou (forest-dwelling ecotype), the hoary bat and the southern bog lemming.

More than fifty archaeological sites have been identified within the territory covered by the planned Albanel-Témiscamie-Otish biodiversity reserve. The sites were mainly found along the banks of the Temiscamie River (thirty sites or so), along Lake Albanel (ten sites or so) and along the Lake Mistassini (ten sites or so). In addition, the planned biodiversity reserve contains the Colline-Blanche archaeological sites that include a quartzite quarry in Mistassini and Antre du Lièvre (*Wapushakamikw*).

In addition to protecting the territory, some activities are prohibited under the *Natural Heritage Conservation Act*, including the following:

- Mining, natural gas and petroleum development;
- Forest management within the meaning of article 3 of the Forest Act (R.S.Q., c. F-4.1);
- Hydropower development and any commercial or industrial energy production.

➢ *PLANNED HIRONDELLE BIODIVERSITY RESERVE*

The planned biodiversity reserve covers a surface area of 322 km². The reserve should obtain the official title of biodiversity reserve once all the steps involved in its development are completed. This type of reserve is managed under the *Natural Heritage Conservation Act*.

The boundaries of the natural provinces of the Central Plateau of Northern Quebec and Low Hills of the Grande Rivière cut through the planned Hirondelle biodiversity reserve. More specifically, the reserve is part of the natural region of the Knolls of the Lakes Noacocane and Nichicun and the physiographic unit of the Hillocks of Orillat Lake. The purpose of the planned biodiversity reserve is to protect ecosystems that are representative of this natural region of Northern Quebec.

Located in the geological province of Lake Superior, the territory consists of metasedimentary rock and features a dead-ice moraine on a plateau topography with rounded peaks, the facies of which are reminiscent of glaciated landscapes. The biodiversity reserve features an aquatic environment covering about 18% of the territory that will be protected when the reserve is established.

The planned biodiversity reserve is almost entirely located on category III land in accordance with the *James Bay and Northern Quebec Agreement* signed in 1975, and the *Act respecting the Land regime in the James Bay and New Quebec territories* (R.S.Q., c. R-13.1). Three traplines owned by the Crees are affected by this reserve. The reserve is located within the beaver reserve of Mistassini for which the Crees hold exclusive rights on fur-bearing animals. A resort lease was issued for the planned biodiversity reserve, but for the time being, there are no trails or roads within the territory covered by the reserve.

10.6.2 Logging and Forest Fires

Save for those nature development and conservation projects, forest resources are presently being exploited in certain sectors in the region, including forest management units UAF 026-61 and UAF 026-62. Those units respectively cover a surface area of 684,776 ha and 320,403 ha, and are mainly located south of the study area. Theoretically, a few sectors are left for potential development in the study area, excluding the protected territories, land burned by forest fires, and land considered less interesting for the industry (access and quality of timber). Better access to the territory could encourage forest development in sectors considered currently less accessible.

In addition, a portion of the territory was burned by forest fires over the last decades, covering about 2,770,226 ha in the local study area of the cumulative effects alone. Although vegetation regenerated after the oldest fires, all those areas are still not ready for logging operations or recreational, tourist and traditional activities.

200 000 mE
400 000 mE
600 000 mE
800 000 mE
6 000 000 mN
5 800 000 mN
5 600 000 mN
5 400 000 mN

Zone d'étude régionale rapprochée /
Near Field Regional Study Area

Zone d'étude locale /
Local Study Area

Chisasibi
LG-1
Robert-Bourassa
Radisson
LG-2-A
LG-3
LG-4
LaForge-1
LaForge-2
Brisay
Réservoir Robert-Bourassa
Réservoir La Grande 3
Réservoir La Grande 4
Réservoir Laforge 1
Réservoir Laforge 2
Réservoir Caniapiscau
Route Transtaïga
Wemindji
Eastmain
Baie James
Eastmain-1
Réservoir de l'Eastmain 1
Réservoir Opinaca
Nemaska
Waskaganish
Route du Nord
Route de la Baie-James
Réserve faunique Assinica
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Lac Albanel
Lac Mistassini
Mistissini
Oujé-Bougoumou
Chapais
Chibougamau
Waswanipi
Matagami
Lebel-sur-Quévillon
Amos
Lac Saint-Jean
Saguenay
Réserve de biodiversité projetée Hirondelle
Projet Renard / Renard project
Parc national projeté Albanel-Témiscamie-Otish

0 50 100 km
Échelle / Scale 1: 2 850 000
UTM, zone 18 (NAD 83)

Baie-James / James Bay

Localisation générale / General location

Projet diamantifère Renard / Renard diamond mine project

0 500 km

- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Pourvoiries sans droit exclusif / outfitter without exclusive rights
- Aéroport / Airport
- Hydrobase / Hydrobase
- Aménagement d'Hydro-Québec/ Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec electric power line
- Réseau routier principal / Main road network
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Aire d'étude de projet Renard / Renard Project Study Area
- Zone d'exploitation forestière / Logging area
- Bassin versant / Watershed
- Limite des zones historiques des feux de forêts (avant 1939 à 2010)

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Activités récréo-touristiques et d'exploitation forestière / Recreational and logging activities

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_EC_RTEF_111216.WOR
Source: Pouvoiries / Outfitter, MRNF, 2010
Décembre 2011 / December 2011

Carte / Map 10.6.1

10.7 Biophysical Cumulative Effects Assessment

The wide range of past, current and future projects and activities undertaken within the perimeter considered in this analysis will entail a range of cumulative effects on the environment. Within the James Bay territory, the impact of mining projects, roads, outfitting operations and power lines will mainly occur through the reduction and fragmentation of the various types of habitat. Land, wetland and aquatic habitats, the habitats of forest-dwelling caribou, moose and fish, as well as the territory used by the Crees are the main types of habitat likely to be affected by the various projects.

The potential cumulative effects on the biophysical environment of the Renard Project will be felt mainly in the local study area, as identified in Section 10.2.2. Few cumulative effects are expected in the immediate study area, given that all the projects are quite far away from one another and that the potential sources of contaminants on the Renard Project site itself have different potential receptors (pits, drainage network, etc.). Few effects are also expected in the immediate regional study area. Among all the projects and activities mentioned in the previous sections, Map 10.7.1 illustrates those likely to generate cumulative biophysical impacts with the Renard Project.

As discussed above in Section 10.2.1 (Table 10.2.1), the main valued environmental components selected for the assessment of the cumulative biophysical environmental effects of the Renard Project are:

- Air quality;
- Soil quality and integrity;
- Surface and grounwater quality and quantity;
- Aquatic fauna (freshwater fish and benthos) and their habitats;
- Terrestrial wildlife (birds, herpetofauna, mammals) and their habitats (particularly caribou, moose, fur-bearing animals and waterfowl habitats);
- Vegetation and wetlands.

The potential cumulative effects on these valued environmental components can be estimated based on indicators associated with habitats likely to be affected. The indicators selected for this assessment include:

- The location of sites in reference to regional sub-watersheds;
- The surface area or areas likely to be affected by the projects;
- The length of linear infrastructures;
- The environmental criteria for air, soil, water, and aquatic environments;
- The consumption of energy.

Table 10.7.1 summarizes the potential cumulative environmental effects of the project likely to occur in the different habitats, and their associated indicators.

10.7.1 Terrestrial Environments, Wetlands and Aquatic Environments

All the projects (mining, logging, road) undertaken within the assessment region will result in the loss or deterioration of a portion of natural terrestrial, wetland and aquatic environments. Disturbed areas can therefore serve as indicators to measure cumulative effects. In addition, contaminant concentrations measured in effluents and potential receptors, along with the number of developed projects per sub-watershed, can also serve as indicators of cumulative effects.

- *CURRENT AND FUTURE ACTIVITIES*

Mining projects in advanced stage of development within the local study area (Renard, Matoush, MacLeod Lake, Eastmain Mine and Ruby Hill, Lavoie), will cause, if they are realized, the destruction of natural terrestrial environments (soil, vegetation) to a degree directly related to the surface area of facilities (pits, tailing sites, storage areas, plants, workshops, garages, other infrastructures, footprints of access roads, etc.). However, it is quite hard to quantify those surface areas on the basis of information available on projects other than the Renard Project, especially the proportion of affected terrestrial environments, wetlands and aquatic environments.

Unlike other types of mining facilities (gold, iron, etc.) that might require the excavation of vast pits, the Renard Diamond Project will consist of mining narrow kimberlite pipes on the surface through small pits and underground operations. Its surface footprint should therefore be more compact than that of other typically more extensive mining projects (gold, metals, uranium).

The footprint of the Renard Project is estimated at about 307 ha on land environments and wetlands and 4 ha in aquatic environments. For the purpose of assessing the cumulative effects and relating them to the area concerned, a 1,700 ha footprint surface area has been allotted to each of the other potential mining projects (Matoush, Lake MacLeod, Eastmain and Ruby Hill Mine, Lavoie). This surface area corresponds approximately to the area covered by the infrastructures of the Osisko Project under development in Malartic (information available on the Internet), which represents a very large-scale gold mining facility. This surface area can serve as a realistic upper limit to assess surfaces affected by the other mining projects. Hence, the individual surface area of each mining site, including the Renard Project, corresponds to less than 0.02% of the local study area of cumulative effects (9,469,500 ha). Overall, the potential mining sites (Renard, Matoush, MacLeod Lake, Eastmain and Ruby Hill Mine, Lavoie) would cover less than 0.08% of the local study area of cumulative effects.

600 000 mE
800 000 mE
6 000 000 mN
5 800 000 mN
Réservoir Laforge 1
Brisay
Réservoir Caniapiscau
Zone d'étude locale / Local Study Area
LaForge-1
Nikamo
Réservoir La Grande 4
LG-4
Eaux d'amont de la Caniapiscau
Cours supérieur de la rivière La Grande
Cours supérieur de la Sakami
Réserve de biodiversité projetée Hirondelle
Projet Renard / Renard project
Mouchalagane
Parc national projeté Albanel-Témiscamie-Otish
Projet mine Eastmain / Eastmain mine project
Cours supérieur de la Eastmain
Projet Lavoie / Lavoie project
Projet Lac Macleod / Macleod lake project
Projet Ruby Hill / Ruby Hill project
Projet Matoush / Matoush project
Cours supérieur de la rivière aux Outardes
Réserve faunique des Lacs-Albanel-Mistassini-et-Waconichi
Cours moyen de la Eastmain
Cours supérieur de la Péribonka
Cours supérieur de la Rupert
Lac Mistassini
Lac Albanel
10554-02
167
Baie-James / James Bay
0 25 50 km
Échelle / Scale 1 : 1 300 000
UTM, zone 18 (NAD 83)

Localisation générale / General location
Projet diamantifère Renard / Renard diamond mine project
0 500 km

- Ville, municipalité / City, municipality
- Communauté crie / Cree community
- Mine active / Operating mine
- Projets d'exploration de ressources minérales / Mineral resources exploration projects
- Mines qui pourraient être mises en exploitation à court ou moyen termes / Short and medium term potential mining projects
- Ancienne mine / Old mine
- Poste de transformation Nikamo / Nikamo substation
- Pourvoiries sans droit exclusif / outfitter without exclusive rights
- Aéroport / Airport
- Hydrobase / Hydrobase
- Aménagement d'Hydro-Québec / Hydro-Quebec facility
- Ligne électrique d'Hydro-Québec / Hydro-Québec electric power line
- Ligne électrique potentielle d'Hydro-Québec / Hydro-Québec potential electric power line
- Réseau routier principal / Main road network
- Routes projetées d'accès aux bancs d'emprunt / Projected access roads for the exploitation of borrow pits
- Réseau routier secondaire / Secondary road network
- Prolongement de la route 167 Nord vers les Monts Otish / Extension of Route 167 North to the Otish Mountains
- Chemin de fer / Railroad
- Zone d'exploitation forestière 2661-2662/ 2661-2662 Logging area
- Parc national projeté / National Park project
- Réserve de biodiversité projetée / Projected biodiversity reserve
- Réserve faunique/ Wildlife reserve
- Limite des feux de forêts (Avant 1990) / Forest fires prior to 1990
- Limite des feux de forêts (1990 à 2010) / Forest fires between 1990 and 2010
- Bassin versant / Watershed
- Zone d'étude de projet Renard / Renard Project Study Area

les diamants stornoway (canada) inc.

Projet diamantifère Renard / Renard diamond mine project

Étude d'impact environnemental et social
Environmental and Social Impact Assessment

Sources potentielles d'effets cumulatifs sur le milieu biophysique / Potential sources of cumulative effects over the biophysical environment

ROCHE

Carte de base / Base Map : BDGA, 1M, 2010
Fichier / File : 61470_EIES_EC_SPMB_111216.WOR
Source: - Projet d'exploration de ressources minérales / Mineral resources exploration projects, MRNF, 2010*
Pourvoiries / Outfitter, MRNF, 2010
Décembre 2011 / December 2011

Carte / Map 10.7.1

Table 10.7.1 Past, current and future projects identified in the study areas as potential generators of cumulative effects upon valued environmental components of the biophysical environment and potential associated indicators

Projects or activities		State of the project		Project watershed	Potential surface area concerned by the project or activity in the cumulative effects study area (terrestrial and aquatic environment) (ha)	Potential impacts on significant environmental components (biophysical environment)						Potential indicators of potential cumulative effects														
		Past and present	Future			Terrestrial environment	Wetlands	Aquatic environment	Energy supply	Caribou habitat	Moose habitat	Concerned watershed							Potentially affected surface area	Linear infrastructure	Biophysical environment				Energy supply		
												Eastmain	Broadback	Opinaca	LaGrande River	Rupert	Perlbonka	Sakami	Lake Mistassini	(% local study area of the cumulative effects)	(length - km)	Environmental quality criteria concerning drinking water	CCME environmental quality criteria (soil and/or aquatic environment)	RPRTC criteria	Directive 019	Number of stream crossings	Source type	GHS tons/year (CO_2 equivalent)	Energy (kW)
Mining operation																												
Past mining operations	Eastmain Mine	X	X	Upper Eastmain	1 700	Under exploration	Wetland habitats may continue to be subject to changes in water quality (TSS, metals)	Stream habitats of fish and benthos may continue to be subject to changes in substrate (sediments) and water quality (SS, metals, etc.)	No additional demand or emission	Under exploration	Limited effects (abandon)	x								0.02%	n.a.	x	x	x	x	0	0	0	0
	Troilus	X		Upper Broadback	1 700								x							n.a	n.a.	x	x	x	x	0	0	0	0
	Former mines of the Chibougamau and Chapais mining camps (Joe Mann, Copper Rand, Springer, etc.)	x		Southern watersheds	>1,700	Sites being rehabilitated		Changes in freshwater quality may continue to affect drinking water quality and the recreational use of waterways		Sites being rehabilitated	Sites being rehabilitated									n.a	n.a.	x	x	x	x	0	0	0	0
Current and future projects	Renard		X	Upper Eastmain	311	Increase in total dust emissions and noise disturbances due to the sites SOx and NOx emissions	Wetland habitats may continue to be subject to changes in water quality (SS, metals)	Additional pressure on freshwater resources due to the harnessing of water for projects may contribute to recharge reduction during the intermediate-to-low flow period	Possible electrical hook-up with LG4 for Renard, setting up of a power line and habitat disturbance and destruction (flora and fauna); territorial segmentation	Limited destruction (vegetation), restricted to the site	Limited destruction (vegetation), restricted to the site	x								0.003%	n.a.	x	x	x	x	n.a.	Hydro-electricity	1,502 (quantity of fuel consumed)	14 000
	Matoush		X	Middle Eastmain	1 700	Disappearance or displacement of species	Destruction of part of the wetland area in zones characterized by new mining and related infrastructure development	Potential increase in TSS and surface water and groundwater metal concentrations due to leaching on mine sites				x								0.02%	n.a.	x	x	x	x	n.a.	Diesel	Quantity of fuel consumed	n.av.
	MacLeod Lake		X	Upper Eastmain	1 700	Destruction of part of the wildlife habitat in zones characterized by new mining and related infrastructure development	Disappearance or displacement of species	Disappearance or displacement of species	Possible electrical hook-up and dam for MacLeod Lake, setting up of a transmission line and habitat disturbance and destruction (flora and fauna); territorial segmentation	Movement affected on a limited scale	Movement affected on a limited scale	x								0.02%	n.a.	x	x	x	x	n.a.	Hydro-electricity	Quantity of fuel consumed	n.av.
	Lavoie		X	Upper Eastmain	1 700	Destruction of part of the indigenous vegetation in zones characterized by new mining and related infrastructure development	Dewatering resulting from pit drainage caused by a lowering of the water table or a reduction in water inflow	River habitats of fish and benthos may continue to be subject to changes in substrate (sediments) and water quality (TSS, metals, etc.)	Emissions from diesel generator (increase in GHG)			x								0.02%	n.a.	x	x	x	x	n.a.	n.av.	Quantity of fuel consumed	n.av.
	Blackrock		X	Outside the region	1 700	Soil degradation/erosion		Stream crossings	Stream crossings											n.a	n.a.	x	x	x	x	n.a.	Hydro-electricity	Quantity of fuel consumed	n.av.
	Whabouchi		X	Middle Eastmain	1 700							x								n.a	n.a.	x	x	x	x		Hydro-electricity	Quantity of fuel consumed	
	Eleonore		X	Lower Opinaca	1 700								x							n.a	n.a.	x	x	x	x	n.a.	Hydro-electricity	Quantity of fuel consumed	n.av.
Others																												
Route 167 extension			X	Upper Eastmain Upper Rupert Lake Mistassini	3 450	Destruction of terrestrial habitats (route and borrow pits) Increased noise and dust due to more intense traffic	Destruction of wetland habitats (route and borrow pits)	Possible impacts on stream crossings	n.a.	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access and traffic	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access and traffic	x				x			x	0.04%	240	n.a.	n.a.	n.a.	n.a.	152	n.a.	n.a. (vehicle contributions)	n.a.
Electrical power line (Renard-LG4)			X	Upper Eastmain Upper Sakami Middle La Grande River	1 320	Destruction of terrestrial habitats	Destruction of wetland habitats	Little impact	n.a.	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access (wolves and humans)	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access (wolves and humans)	x			x			x		0.01%	150	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Roads for MacLeod Lake and other mining sites			X	Upper Eastmain	267	Destruction of terrestrial habitats (route and borrow pits) Increased noise and dust due to more intense traffic	Destruction of wetland habitats (route and borrow pits)	A few possible impacts on stream crossings	n.a.	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access and traffic	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access and traffic	x								0.003%	134	n.a.	n.a.	n.a.	n.a.	n.av.	n.a.	n.a. (vehicle contributions)	n.a.

Table 10.7.1 Past, current and future projects identified in the study areas as potential generators of cumulative effects upon valued environmental components of the biophysical environment and potential associated indicators

Projects or activities	State of the project		Project watershed	Potential surface area concerned by the project or activity in the cumulative effects study area (terrestrial and aquatic environment) (ha)	Potential impacts on significant environmental components (biophysical environment)						Potential indicators of potential cumulative effects																
	Past and present	Future			Terrestrial environment	Wetlands	Aquatic environment	Energy supply	Caribou habitat	Moose habitat	Concerned watershed								Potentially affected surface area	Linear infrastructure	Biophysical environment					Energy supply		
											Eastmain	Broadback	Opinaca	LaGrande River	Rupert	Péribonka	Sakami	Lake Mistassini	(% local study area of the cumulative effects)	(length - km)	Environmental quality criteria concerning drinking water	CCME environmental quality criteria (soil and/or aquatic environment)	RPRTC criteria	Directive 019	Number of stream crossings	Source type	GHS tons/year (CO_2 equivalent)	Energy (kW)
Trans-Taïga Road	X		Middle La Grande River	528	Increased noise and dust due to more intense traffic	No new anticipated impact	No new anticipated impact	n.a.	Habitat fragmentation; increased mortality due to an increase in traffic	Habitat fragmentation; increased mortality due to an increase in traffic				x					0.006%	151	n.a.	n.a.	n.a.	n.a.	n.av.	n.a.	n.a. (vehicle contributions)	n.a.
Corridor for MacLeod Lake generating station		X	Upper Eastmain	45	Destruction of terrestrial habitats	Destruction of wetland habitats	Few impacts	n.a.	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access (wolves and humans)	Limited habitat destruction, restricted to infrastructure; territorial fragmentation; increased mortality due to easier access (wolves and humans)	x								0.0005%	10	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
La Grande 4 reservoir	X		Middle La Grande River	70 700	No new anticipated impact	No new anticipated impact	No new anticipated impact	n.a.	No new anticipated impact	No new anticipated impact				x					0.75%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
LG4 hydroelectric dam		X	Upper Eastmain	n.a.	No new anticipated impact	No new anticipated impact	No new anticipated impact	n.a.	No new anticipated impact	No new anticipated impact	x								n.a	0.246	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Forestry development	X		Upper Broadback Upper Rupert Lake Mistassini	179 970	Increased destruction of terrestrial habitats due to easier access and new forest roads	Increased destruction of wetland habitats due to easier access and new forest roads	Impacts of operations on water quality (TSS due to erosion), possible impact on stream crossings	Impacts of machinery	Increased destruction of caribou habitats	Increased destruction of moose habitats		x			x			x	2%	n.av.	n.a.	n.a.	x	n.a.	n.a.	n.a.	Increase (carbon sinks)	n.a.
Forest fires	X	X	All watersheds	2 770 226	Increased destruction of terrestrial habitats due to a greater human presence in the area (risk of fire)	Increased destruction of wetland habitats due to a greater human presence in the area (risk of fire)	Impacts of fire on water quality (TSS due to erosion)	Few impacts	Increased destruction of caribou habitats due to a greater human presence in the area (risk of fire); migration	Increased destruction of moose habitats due to a greater human presence in the area (risk of fire); migration	x	x	x	x	x	x	x	x	29%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Significant	n.a.
Recreation-and-tourism activities																												
Albanel-Mistassini-and-Waconichi-Lakes Wildlife Reserve	X		Upper Rupert Upper Péribonka Upper Broadback Lake Mistassini	556 604	Preservation and development of terrestrial habitats	Preservation and development of wetland habitats	Preservation and development of aquatic habitats	n.a.	Preservation and development of caribou habitats	Preservation and development of moose habitats		x			x	x		x	6%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Decrease	n.a.
Proposed Albanel-Témiscamie-Otish biodiversity reserve		X	Upper Eastmain Upper La Grande River Lake Mistassini	928 053	Preservation and development of terrestrial habitats	Preservation and development of wetland habitats	Preservation and development of aquatic habitats	n.a.	Preservation and development of caribou habitats	Preservation and development of moose habitats	x			x				x	10%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Decrease	n.a.
Proposed Hirondelle biodiversity reserve		X	Upper Eastmain Upper Sakami Middle La Grande River	32 200	Preservation and development of terrestrial habitats	Preservation and development of wetland habitats	Preservation and development of aquatic habitats	n.a.	Preservation and development of caribou habitats	Preservation and development of moose habitats	x			x			x		0.34%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Decrease	n.a.
Outfitters	x	x	Upper Eastmain Upper Sakami Middle La Grande River Lake Mistassini	Few impacts, limited to lakes	Limited destruction of terrestrial habitats / noise (hydroplanes)	Few effects	Increased pressure on halieutic resources due to an increased number of outfitters	Increased number of generators and emissions	Increased mortality due to easier access (humans)	Increased mortality due to easier access (humans)	x			x			x	x	Limited	n.a.	x	n.a.	n.a.	n.a.	n.a.	Diesel / propane	Negligible	n.av.

Notes:
n.av.: not available
n.a.: not applicable

With regard to the area nearby the Renard Project, construction of the mining facilities will affect about 307 ha of land and wetland, representing 2.4% of the selected Renard Project study area (12,710 ha) or less than 0.003% of the entire local study area of the cumulative effects. The footprint of the mining facilities and the borrow pits required for the construction should destroy only a slight extent of wetlands, that is about 6.0 ha of the Renard Project study area (0.05%) or a negligible portion of the entire local study area of the cumulative effects. The construction will require the dewatering of two small lakes of 3 ha and 1 ha respectively, and the diversion of small streams to operate the open-pits. The lacustrine surface area affected will thus be 3.75 ha, that is 0.03% of the selected Renard Project study area, and close to 1,341 m of total stream length.

The construction and operation of the Matoush mine could also cause losses in all these types of environments, although no surface areas can currently be calculated given the lack of information available. An access road to the site will have to be constructed, but it will be of short distance since the the Otish Mountains Route is planned less than 1 km away from the Camp Matoush, what would represent about 2 ha of territory affected.

The construction and operation of the Lake MacLeod copper-molybdenum mine will also cause losses in terrestrial environments, wetlands and aquatic environments. The overall surface area of the environments disturbed by the mining facilities and borrow pits required for construction and operations is unknown, but it should also be very limited compared to the local study area of the cumulative effects. Access to the site will also require the construction of a road stretching from the future Route 167 over a distance of about 70 km. If the right-of-way of the highway is 20 m, losses in terrestrial environments, wetlands or aquatic environments would be about 140 ha. Regarding the access roads to the Eastmain and Lavoie mine projects, losses in natural environments are estimated at 0.6 ha and 124 ha respectively, on the same basis of calculation.

All the mining projects will influence the aquatic environments at different degrees other than simply dewatering the bodies of water for construction purposes; for instance, the number of stream crossings of access roads. In addition, although the mining effluents will be controlled and, if needed, treated before being discharged into the waterways, the usual site operations will nonetheless release a certain quantity of total suspended solids (TSS) and metal loads into the rivers. With the Renard Project, results from the modelling of the treated effluent plume suggest a fast dispersion of effluents from the discharge point. Hence, the spatial extent of the plume in Lake Lagopede will be limited and will not cause any cumulative effects with other projects. Given strict design criteria for wastewater treatment systems, no significant impact is anticipated on aquatic life beyond the limits of the plume.

In addition, there could be other potential sources of contaminants in the surface and groundwaters. For instance, seepage water coming from processed kimberlite confinement area might re-emerge in Lake Lagopede and nearby streams but with an extent limited to the immediate vicinity of the shore. With

regard to the Renard Project, anticipated concentrations should not cause significant impacts on aquatic life, given the low leaching potential of mining materials (Golder, 2011c).

There might also be an increase in TSS in the watercourses during construction of the projects. Erosion and sediment transport control measures that will be applied at the source will help to reduce the intensity and spatial extent of this impact that will generally be of short duration during high-intensity thunderstorms or snow melt.

With regard to the other infrastructure projects in the local study area of cumulative effects, the construction of the Otish Mountains Route could cause losses of about 3,450 ha of terrestrial habitats (road and borrow pits) and close to 38 ha of wetlands, including 32.5 ha of peat bogs and 5.3 ha of riparian environments, with impacts stretching over a distance of 240 km (0.04% of the local study area of cumulative effects). In addition, road maintenance could increase concentrations of sand and other particles in watercourses. Lastly, road traffic will increase within the territory, with related inconveniences like noise, dust emissions, and higher potential of accidents and spills.

Some other operations will have various impacts on terrestrial environments, wetlands and aquatic environments. The few outfitters in the sector should cause only limited local impacts (camp infrastructure, wastewater and solid waste management, etc.). In spite of the presence of protected areas, additional logging operations potentially generated by the opening of the territory will mainly reduce the surface area of terrestrial environments and wetlands, in addition to a few aquatic environments with stream crossings. The areas currently selected for mining operations in the local study area directly cover a surface area of 171,840 ha for UAF-026-61 and 8,130 ha for UAF-026-62 (2% of the overall local study area of cumulative effects), compared to the parks and protected areas covering about 1,515,857 ha (16.3% of the entire local study area of cumulative effects).

The influence of forest fires on land use is not to be overlooked. Two forest fires already burned about 31% of the local study area of cumulative effects. An increasing number of forest fires would temporarily reduce the surface area of natural environments and access to the territory. Therefore, a higher occurrence of forest fires in a context of climate change, combined with increased industrial, commercial, recreational and tourist activities in the region would therefore mean a higher potential of accidental fires, which in turn could partly restrict the future use of the territory and represent a risk for those economic activities.

➢ *PAST ACTIVITIES*

Past activities already undertaken on the territory probably impacted the terrestrial environments, wetlands and aquatic environments. However, several of those areas are being regenerated (logging, fires) or restored through assisted revegetation (mining projects). It has been reported that the impact of forest fires and logging wears off after 30 to 40 years for pine forests and 70 to 80 years for spruce forests, compared to 30 to 50 years for mining sites.

The impact of treated wastewater discharges or exfiltration waters from the storage sites of the last mining projects into the water network has undoubtedly, for the most part, already dissipated. Once effluent discharge has stopped, water inflow from non-disturbed areas of the watershed helps to quickly restore the physico-chemical characteristics of the water network. When a mining effluent remains after operations are over, most chemical reactions tend to stabilize after a certain amount of time (e.g., more or less constant discharge concentrations). The primary cause of current discharges could be acid mine drainage resulting from mine tailings or waste sites left behind or poorly managed. In the immediate regional study area of cumulative effects, the presence of high concentrations of certain metals (As, Cd, Cu, Ni, Zn) in sediments collected near mine tailings sites was reported, particularly in the vicinity of the Copper Rand Mine south of the Principale Mine and at the foot of Principale tailings[4]. However, it was impossible to precisely identify the proportion of those metal contents coming from natural sources from those coming from anthropogenic sources, given the various types of on-site mineralization.

Limited accidental contamination (leakage, spills) is considered as local. In general, impacts are short-term, providing that they are caught on time. No cases of major limited contamination from former mining sites have been knowingly reported.

10.7.2 Power Supply

The implementation of the different projects within the territory and their nature will require a major source of power supply. Two main sources may supply the electric power needed: diesel generators, likely to generate greenhouse gas (GHG) emissions, or hydro-electric power plants supplying electricity by power lines, the right-of-way of which will likely affect related natural environments. The cumulative effects resulting from electricity supply will be measured on the basis of indicators, such as the level of GHG emissions, the number of kW generated and the distance covered by the power lines.

To be operational, each mining facility requires a major constant, reliable supply of power. For the Renard Project, two main alternatives were closely examined after eliminating other non-viable alternatives. The first is the installation of generators producing a maximum output of 21,600 kW, and the second is the possibility to obtain power from a Hydro-Québec power line that would cover a distance of about 165 km from LA-1 (Nikamo station) located north of the Project. This power line would

[4] MDDEP Site: http://www.mddep.gouv.qc.ca/eau/eco_aqua/chibougamau/2002.htm

have a right-of-way of 65 m to 80 m along its entire length and would affect an estimated 1,320 ha of natural environments (0.01% of the entire local study area of cumulative effects).

Diesel generators producing a maximum output of 3,300 kW may supply electricity to the Matoush Mine. Electricity may also be supplied to the Macleod Lake Project by a system of diesel generators. However, for the latter, recent study results recommend the construction of a small power plant on the Eastmain River; consequently, a corridor of some 7 km may be developed to transmit this back-up energy (Western Troy Capital Resources, press release, May 2011). This represents about 31.5 ha of natural environments likely to be affected, in addition to the terrestrial and aquatic environments in the vicinity of the plant.

Using diesel generators will cause atmospheric emissions to increase in the region. Based on prevailing winds, emissions from the generators of each mining site could deteriorate locally the quality of air. The impacts should, however, be limited because the sites (plumes) are very far from one another, and the plumes should not cause any cumulative effects based on simulations conducted for the Renard Project. In more general terms, the annual GHG emissions of those facilities will instead contribute to increasing the overall emission rates of the provincial and national GHG footprint.

The construction and presence of power lines will fragment and reduce the surface area of habitats. However, the land cleared for the power lines will make it easier for humans and animals to travel the territory.

10.7.3 Large Mammal Habitats

Any project implemented in a forest environment affects large mammal habitats directly or indirectly. The surface area of habitats likely to be affected is an indicator for the assessment of cumulative effects. The main species affected by projects located in Northern Quebec are caribou and moose. Surveys conducted as part of the Renard Project have allowed assessing potential cumulative effects on those two species.

- *CARIBOU*

The survey of caribou populations conducted in the Renard Project study area shows that the territory represents an habitat with limited potential for the species at this time, given the low number of individuals reported. All the caribou counted in the nearby area of the Renard Project are of the migratory ecotype, according to their morphology and travel behaviour. The density of migratory caribou counted during the survey was 0.4 caribou/100 km². However, it is not necessarily relevant to determine the density of migratory caribou, because those individuals only gather in the area to spend winter and the counting of migratory caribou herds is done in their respective calving areas.

The presence of the forest-dwelling ecotype caribou, considered as an endangered species in Canada under the *Species at Risk Act* (SARA) and vulnerable in Quebec under the *Act respecting threatened or*

vulnerable species (R.S.Q., c. E-12.01) was not confirmed in the Renard Project study area during the 2011 winter survey (7,621 km²). However, given its potential presence and the large number of projects and activities likely to be undertaken, a forest-dwelling caribou protection plan will be implemented as part of the Renard Project, particularly to consider potential impacts of new travel corridors across the land.

Based on tallymen's observations, caribou is now less present in the region than in the past, particularly since Camp Lagopede was set up (Lussier, 2010). The presence of black bear undoubtedly contributes to increased predation on young caribou. There has always been a high density of bears in the Renard Project study area, even before exploration began. However, the presence of Camp Lagopede has increased the number of bears in the surrounding area, lured by food. The implementation of other mining projects could also influence the presence of caribou within the territory. Migratory caribou have possibly been using the study area less, because of a lower number of individuals and a smaller wintering range of migratory caribou herds (Jean and Lamontagne, 2004; Brodeur, 2010).

Among the large-scale projects and activities planned in the local study area of cumulative effects, the Route 167 toward the Otish Mountains will have by far the strongest impact on the caribou habitat in terms of surface area, with the exception of forest fires. The construction of the Otish Mountains Route alone will cause an estimated maximum total loss of 2,602 ha out of 3,450 ha in vital forest-dwelling caribou habitats within the local study area, if all the borrow pits are used. Generally speaking, those habitats consist of mature or old coniferous stands and peat bogs. Considering an 80-m right-of-way and a similar proportion of stands vital to the forest-dwelling caribou, the power line to supply the Renard Project site could affect a surface area of at least 900 ha within the local study area of cumulative effects. The access road leading to the MacLeod Lake mining site could affect an extent of some 105 ha. Lastly, forestry operations could affect over 134,000 ha of habitats in the same proportions. The existing natural park and the future park and reserve projects will become protected areas serving to protect and preserve biodiversity in the area, including forest-dwelling caribou and moose (1,516,857 ha).

Building the Route 167 toward the Otish Mountains will open a new corridor for wolves to travel in; as a result, wolf predation on caribou located further north of the territory will increase. Along the same lines, all the roads built to allow access to mining camps and all the other projects (power lines, outfitters, etc.) will also make it easier for wolves to travel around the land.

Humans will also become caribou predators as the new roads will make it easier for them to travel to new hunting grounds and increase their chances of success. Although forest-dwelling caribou are protected, poachers will always find a way to access this broader territory to practice their "activity".

- *MOOSE*

Clearing land to build the Renard Project will cause loss in vital moose habitats. Dense spruce stands, pine stands, mixed stands and wetlands are the preferred habitats sought by moose. However, no moose or track trails have been observed within the Renard Project study area. Therefore, the density of moose in the area is considered as nil.

However, the Renard Project has raised certain concerns among tallymen. Some of them have reported that since operations began at Camp Lagopede, moose have gradually left the area because of disruption caused by exploration work (Lussier, 2010). Like the caribou, the lack of moose in the area is potentially linked to the increased presence of bears. In addition, implementing other mining projects could further increase the presence of bears within the territory.

The construction of the Otish Mountains Route will cause a loss of about 101 ha of stands preferred by moose, while the operation of borrow pits will cause a loss of 342 ha of moose habitats in the local study area of cumulative effects. However, natural conservation sites (e. g., Albanel-Témiscamie-Otish National Park and others) will provide protection areas to preserve a habitat conducive to support moose populations and breeding in that area.

Land clearing needed for building the other mining projects and the outfitting operations will also mean losses in vital moose habitats. As moose go further up north in Quebec, the less they will find deciduous or mixed stands needed for sustenance. However, observed climate change and the development of new roads to access the territory could extend the species' distribution to the north. The power line that should be built northbound between LA-1 (Nikamo) and the Renard Project may only affect 168 ha of stands vital to the moose in the local study area. This extent is obtained by considering the 80 m right-of-way of the power line within a territory containing about 12.8% of stands vital to the moose. Forestry operations conducted further south in the study area alone could affect more than 23,000 ha of habitat preferred by moose in a region where hunting pressure is likely to increase, given the closer proximity to Mistissini.

Land clearing can be advantageous to moose in the boreal forest area; for instance, land clearing stimulates the regeneration of deciduous or mixed stands. In certain types of boreal forests, regeneration of deciduous species (e.g., white birch, poplar) along the right-of-way of roads, usually follows land clearing needed to build them, which provides an additional food source for moose. Nonetheless, the impact of mining projects on moose habitat will be very limited, because most operations will take place in the domain of the spruce-lichen forest.

The construction of the Otish Mountains Route, access roads and the hydro-electric power lines within the territory will make it easier for both humans and predators to travel. Those new access ways alone should not be a risk to the moose population; however, they will partly contribute to increasing their mortality rate.

10.8 Cumulative Socio-economic Effects

As discussed in Section 10.2.2, the study of cumulative socio-economic effects is preferably done on a regional scale (immediate and expanded regional study areas), in this case the territory of Eeyou Istchee, and even the Nord-du-Québec region as well (Map 10.7.1). The potential cumulative socio-economic effects are related to the impacts upon the VESC of the human environment analyzed in Chapter 8 (use of land and natural resources, health and welfare, landscape, economic spinoffs, etc.). Taking this environmental assessment into consideration, along with the concerns expressed during consultations with the populations involved, the following significant valued socio-economic components of the Renard Project, upon which cumulative effects may be envisaged and analyzed, come to the forefront:

- Economic spinoffs (development of economic activities and employment); and
- Land use.

The potential cumulative effects upon these valued socio-economic components may be assessed based on indicators related to employment and traditional Cree activities, namely:

- The number of jobs involved in the projects considered (construction and operations); and
- The areas affected by the project (traplines).

Concerning these indicators, it should be emphasized that they were selected as representing issues of importance that can be documented for purposes of eventual monitoring. As such, it will be understood that the number of jobs is only one facet of local and regional economic spinoffs, which also include indirect and induced effects on employment, business opportunities for regional firms, the development of expertise and training, GDP, fiscal spinoffs, etc.

The number of traplines is also a limited indicator. Cumulative effects upon land use by the Cree in fact include much more varied and complex aspects referring, for example, to the number of users involved and to various hunting, fishing, trapping and other related activities, as well as to broader realities, such as cultural identity or the population's nutrition and the well-being of elders (food from natural sources).

Table 10.8.1 summarizes the potential cumulative socio-economic effects of the Renard Project and presents the indicators associated with them.

10.8.1 Economic Spinoffs

The available data and current context testify to the increasing importance of the mining sector for Quebec's economic development. According to a roundup paper provided by Quebec's *Ministère des Ressources naturelles et de la Faune* (Ministry of natural resources and wildlife, or MRNF)[5], mining activity in Quebec represented nearly 1.6% of the province's GDP in 2008, with a contribution of as much as $4.8B. In all, activities linked to mining production generated over 16,000 direct jobs and the equivalent of 14,000 indirect jobs, while investments in fixed assets and construction produced the

[5] MRNF, Study on the Economic Impact of Mining Sector Activities and Investments in Quebec – Briefing Card, May 2011.

equivalent of 3,600 jobs on average per year. For the Quebec government, mining activities and company investments represent revenue in the order of $250M per year, including taxation of company expenditures and income tax from workers' salaries. According to the most recent data available from the MRNF, the economic slowdown of 2008 had no significant effect on mining investments in Quebec. On the contrary, these investments reached a new historic peak of $2.04B in 2009, and data for 2011 suggests that they have continued to rise, reaching nearly $2.9B. Private mining investments will therefore generate significant economic spinoffs linked to an increase in sector royalties.

As such, once undertaken, the Renard Project and other projects of the same ilk should generate socio-economic benefits, particularly by directly contributing to the building or maintaining of new access roads, such as Route 167, and also through the reinvestment of government revenue in local infrastructures (airports, roads, ports, etc.). The most obvious cumulative effects resulting from undertaking the Renard Project will be reflected in economic conditions, especially in the regional study area (immediate and expanded), i.e. the zone including, respectively, the communities of Mistissini, Chibougamau, and Chapais, and the Eeyou Istchee Baie-James territory.

The effects of constructing various mining projects will be felt on the demand for goods and services in the region of the project. For example, an increase in demand for skills, workers, materials, and transportation logistics (trucks, helicopters, hotels, etc.) will foster economic development in the immediate region of the project (Mistissini – Chibougamau – Chapais), as well as in other centres of the James Bay region.

The effects of undertaking various mining projects will also be felt as regards needs for a specialized and semi-specialized workforce. The new needs cannot all be met by the local population, and the arrival of workers from the outside may therefore result in a new influx of permanent residents, although a certain number of workers will regularly travel between the mine sites and their homes elsewhere in Quebec. This influx of workers will lead to a strengthening of services and an improved quality of life in Chibougamau and Chapais. On the other hand, training will certainly be available for the regional population in order to improve the employability of regional workers, as a means of making optimum use of the locally available workforce.

Table 10.8.1 Past, current and future projects identified in the study areas as potential generators of cumulative effects upon valued socio-economic components and potential associated indicators

Projects or activities	Geographical situation	State of the project		Significant socio-economic components			Potential cumulative effects indicators		
		Past and current	Future	Economic development and workforce	Facilities, infrastructures and public services	Cree communities	Number of new workers involved in the project (construction and operations)	Additional population linked to workers requiring services	Territory and types of Native activities affected
Mining operations									
Past and current mining operations	Eastmain Mine	X	X	Little impact (monitoring only)	Little impact	Little impact	0	Population remaining in the region after closure of the project	Recovery of territories
	Troilus and the former mines of the Chibougamau and Chapais mining camps (Joe Mann, Copper Rand, Springer, etc.)	X					0		
Current and future projects	Renard		X	Projects will create a number of direct and indirect jobs during construction and operations. Money will be spent in the region due to the jobs created.	Additional pressure on social, health and security services due to presence of new employees and their families.	Additional pressure on the traditional way of life Attraction for new, well paid jobs Migration of workers away from communities	Average 450	n.av.	Less time for traditional activities due to new jobs Influence on hunting as a result of changing migration patterns of large mammals
	Matoush		X				300	n.av.	
	MacLeod Lake		X				250	n.av.	
	Lavoie		X				Estimate (between 50 and 150)	n.av.	
	Blackrock		X				250	n.av.	
	Wabouchi		X				150	n.av.	
	Eleonore		X				600	n.av.	
Recreation-and-tourism activities									
Assicana and Albanel-Mistassini-and-Waconichi-Lakes Wildlife Reserves			X	Projects could create a few direct and indirect jobs. Additional expenditures by new visitors (food, camping accessories , etc.)	Additional moderate pressure on infrastructures given the presence of visitors due to new access routes.	Additional pressure on the traditional way of life	Slight	Slight	Little effect
Proposed Albanel-Témiscamie-Otish biodiversity reserve			X				Slight	Slight	Little effect
Proposed Hirondelle biodiversity reserve			X				Slight	Slight	Little effect
Others									
Route 167 extension			X	More and easier exchanges between regions	Increased traffic	Additional pressure on the traditional way of life	Temporary	n.a.	Increased travel to carry out traditional activities
Power line (Renard-LG4)			X	Little impact	Increased pressure on electricity infrastructures	Little impact	Temporary	n.a.	Will facilitate travel for certain activities
Road for MacLeod Lake (and other sites)			X	Little impact	Increased traffic	Additional pressure on the traditional way of life	Temporary	n.a.	Will facilitate travel for certain activities
Trans-Taiga Road		X		More and easier exchanges between regions	Increased traffic and noise	Additional pressure on the traditional way of life	Little effect	n.a.	Little effect
Corridor for the MacLeod Lake generating station			X	Little impact	Decreased pressure on electricity infrastructures	Little impact	Temporary	n.a.	Will facilitate travel for certain activities
La Grande 4 reservoir		X		Little impact	Little impact	Little impact	Little effect	n.a.	Little effect
Hydroelectric dam		X		Little impact	Little impact	Little impact	Little effect	n.a.	Little effect

Notes:
n.av.: not available
n.a.: not applicable

This demand for a specialized workforce in the mines will not abate any time soon, or so it would seem, for future employment prospects would appear to be very good. In this respect, let us first point out that current activities associated with mining production generate over 16,000 direct jobs in Quebec (MRNF, 2011a). The 450 or so jobs to be created by the Renard Project on average per year will add to this active workforce and contribute commensurately to reaching the economic and strategic objectives established in the Quebec Mineral Strategy (Gouvernement du Québec, 2009), and in the Regional Plan for Integrated Land and Resource Development (RPILRD) for James Bay (CRRNTBJ, 2010), in conjunction with the Strategy for the Accelerated Development of Quebec's Diamond Potential (MRNF, 2011b).

The creation of jobs by the Renard Project will have a notable cumulative effect in terms of economic spinoffs, which will be added to the spinoff jobs created by other mining projects in the Nord-du-Québec region. In this regard, it should be noted that the Mining Industry Sectoral Workforce Committee has determined that the mining industry will require 7,453 workers in the Nord-du-Québec region from now until 2020 (CSMO Mines, 2010).

Faced with such a level of demand, the positive cumulative effect of the Renard Project and other mining projects may be counterbalanced by a negative cumulative effect in terms of workforce availability. The recent flurry of mining activity in Quebec has in fact led a number of observers to express concerns regarding inter-regional, even international, competition in the hiring of qualified personnel. For example, at the beginning of 2011, reports emerged regarding the concerns of the Quebec Mining Association, which reckoned that the industry would require 6,000 workers within a five-year period, starting at that time (Lévesque, 2011). More recently, media reports also pointed out that the phenomenon was reaching international proportions, with the Xstrata Nickel company undertaking a campaign to recruit workers from the mining sphere in the Abitibi-Témiscamingue and Côte-Nord regions for its mining project in New Calendonia.

The projected overall cumulative effects of the Renard Project and other mining projects in the Nord-du-Québec region, as well as in the regions of Abitibi-Témiscamingue and Côte-Nord, are positive as regards job creation and economic spinoffs. In spite of a potentially problematic effect with respect to the availability of a qualified workforce, the Renard Project may be viewed from the angle of wealth creation, which will be very significant compared to other projects that have had or may have an impact on regional economic spinoffs (Table 10.8.1). From a historical perspective, it must be recognized that a project with the scope of the La Grande hydroelectric complex had notable economic spinoffs on a Quebec-wide scale, especially as regards the development of recognized expertise among both builders and consulting engineers. On a regional scale, the jobs currently linked to operations of the hydroelectric works of the La Grande complex nevertheless remain relatively limited in number compared to those generated in the mines. As for the other projects that have been inventoried, they are relatively marginal in terms of job creation and direct economic spinoffs compared to the Renard

Project and other mining projects. These projects are of limited scope in terms of direct job creation (for instance in the area of recreation and tourism), or are essentially characterized by temporary jobs linked to construction (the Eastmain-1-A-Sarcelle Hydroelectric Project or the Route 167 extension being two such examples). A synergy will nevertheless be noted among these projects, along with their concomitant regional economic spinoffs, which may prove far from negligible. This is the case, for example, as regards the close link between the implementation of the Renard Project and the extension of Route 167, with Stornoway and the government of Quebec having agreed to join forces in the construction of this main route designed to open up the region, as specified in the Plan Nord. Generally speaking, this new access will also facilitate and improve exchanges among regions, communities and families; encourage travel to new conservation parks; make other mining resources more accessible; and engender economic spinoffs that will complete the ripple effect already clearly apparent as a result of the access routes to the James Bay region built to promote hydroelectric development in the region (James Bay Road, North Road, and Trans-Taïga Road).

A synergetic effect will also be noted between the Eastmain-1-A-Sarcelle Hydroelectric Project and mining projects in the Nord-du-Québec region. As such, this project created various tools for optimizing regional economic spinoffs among Jamesians and Crees, for instance ComaxNORD and the Boumhounan Agreement. These measures are a continuation of the Impacts and Benefit Agreement (IBA) previously signed by the Crees and Inmet Mining Corporation for the Troïlus Mining Project. These agreements influenced the IBA involving Stornoway and the Crees and will no doubt influence other mining projects to come by stamping these projects with a concerted vision as regards optimizing regional economic spinoffs.

The monitoring of appropriate indicators with respect to cumulative effects upon economic spinoffs involves a number of participant-stakeholders, such as the Mining Industry Sectoral Workforce Committee (CSMO Mines) and the regional administrations of Emploi Québec for the Nord-du-Québec, Abitibi-Témiscamingue and Côte-Nord regions. This consortium has, most notably, recently mandated the James Bay Joint Action Mining Committee (TJCM) to provide an estimate of workforce needs in Quebec's mining sector for the 2010-2020 period (CSMO Mines, 2010). However, the study has also highlighted the complexity of predictions in this field by identifying the numerous factors influencing workforce needs in the mining sector. "The globalization of markets, the price of mineral substances, the mechanization of industry, new standards of quality control, the distance of projects from urban centres, the vast array of mineral operations in Quebec, extra-regional competition, and human-resource management practices are among the factors that have had very real impacts on changing needs as regards the workforce." These are all factors that may influence cumulative effects monitoring of the Renard Project and of other mining projects in terms of their impact on the regional and Quebec-wide economies.

10.8.2 Land Use by the Crees

Job creation in the Cree community linked to the Renard Project and other mining projects could have a short-term impact on the traditional lifestyle of the Crees, at least among certain community members. Cree working in Nord-du-Québec mines could, for example, end up with less time to pursue traditional activities, such as hunting, fishing and trapping. On the other hand, the income generated in such families by the mining economy could give other members of the community increased financial wherewithal to purchase the equipment and vehicles required for these practices.

New access options (Route 167, roads to the mines, energy corridors, etc.) should, for their part, foster and improve exchanges among communities, at least to a certain extent. They will also facilitate travel to new sectors where various community members can pursue traditional activities. However, this increase in traffic between Chibougamau and the mine sites could cause noise, dust and security problems which may affect the local pursuit of hunting, fishing and trapping.

When trying to assess the cumulative effects of the Renard Project, in conjunction with other past, present and future projects, it is difficult to reach an accurate appraisal as many factors extraneous to the Renard Project itself are at issue here. Moreover, in order to provide such an assessment, we must also consider realities and indicators that go beyond Stornoway's expertise and responsibilities. These indicators can only really be documented and monitored by regional Cree organizations equipped with the appropriate databanks and knowledge. A simple example of such activity monitoring may be seen in the accurate documentation by either the Cree Trappers' Association (CTA) or the Cree Hunters and Trappers Income Security Board (CHTISB) of the harvesting of fur-bearing animals. Other more general information may also be documented by the various branches of the Cree Regional Authority (CRA), more specifically its Departments of Economic-Development and Environment.

Taking into account a basic indicator, i.e. the number of traplines affected by various projects, it is, however, possible to characterize the cumulative effect of the Renard Project on land use by the Crees (see Table 10.8.1). For example, it is very clear that mining projects normally impact a very limited number of traplines (Troïlus, Matoush and Eleonore, three traplines each; Renard, one trapline). Considering the mining projects that are currently in the development or implementation phase, we estimate that approximately 20 traplines may be affected in the coming years. All of these cases involve local disruptions of hunting, fishing and/or trapping activities that may be linked to the actual footprint of the mining facilities or to certain disturbances.

These effects are very limited if compared to the impacts of the La Grande Hydroelectric Complex (approximately 40 traplines affected), the Eastmain-1-A-Sarcelle-Rupert Hydroelectric Project (36 traplines) and the James Bay access roads. These projects have had an even greater effect on land use by the Crees given that the inconveniences they cause are neither sporadic nor local, but broader in regional scope. An analysis of the cumulative effect of hydroelectric projects in the James Bay area has

shown that between 1975 and the Rupert diversion bay impoundment in 2009, a total of 13,908 km^2 of Cree traplines were submerged, representing nearly 4 % of the total trapline area in Eeyou Istchee (368,799 km^2) (Hydro-Québec, 2004). This study also highlighted the overall positive effects of access roads to the James Bay area. Leaving aside some use conflicts related to the opening of the area, these roads have facilitated travel between the Cree communities and hunting, fishing and trapping grounds.

In conclusion, it will be noted that conservation projects, such as the existing Assinaca and Albanel-Mistassini-and-Waconichi-Lakes Wildlife Reserves and the proposed Albanel-Témiscamie-Otish National Park also affect, or will affect, a large number of traplines. The overall effect of the projects is, however, positive to the extent that some traditional Cree activities have been and will be preserved in these areas and Cree people are involved in wildlife-management activities therein.

10.9 Greenhouse Gas

In the context of Stornoway's sustainable development policy and the province of Quebec's commitment to combat climate change, energy use and reducing greenhouse gas (GHG) emissions are important factors to be taken into account in the conception and operation phases of the project. Cumulative effects associated with the production of GHGs are therefore of primary concern in the expanded regional study area. The design of the project during the feasibility phase incorporated numerous measures to optimize and reduce energy consumption in each area of operation. The project includes monitoring, material, software and communications network equipment designed to oversee and manage energy consumption in the form of electricity and fossil fuels.

The main sources of GHGs from the project are likely to be activities linked to energy consumption. Two main alternatives have been thoroughly examined, i.e. the use of diesel generators and hydroelectric supply by power line. The GHG estimate for the first option includes emissions associated with the construction of the generator sets and with diesel transportation and combustion. GHG emissions for the second option involve construction of the high-voltage line, modification of the electrical substation, and power consumption on the Hydro-Québec grid. The GHG-generation estimate for the project is an average of 73,412 tons of CO_2 equivalent (eq) per year for the diesel-fired generator alternative and 1,502 tons of CO_2 equivalent (eq) per year for supply by hydroelectric power line.

As of now, the first alternative has been chosen for the Renard Project, mainly because of the high initial cost associated with the construction of a power line compared to that of the diesel-fired power plant. Energy consumption and total GHG emissions will be recorded and conveyed to the general public and government in Stornoway's annual sustainable-development report.

If other mining projects are undertaken in the project region, they could share construction costs for the line, and it may then become advantageous for the Renard Project and the other projects to connect to the Hydro-Québec grid.

10.10 Summary and Conclusion

When the project was drawn up, significant efforts were made to minimize its negative environmental and social-economic effects and to maximize its positive impacts. These measures are thoroughly detailed in the various sections pertaining to the project's impact assessment (chapters 4 to 9). Nevertheless, both positive and negative cumulative effects are anticipated if the Renard Project is implemented. Greater access to the area through roads and power lines will foster exchanges between regions and will also facilitate the undertaking of new projects and activities (mining, forestry, outfitters, recreation and tourism parks, traditional Native activities, etc.), leading to a general increase in land use and increased pressure on the environment, resources and regional services. The main anticipated cumulative effects are as follows:

- A direct increase in land use and in pressures on the natural environment (terrestrial environment, wetlands, aquatic environments, habitats, etc.) resulting from a greater number of mining projects and activities being undertaken due to better access to the area;
- Degradation, mainly limited to the actual biophysical-component sites (soil erosion, noise, air quality, water quality, GHG, etc.), primarily due to the distance between projects and activities;
- Increased pressure on local and regional resources (natural resources, drinking water supply, power supply, purchases of goods and services, workforce, housing, etc.); and
- A significant contribution to regional economic development for towns and local communities.

The overall footprint of the projects and activities will remain relatively modest given the vastness of the area concerned. The projects are, in particular, relatively compact, far from one other, and governed by a well established regulatory framework (James Bay and Northern Québec Agreement). The aforementioned effects must, nevertheless, be addressed and monitored, and mechanisms and measures will have to be put in place to identify and manage these potential cumulative effects. Figure 10.10.1 presents a summary of positive and negative effects on biophysical and socio-economic components that are likely to be impacted by cumulative effects.

		Combined Effect
Cumulative biophysical effects		
	Terrestrial, aquatic, wetland environments: mining sites and infrastructures (transportation) in relation to natural conservation areas	▼
	Energy supply: transportation infrastructures (power lines) in relation to quality of regional supply (access)	▽
	Caribou and moose habitats: total populations in relation to changes in migration patterns	▽
	GHG production: global budget (hydroelectric power in relation to the use of power generating sets)	▽
Cumulative socioeconomic effects		
	Economic spin-offs: collective wealth (employment, health, education, etc.) in relation to manpower needs and procurement	▲
	Cree land use: local nuisances and gradual changes to practice of traditional hunting, fishing and trapping activities	▽

Legend – Impact Significance Symbols

▽ Low negative	△ Low positive
▼ Moderate negative	▲ Moderate positive
▼ High negative	▲ High positive

Figure 10.10.1 Summary of anticipated cumulative environmental effects within the framework of the Renard Project

Management of cumulative effects potentially associated with the Renard Project in relation to other proposed projects or activities will require a concerted and collaborative effort by industry, local communities, and various levels of government. This process will result in a precise defining of the duties and responsibilities of each of these players. In this context, Stornoway will assume all environmental and social responsibilities directly associated with the Renard Project. On a regional scale, Stornoway is also willing to actively participate in all cooperative efforts in terms of monitoring, planning, and research, particularly by providing input related to the mining project.

Although specific measures to manage cumulative effects must be addressed and managed at regional and local levels, the following are proposals for management based on initiatives adopted within the framework of the project:

- Control of mine tailings (air and water, solid waste) : discharge limits are defined and included in regulatory requirements. Control of mine tailings should be uniform across all sectors;
- Regional monitoring : regional monitoring of key environmental and socio-economic indicators could be conducted by regulatory authorities to further develop a 'current conditions' database. This would also serve as a tool to assess change and the impacts of growth;
- Common land-use planning and zoning : effective land-use planning and zoning are essential for the management of cumulative effects and a reduction of conflicts over land use;
- Establishment of a collaborative research program with other local and regional stakeholders to assess the project's impact on fishery resources. Similar initiatives could be undertaken in other sectors;
- Consultation and stakeholder commitment : the ongoing commitment of local communities in planning changes is important in order to manage growth expectations;

- Conservation of archaeological resources : a regional approach to the management of archaeological and cultural resources could be undertaken and linked to local and regional planning efforts; and
- Regional biodiversity conservation : development must be balanced with conservation priorities. Governments at all levels could develop a regional approach to the management of protected areas by considering the land earmarked for development as an integral part of land-use strategy.

Chapter 11

Environmental and Social Management Plan

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11 Environmental and Social Management Plan

11.1 Management System

The environmental and social management plan for the Renard Project will be based on ISO 14001. This management system will track and control the project's impacts on the environment and will thereby reconcile the requirements of the proposed mine operation with the regulatory framework and standard practices generally followed in the industry. Thus, the environmental policies of Stornoway Diamonds (Canada) Inc., will guide the long-term management plan, taking into account the interrelated nature of the environmental, social, and economic dimensions of the Renard Diamond Project.

The process of implementing an Environmental Management System (EMS) in a company depends largely on the commitment of senior management to implement an environmental or a sustainable development policy consistent with its values and activities. The planning component of a management system must meet four requirements, which are:

- The identification of significant aspects and their environmental impacts;
- The identification of regulatory requirements;
- The setting of measurable goals and targets to reduce significant impacts;
- The implementation of environmental programs, including resources and a timetable.

Stornoway already has an environmental policy that will provide a foundation for the EMS. This policy specifies that the company is committed to maintaining sound environmental practices in the planning and carrying out of all its activities.

To achieve this, Stornoway, with its employees and contractors, will:

- Examine the potential impact to the environment of all proposed activities and take steps to minimize or where possible, eliminate the impact;
- Ensure that all activities are in Compliance with all environmental legislation and regulations;
- On a continuous basis, determine our impact to the environment and through continuous improvement, strive to attain higher levels of environmentally conscious performance;
- Maintain a high level of environmental protection by applying practices and technologies that minimize impacts and enhance environmental quality;
- Maintain dialogue with the communities and other stakeholders with the area of influence of its exploration programs;
- Progressively rehabilitate disturbed areas, develop closure plans that can be continuously improved and incorporate new technologies where practica;
- Train all employees and contractors to understand their environmental responsibility related to its Mineral Exploration Properties.

The policy also specifies that the company will draw from the e3 electronic manual to develop its environmental and social strategies at the corporate level.

The Renard Project includes the design, construction, commissioning, operation, and closure of facilities. As early as the design phase, the project implemented measures to minimize its environmental and social impacts. Through consultations with the Cree Nation of Mistissini, the Grand Council of the

Crees (Eeyou Istchee) and the Mistissini Band Council, which took place in the early 2000s before and during the environmental baseline study and at the beginning of the impact assessment (Environmental Exchange Group meetings), the project leaders took into account the comments and concerns of the community in the project design. The project also drew on the best national and international practices to mitigate project impacts and to enhance post-closure impacts. The manpower required for construction will represent a positive effect on the socio-economic context of the James Bay territory and Abitibi-Temiscamingue region, with nearly 400 jobs in equivalent person-years. In the roughly three years of the construction phase, the initial investment of $801.8 million should generate other economic spinoffs of about $733 million. The Renard Project will likely increase employment or business incomes for M11 trapline users, while encouraging, depending on availability and interest, land use and the practice of traditional activities. The mining operations of the Renard Project should generate a total of 432 direct jobs dedicated to mining and ancillary facilities. In addition to these direct jobs, the project will contribute to maintain jobs with suppliers and traders, whose activities will increase due to the maintained or additional revenues of the direct and indirect workers. The annual economic spinoffs that will be created by the operation expenses of the Renard mine are estimated at $110.8 million. In addition to these benefits, government and public revenues are added, including income tax, the consumption taxes, taxes on business profits, payments to the Crees under the *Paix des Braves*, the mining company taxes paid to the governments of Quebec and Canada, and mining royalties. The economic impact of the project during the operation phase is considered a high and positive impact.

11.1.1 Environmental Management System (EMS)

The ISO 14001 international standard, on which the management plan is based, prescribes the requirements for an environmental management system that enables an organization to formulate policies and objectives, while taking into account the legislative requirements and the information on significant environmental impacts. It applies to environmental aspects that the company can control and have an influence on.

The implementation of an environmental management system will help monitor and validate the environmental impacts that have been assessed as part of the impact assessment. Moreover, its application will ensure the control of impacts in accordance with the applicable regulatory framework and the best practices. Finally, the impact monitoring will allow for continuous improvement of practices that will result in a substantial reduction of environmental impacts.

As indicated in Figure 11.1.1, the implementation of the EMS is based on a model of a continuous improvement cycle, based on the principle of quality management as outlined by the Deming wheel (*Plan, Do, Check, Act - PDCA*). The steps involve continuous planning (*Plan*), implementation (*Do*), monitoring and evaluating (*Check*) and action (*Act*) to improve the performance of the EMS.

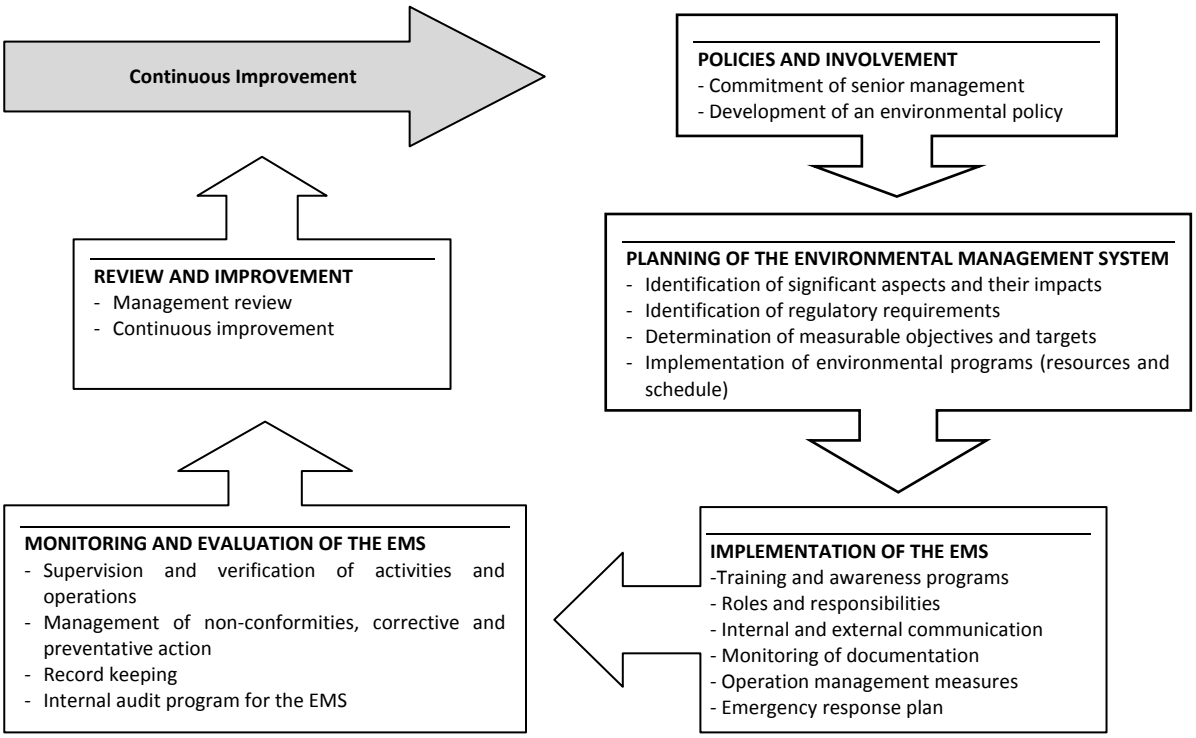


Figure 11.1.1 Steps for an Environmental Management System according to ISO 14001 Standards

The implementation of the EMS requires the introduction of several elements:

- An integrated program for training and awareness;
- An organizational structure that clarifies roles and responsibilities in environmental matters;
- A list of procedures for internal and external communication;
- A control centre for environmental documentation;
- Measures for managing operations;
- An environmental emergency response plan (see Section 12.5).

Monitoring and assessment of the management system are governed by four requirements:

- Monitoring and measuring activities and operations (see Section 11.4);
- The establishment of responsibilities in regard to the management of non-conformities, and corrective and preventive actions;
- The keeping of records;
- The implementation of an EMS internal audit program.

Management reviews will be conducted to support continuous improvement in all areas of the environmental management. The management team will review, but not limited to:

- The environmental policy and the commitments relevant to this policy;
- The performance with respect to environmental objectives;
- The conclusions and action plans resulting from audits or periodic self-assessments;
- The applicability of the management system in relation to the following:

- Changing regulatory requirements, international and other trends, the expectations of interested parties and stakeholders involved in the project, processes and procedures, market pressures, administrative structures and organization;
- The adequacy of resources devoted to achieving the objectives and goals;
- The technologies under development;
- The recommendations and corrective action plans developed from the investigation of accidents and incidents;
- The requirements in regards to reporting and communication.

The environmental and legal aspects, as well as the processes, objectives, targets, and roles and responsibilities found in the Environmental Management Manual will be reviewed and modified if needed to incorporate the necessary improvements after conducting compliance audits.

After the mine has started its operations, and following a period sufficient for the evaluation of the effectiveness of the EMS, the company will seek ISO 14001 certification for the Renard Project.

11.1.2 Performance Objectives of the Environmental Management System (EMS)

The scope of the performance objectives related to the implementation of the EMS will guide the actions and measures that the company will put into practice to minimize its social and environmental impacts and to maximize its performance. The setting of specific, measurable, accessible, and stimulating objectives will contribute to the promotion of healthy and sustainable social and environmental actions in relation to the project and will also lead to positive economic, social, and environmental results.

These general objectives are to:

- Identify and assess the social and environmental impacts, both positive and negative, in the project's area of influence;
- Avoid or minimize, mitigate or compensate the negative impacts on workers, the affected communities, and the environment;
- Make sure that affected communities are appropriately engaged in resolving issues that may affect them;
- Promote a better social and environmental performance of companies, through the effective use of management systems.

The environmental management system will be evaluated regularly to ensure that:

- The systems work;
- Employees and subcontractors comply with all requirements of the EMS;
- All aspects and significant risks also have adapted protective devices;
- Effective control technologies are implemented;
- An approach based on feedback is adopted to enable continuous improvement in environmental performance.

The results for the performance of the EMS will be regularly communicated to employees, the management team, the suppliers, and stakeholders of the local community. This disclosure will allow these diverse groups of individuals to measure their environmental and social impacts while making the link between their actions and the performance of the organization in regard to these issues.

11.2 Environmental Management

The Renard Project social and environmental management program will prioritize the use of the best available and economically applicable technology, in addition to the continuous improvement in environmental performance. Specific management plans will be developed to minimize the significant residual impacts identified in the Environmental and Social Impact Assessment (ESIA), and to meet the corporate as well as the regulatory requirements.

11.2.1 Environmental and Social Management Plan

The environmental and social management plan will affect all the phases of the project, from construction to closure and rehabilitation. This plan is divided into three distinct phases.

- *PHASE 1: PLANNING*

Environmental and social analysis

The environmental assessment conducted as part of the impact study has established a list of the key environmental and social issues associated with the project, the legal and regulatory requirements applicable to the project, the best environmental practices in the field and the emergencies and accidents that occurred in other similar contexts. This analysis forms the basis of documentation for the EMS.

Writing of the environmental policy

In addition to Stornoway's corporate environmental policy, the project will develop a project-specific environmental policy that will outline the commitments of the highest levels of management and that will be the foundation for the environmental objectives and targets to be set for the project. This policy will be consistent with the environmental analysis; it will cover all aspects identified and will be completed before work begins.

Objectives, targets and program(s)

As mentioned in Section 11.1.2, objectives and performance targets will be set in relation to the various environmental impacts identified during the environmental assessment. These objectives will be developed based on the technologies used, the processed material and processes used on the project site. For each objective, a program will be established to identify the approaches that will be used to achieve these goals. It should be noted that the objectives, targets, and programs will vary according to the project phases (construction, operation, closure, post-closure) as the environmental aspects will change at each step. In order to record the impacts of the Renard Project in a perspective of long term cumulative regional effects, Stornoway will set aside adequate funding for conducting post-closure monitoring of employment conditions. The sum required for such monitoring will be identified in consultation with the Renard Committee and will be part of a fund similar to the financial guarantees for

site restoration at the mine closure. Topics that could be analyzed by this post-closure monitoring include the following: hiring procedures, training programs, advancement opportunities, working conditions, strengths and weaknesses in terms of employment and employability after closure.

- *PHASE 2: IMPLEMENTATION*

Definition of roles and responsibilities of resource people

For the environmental management system to be truly effective, it is important that each person assigned to the project (managers, employees, contractors, suppliers, etc.) be aware of his responsibilities regarding the environment. As environmental management is an all-encompassing notion, it is imperative that everyone has a role to play at this level. Table 11.2.1 presents a non-exhaustive list of various resource people that will be involved in the project. For each of them, one or more roles are identified.

Environmental Management Manual

To facilitate the transfer of knowledge and the dissemination of the management system, an Environmental Management Manual will be produced. This manual will incorporate all the elements mentioned above (an environmental policy, objectives, targets, programs, roles and responsibilities, environmental issues, legal requirements and other regulations, an anticipated risk register, and an emergency response plan), the procedures for storage and update of environmental data, and the procedures for staff training.

Training

For each phase of the project (construction, operation, closure), a training session will be offered to all employees in order to familiarize them with the EMS. Individual coaching sessions will also be held with those responsible for the EMS to guide them in the achievement of their tasks. Each new employee will also be trained throughout the operation of facilities.

Table 11.2.1 General Environmental Roles and Responsibilities of Human Resources and Project Stakeholders

Human Resources and Stakeholders	Environmental Roles and Responsibilities
Site Director	• Promoting the best environmental practices to all employees; • Promoting an environment conducive to sound environmental management; • Monitor global environmental actions; • Being accountable for overall results.
Department Manager (Supervisors)	• Promoting the best environmental practices related to the department; • Participating in the implementation of any new measures to minimize the environmental impact of the department; • Being a communication link between employees and the environmental manager; • Being accountable for results within the department.
Professionals	• Being responsible for identifying issues specific to their field of expertise; • Respecting the environment in the practices related to the profession.
Workers and employees (including those mentioned above)	• Ensuring that their work respects the parameters set by the EMS and the environmental policy; • Monitoring processes around the workstation and making suggestions to improve practices and to reduce the negative environmental impacts.
Environmental Protection Supervisor	• Ensuring the achievement of objectives set by the EMS; • Providing training for all employees regarding the environmental imperatives of the facilities; • Centralizing all environmental information and classifying it intelligibly; • Updating the environmental procedures annually; • Ensuring an annual review of objectives and targets of the EMS; • Coordinating the implementation of any new measure to reduce the environmental impacts of the project; • Being responsible for achieving targets and objectives.
Contractors and Suppliers	• Contributing to the achievement of objectives by providing products and services that reflect these goals.
Land users	• Participating in information sessions and consultations; • Informing the company of any environmental issues arising from the operation of facilities.

Compliance audits

Every year, management will conduct an internal compliance audit for the mine site EMS in order to ensure that the environmental procedures are followed and that the targets are achieved according to the objectives. A compliance report will be presented to management to indicate the levels of compliance and areas for improvement, wherever necessary.

Management review

Annually, management will also review the objectives in order to continually improve them. At this stage, environmental and legal aspects, as well as the processes, objectives, targets, roles, and responsibilities contained in the Environmental Management Manual will be reviewed and modified if necessary to incorporate the necessary improvements following the compliance audits.

11.2.2 Development of Environmental and Social Management Plans

Measures will be implemented to prevent or mitigate impacts on the environment that may occur during the construction, operation, closure, and post closure phases of the project. EMPs will be developed for each relevant component of the project in order to control various aspects of environmental performance on the site. Each plan will be developed according to the specific context of the regulatory requirements, the authorizations, the Environmental Design Criteria (EDC) and the project guidelines. Management measures specific to each project component will be developed to avoid, minimize and/or mitigate potential negative impacts on the environment. Environmental controls will be specifically developed for each project component to control emissions. Details are presented and described in the following sections.

Each EMP will have the same structure so that a coherent environmental performance management can be conducted.

Each plan will contain the following elements:

- The policy requirements and environmental regulations, including a summary of the permits required during the different phases of the project, the relevant elements of governmental authorizations, and the operating objectives derived from the EDC of the project;
- General measures for prevention and impact management, including general environmental controls to prevent and manage environmental impacts, in addition to the general mitigation measures identified in the sections on impact assessment of the ESIA;
- The roles and responsibilities of the management team, the employees and the subcontractors in connection with the implementation and maintenance of a specific plan;
- The verification, control, and monitoring reports in regard to the regulatory requirements, authorizations and EDC, and guidelines of the project;
- The development, implementation, and evaluation process in terms of corrective actions implemented to address problems found during verification and control activities and during observations.

Specific plans will be developed for the following management activities:

- Air emission management;
- Noise and vibration management;
- Water, sediment and sludge management;
- Pollution prevention;
- Solid waste and hazardous material management;
- Management of social concerns.

11.2.2.1 Air Emissions and Air Quality Management

The management plan for air emissions and air quality will focus on ensuring that the equipment used in the construction, operation, and closure of the mine has an environmental performance that meets the regulatory requirements and air quality objectives established by the project.

This management plan will include an equipment maintenance program to reduce the emissions of rolling material, a program to minimize fugitive emissions, a program of preventive maintenance of the production equipment, and a sampling program of equipment that releases emissions into the atmosphere to ensure compliance with the standards that appear in the *Clean Air Regulation*.

11.2.2.2 Noise and Vibrations Management

Noise levels at the mine site will be actively managed by a monitoring program conducted on a quarterly basis for the first year of operation. Thereafter, monitoring may be done on an annual basis. Monitoring will specifically concern the accomodation and services complex where workers will live.

These measures will help to validate the mitigation measures implemented and to make corrections if necessary. The acoustic monitoring will also identify the noise sources responsible for noise levels that may increase disturbances. This identification will help to properly manage both the fixed and mobile equipment involved, and to make adjustments to these sources if required. It will also allow to assess whether aging equipment could be responsible for various sources of noise increase.

11.2.2.3 Water, Sediment, and Sludge Management

The plan will address risk management and problems identified in the impact assessment sections of the ESIA. It will prioritize the implementation of mitigation measures for the different phases of the project, in compliance with the applicable standards.

The water management plan will mainly include:

- The establishment of a system of diversion of uncontaminated runoff;
- The establishment of a system to collect and treat potentially contaminated water;
- The implementation of erosion control measures, so as to prevent the generation of suspended solids at the source;
- The implementation of measures to accelerate the flooding of pits in the closure phase and the return as much as possible to the hydrological baseline conditions.

The sediment and sludge management plan will focus on the disposal of sediment from the two lakes that will be drained at the beginning of the construction phase, and of sludge from the sedimentation ponds and the domestic wastewater treatment plant.

The water, sediment, and sludge management plans will involve all departments and will be implemented in all phases of the project.

11.2.2.4 Pollution Prevention

The plan will address the pollution prevention management measures required so as to comply with the project EDC, the authorizations and regulatory requirements in regard to air emissions, air quality, effluent quality, surface water and groundwater quality, soil quality, and ambient noise levels.

The plan will also address issues related to the handling and storage of petroleum and chemical products, as well as the prevention and response measures to spills and the transport of hazardous materials. It will involve all departments and will be implemented during all phases of the project.

Appropriate and reliable emission control equipment will be selected and used in the project. The control instrumentation will be subject to a preventive maintenance program and regular calibration. Environmental performance will be evaluated using environmental surveillance plans.

11.2.2.5 Solid waste and Hazardous Material Management

- *SOLID WASTE MANAGEMENT*

The management of solid waste on the Renard Project site will be based on three complementary management approaches around which additional management practices and corporate policies will be structured. These three elements are:

- Source separation;
- The 4R-D, which means prioritizing reducing, reusing, recycling, and recovery of solid waste;
- Monitoring of volume.

A fourth element, which is more general, will also be implemented. It consists of training employees in regard to waste management so as to maximize results. This section establishes guidelines that direct the management of solid waste throughout the life cycle of facilities. However, it is important to note that management plans will be developed for each individual project phase (construction, operation, closure).

The element with the greatest importance in the solid waste management of the project is the source separation. This approach will allow solid waste to be separated as soon as they are produced, and will also allow materials that have a potential value to be reused and recovered. At each location where solid waste will be produced, garbage containers to separate the various materials will be installed. To this end, it will also be important to make employees responsible and to introduce them to the different categories of solid waste that will be managed in the project so that they are able to assess their work

environment and add the bins and garbage containers needed to improve the diversion rate of materials.

Afterwards, the solid waste management plan will promote practices based on the 4R-D, meaning, if possible, reducing, reusing, recycling, and the recovery of solid waste. By minimizing disposal, the environmental footprint of the facilities provided for this purpose is decreased, and the life cycle is extended. This is particularly true for trench landfill site. The recovery of solid waste can also generate income to reduce the costs associated with solid waste management. In addition, all employees will be involved and each will be asked to provide proposals and ideas for reducing, reusing, recycling, and recovery of solid waste generated. These ideas will be studied and the most promising will be implemented. The company will periodically review the various collected materials and will identify materials that are most commonly disposed of to improve management practices and to update the application of the 4R-D philosophy in the particular context of the Renard Project site.

Finally, the management of solid waste on the site will involve close monitoring of the quantities that are produced, recovered for their value, or disposed of. A particular log will be used to conduct this monitoring, which will observe the evolution of solid waste management and identify the strengths and areas for improvement. The main indicators to be monitored are:

- Total quantity of generated solid waste;
- Rate of diversion;
- Quantities for each sector of management;
- Total quantity of buried materials.

For each of these indicators, targets will be set according to the objectives of the company. These targets will also serve as a challenge and a motivation for each employee, who will be notified and who will be able to follow these indicators that will be posted and regularly updated in the main buildings. This will encourage individuals to do their part and to consciously contribute to measures of solid waste management.

➢ *MANAGEMENT OF HAZARDOUS MATERIALS*

The management of hazardous materials on the Renard Project site will be performed first and foremost in a spirit of diligence and in compliance with applicable regulations (among others: *Regulation respecting hazardous materials*, *Regulation respecting halocarbons*, *Transportation of Dangerous Substances Regulation*, *Regulation under the Act respecting explosives*). In addition, three management principles will be applied to minimize any problems associated with these materials that present significant risks to the environment if not managed properly. These three elements that will be given special attention are: minimizing the transfer of hazardous materials, reducing the use of hazardous materials at the source, and keeping close track of hazardous materials.

The first management principle that will be applied is the minimization of transfers. This means that the acquisition and internal distribution of products identified as hazardous materials will be done so that the original containers can easily be moved without the use of an intermediate container. It also means that when transfers are necessary, the equipment adapted to the product and the transferring operation will be used to avoid spillage. For example, in the garage where motorized equipment will be maintained, a system for recovering waste oil will be put in place to limit handling. Furthermore, the use of equipment that does not require being filled by hazardous materials will be preferred. For example, the batteries used will be disposable and they will be returned to the south to be recycled when they are no longer of use, instead of filling them with acid and exposing workers to these substances.

The second principle is the source reduction of hazardous materials. Without endangering the various pieces of equipment used to carry out routine operations on the site, we will seek at all times to limit the amount of hazardous materials acquired and used. This will be achieved by choosing more efficient equipment in this area, by modifying established protocols or by rationalizing the use of equipment. Replacement of certain hazardous materials by non-hazardous materials, or safer materials, will also be considered in some cases to reduce environmental risks and impacts on human health. However, a profitability and overall environmental performance analysis must be performed first before changing any process or purchasing any equipment.

The third management principle that will be applied will consist of closely monitoring the inputs and outputs of hazardous materials and hazardous waste. The close monitoring of materials includes the documentation and use of records to note and keep track of the location and quantity of hazardous materials stored on site. This principle also takes into account the Workplace Hazardous Materials Information System (WHMIS), which will be used and applied to effectively communicate all information on hazardous materials to be used as part of the Renard Project operations. This information will actively contribute to the monitoring process. In addition, the monitoring of hazardous materials will comply with the *Transportation of Dangerous Substances Regulation*, and activities arising from such compliance will also provide significant information for the integrated monitoring of hazardous materials.

Finally, the informing and training of employees will be an integral part of the management of hazardous materials and hazardous waste. The latter should be aware of the dangers and risks arising from the management of these materials, both for human health and the environment. Full transparency at this level will encourage active participation on the part of employees in regard to the three management principles listed above.

11.2.2.6 Management of Social Concerns

A social action plan will be developed to address and resolve issues linked to the significant residual impacts identified in the Environmental and Social Impact Assessment (ESIA).

In addition to the social concerns management plan, additional plans will be designed according to needs, and taking into account the public consultation process and emerging concerns. The main components of these plans will touch on the following:

- Mechanisms for information and communication;
- Mechanisms for conflict resolution;
- Establishment of a monitoring committee under the IBA.

11.3 Environmental Monitoring in the Construction Phase

As part of this impact assessment and the environmental obligations there under, the project will implement various mitigation measures, thereby minimizing the significance of environmental impacts during construction activities. The application of these measures will be validated through environmental monitoring and surveillance programs.

These programs specify the means and mechanisms proposed to ensure compliance with the legal and environmental requirements, as well as environmental objectives of the project. The monitoring program ensures the verification of the work progress and the proper functioning of the equipment and facilities in place, as well as the monitoring of any environmental disruption caused by the execution or operation of the project. In addition, its aim is to respect the laws, regulations, and other environmental considerations developed in the plans and specifications. Indeed, Article 22 of the *Environment Quality Act* (EQA) states that authorizations and permits will be issued based on these plans and specifications.

11.3.1 Pre-Construction Phase

➢ *SPECIFIC OBJECTIVES*

- Verify that all authorizations, leases, and permits necessary for the project are in place before starting construction activities;
- Ensure that all participants on site (contractors, construction manager, construction supervisors, foremen, and others) are aware of environmental concerns and environmental protection measures;
- Establish the roles and responsibilities of all participants according to a hierarchical system to ensure that any unplanned situation or non-conformity is taken care of, meaning that the appropriate preventative and corrective measures can be performed at any time;
- Establish the measures they will implement to protect the environment according to their respective activities.

➢ *PROGRAM OVERVIEW*

The environmental monitoring program is an activity that is part of the construction process, and procedures must be documented in the same way as all other construction activities. The first step is to create an inspection team experienced in this type of project, in order to adequately monitor the execution of the work.

11.3.2 Construction Phase

➢ *SPECIFIC OBJECTIVES*

- Ensure that all provisions regarding the environment specified in the plans and specifications are met;
- Ensure that the conditions and requirements of permits and authorizations are met;
- Validate the implementation of mitigation measures in the environmental impact assessment.

➢ *PROGRAM OVERVIEW*

During the construction phase, surveillance will be conducted daily by the inspection team to ensure compliance with the provisions regarding the environment. This includes staff training, regular inspection of the site, monitoring of documentation, reporting, and compliance with communication channels. Site supervision involves direct communication between managers and all staff in order to efficiently and immediately resolve situations that are deemed non-compliant. This organization of environmental monitoring of the project will establish a process that documents and monitors construction activities, construction observations, decisions made about situations of non-compliance, the corrective actions taken and the outcomes of these actions and finally, the preventive measures that are in place to ensure that non-conformities do not recur. In addition, during the construction phase, the inspection team may also identify improvements that could be made to the mitigation measures while meeting the requirements, specifications, and the environmental goals and objectives established in the impact assessment.

11.4 Environmental Monitoring Plans

The overall objective of the environmental monitoring plan is to measure, observe, and document any environmental changes (natural or related to the project) in relation to the baseline conditions. It is also to verify the accuracy of the environmental assessment and to evaluate the effectiveness of the mitigation measures.

In this sense, *Guideline 019* of the MDDEP specifies the nature of certain types of monitoring that must be performed during the operation phase (quality and flow of effluent, quality and level of groundwater, noise levels, air emissions), as well as after closure (quality of surface and groundwater, quality and flow of effluent, monitoring of revegetation).

Although the Renard mine is not a metal mine, it intends to draw upon the Metal Mining Environmental Effects Monitoring Program developed by Environment Canada. This program includes the monitoring of fish and their habitats, of benthic invertebrates, and of the quality and flow of effluent, as well as the quality of water and sediment.

In summary, the Renard Project monitoring program includes monitoring of climate, air quality and air emissions, noise levels, liquid effluents, hydrology and sediment transport, the quality of surface water

and sediment, the quality and levels of groundwater, and the monitoring of benthos, fish, as well as big game.

11.4.1 Physical Environment

11.4.1.1 Meteorology and Climate Monitoring Program

- *WEATHER STATION AT THE MINE SITE*

Two weather stations will be required on the project site. A first station will be for environmental monitoring purposes and a second at the site of the airstrip for environmental needs and those related to air navigation.

The station installed at the mine site will be mounted on a 10-metre tower and will operate using solar power and batteries. Once the electrical distribution system is in place, the station will be supplied via the mine camp network. This station will also measure hydro-meteorological parameters in order to save the settings used for calculating and recording the lake evaporation rate and to support the implementation of the water management plan.

The recording of parameters will be accomplished using an hourly frequency. The recorded data will be collected on a regular basis. The parameters measured by the station are:

- Wind speed at 10 metres above ground;
- Wind direction at 10 metres above ground;
- Air temperature at two metres above ground;
- Relative humidity at two metres above ground;
- Solar radiation at two metres above ground;
- Water temperature at one metre and two metres below the surface of the water;
- Net radiation at the surface of the water;
- Precipitation at two metres above ground.

The data for evaporation, seepage loss, the outflow rate from the lake, and the use of water by the process will be used to calculate water loss. Water input from rainfall, discharges of treated wastewaters and runoffs will be calculated to determine the overall water budget, which will be verified with the elevation level of the lake. Measuring the level of the lake implies that the water level measuring stations installed as part of the environmental baseline study of the project will be kept in operation.

An annual report will present the annual average measured as well as extreme events. The information gathered will also be shared with local stakeholders and government.

- *AIRSTRIP WEATHER STATION*

The station installed at the airport will be mounted on a 10-metre tower and may be connected to the airport's electrical system, which will be powered by power generating sets, and will be equipped with a battery backup power supply.

The recording of parameters will be accomplished using an hourly frequency. The recorded data will be collected on a regular basis. The parameters measured by the station are:

- Wind speed at 10 metres above ground;
- Wind direction at 10 metres above ground;
- Air temperature at two metres above ground;
- Relative humidity at two metres above ground;
- Solar radiation at two metres above ground;
- Sensors for detecting cloud height;
- Sensors for detecting the current weather (fog, mist, haze, and precipitation type);
- Measurement of visibility by scattered radiation;
- Precipitation at two metres above ground.

➢ *QUALITY ASSURANCE*

The data measured will be downloaded twice a week and will be reviewed by an air-quality professional to see if anomalous data are present, which could indicate a problem with the system.

Equipment will be checked once a week to ensure that the instruments close at hand are free from debris, frost, or are damaged, which could prevent the recording of accurate measurements.

11.4.1.2 Program for Monitoring Air Quality and Air Emissions

The monitoring program for air quality and air emissions is aimed at achieving the following objectives:

- Demonstrate compliance with ambient air quality standards and the environmental objectives of the project;
- Demonstrate compliance with the emission standards of different emission sources from the mine;
- Identify trends in terms of air quality and air emissions from the project;
- Provide information to managers of the project's environmental management system;
- Check the accuracy of predictions made by modelling the dispersion of contaminants;
- Prepare response plans to deal with increases in concentrations of contaminants in the air, with exceedances of expected emission rates, and with exceedances of ambient air quality standards;
- Gather information that can supply data to the database concerning the cumulative effects of projects in the region;
- Identify strategies for monitoring and tracking emissions;
- Document the use of fuel in connection with the management of air quality;
- Facilitate the collection of information needed to develop an approach to reducing emissions, which includes the fugitive dust control program.

To achieve these objectives, the air quality management program focuses on five components:

- Meteorological measurements on site (see Section 11.4.1.1);
- Hydro-meteorological measurements on site (see Section 11.4.1.2);
- Measurement of concentrations of total suspended solids, PM_{10} and $PM_{2.5}$;
- Measurement of dustfall;
- Measurement of concentrations of SO_2 and NO_2.

➢ *METHODOLOGY AND APPROACH*

The program must be flexible enough to reflect the evolution of the project, but should maintain consistency in sampling locations in order to monitor trends in terms of air quality.

In regard to the sampling of ambient air, monitoring will be conducted using a combination of stations installed at the mine site and off-site stations. The off-site stations will serve to demonstrate whether the activities of the mine meet the criteria for ambient air. The off-site availability of electricity limits the number of stations that can be established. For this reason, on-site stations will also be set up. One of these stations will be installed near the accommodation complex for workers, which is the nearest inhabited site to the mine facilities.

The monitoring program will cover the three phases of the project: construction, operation, and closure.

➢ *MEASURING EQUIPMENT*

Concentrations of airborne particles

Particulate emissions will come from wind erosion and from movement of light vehicles, heavy trucks and equipment (rolling material such as loaders, drills, graders, bulldozers, etc.). They will also come from the ore processing plant, activities related to the airstrip, construction activities, and the combustion of diesel for power generating sets and rolling material.

Quality standards of ambient air in force in Quebec for particulate matter apply to two categories of particles:

- Total Particulate Matter (less than 100 µm);
- Particles smaller than 2.5 microns ($PM_{2.5}$).

Dustfall

The main sources of dustfall from the project are wind erosion, ore crushing, transportation of processed kimberlite, and the movement of vehicles and equipment. Although emissions of dustfall are no longer regulated in Quebec, they should be measured to ensure that the project's impact on the surrounding environment is quantified and that measures are in place in case of an abnormal increase in dustfall.

Dustfall is measured using deposit gauges. The exposure time is 30 days. Due to the harsh climate that exists at the mine site, sample collection may be more difficult in winter. In these circumstances, it is often preferable to add 50% antifreeze to the water in the gauges in order to prevent freezing. Gauges should at least be installed near the processed kimberlite confinement area, and a control station should be installed off-site.

The pattern of results at the dustfall measuring points will be analyzed and corrective actions taken, if necessary.

Passive samplers for SO_2 and NO_2

Passive samplers for SO_2 and NO_2 are devices that allow the measurement of concentrations in the order of parts per billion (ppb). These samplers do not require electricity, and are well adapted to the harsh climate of the study area. Samplers must be protected from sun and rain. Their use will validate if the emissions of these contaminants meet the standards for the average annual concentrations contained in the *Clean Air Regulation*.

It has been proposed to install passive samplers in the same places as the dustfall gauges and to collect samples following the same schedule as for dustfall for some parameters, and bi-annually for others.

- *LOCATION OF STATIONS*

During the construction phase, the sampling stations should first be installed near areas where construction activities will take place in order to ensure compliance with quality standards for ambient air. A control station will be located off-site to ensure that quality standards for ambient air are met. This control station will be operational during all phases of the project.

In the operation phase, the stations can then be moved to locations where ambient air concentrations will have been estimated highest by model calculations for the dispersion of contaminants. Stations will also be placed near the emulsion explosives plant (if applicable), near the workers' camp, and on the site, near the entrance to the mine. The off-site station will sample total particulate matter, $PM_{2.5}$, and dustfall. It will use passive samplers for nitrogen oxides (NO_x) and sulphur dioxide (SO_2). Stations at the workers' accommodation complex and near the entrance to the mine will sample total particulate matter, $PM_{2.5}$, nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) on an hourly basis. Equipment should be chosen such that interventions in the field will be minimized.

The sampling schedule for total particles should be modelled on the National Air Pollution Surveillance Programme (NAPS). The equipment should be protected from the cold to avoid damage due to the particularly severe climatic conditions that prevail on the site.

A trend analysis will be conducted and will be subject to an annual report, which, if necessary, could propose measures to improve procedures for the management of particulate matter.

A sampling schedule should be maintained to record the occurrence of extreme weather or forest fires that could lead to unusually high emissions of dust.

➢ *QUALITY ASSURANCE PROGRAM*

A quality assurance program should be established to ensure the reliability of measurements of concentrations in ambient air. This program will affect the measurements made for the following contaminants:

Particles and fine particles

- Samples that have not been exposed to the atmosphere (blank) will be analyzed along with other samples;
- The samplers will be calibrated once a year;
- The samples, filters, and solutions will be prepared by an accredited laboratory;
- Sample collection will be made following a protocol defined in advance by an air quality specialist;
- Results will be interpreted by an air quality specialist.

Dustfall

- Samples that have not been exposed to the atmosphere (blank) will be analyzed along with other samples;
- The samples, filters and solutions will be prepared by an accredited laboratory;
- Sample collection will be made following a protocol defined in advance by an air quality specialist;
- Results will be interpreted by an air quality specialist.

➢ *EMISSIONS MONITORING PROGRAM*

The emissions monitoring program (EMP) will be used to calculate emissions from the project and to compare them with estimates used to form the basis for modelling the dispersion of contaminants in the atmosphere.

The emissions monitoring program focuses on three elements:

- Emission estimation;
- Summary of fuel use;
- Control strategies and emission reduction, including the control program of fugitive dust.

Emission estimation

The objectives of the calculation of quantities of contaminants emitted are to:

- Demonstrate the commitment of Stornoway to monitor and control its emissions;
- Develop an appropriate methodology for calculating emissions from the project;
- Show that project emissions do not exceed those modelled in the impact assessment;
- Demonstrate the commitment of Stornoway to minimize emissions.

Types of emissions subject to estimation

1. Combustion

   Combustion sources are:

   - The power units (power generating sets);
   - The heating of the underground mine;
   - The fleet of vehicles used in the underground mine;
   - The fleet of vehicles used on the surface.

2. Fugitive emissions

   Fugitive emissions from the project may come from human or natural sources. Among the sources generated by humans are:

   - Crushing of the ore;
   - Handling materials;
   - Operating the fleet of vehicles, including the raising of dust;
   - Removing the layer of overburden;
   - Taking off and landing of airplanes.

   Wind erosion is a natural source of emissions that may occur from the processed kimberlite confinement area, from the operation areas, and from unpaved roads.

Methods for estimating emissions

The approach for estimating emissions varies according to contaminants.

Sulphur dioxide (SO_2)

For SO_2, the mass balance method is used. Indeed, the production of SO_2 results from the combustion of sulphur in fuel. By knowing the sulphur content of fuel, it is possible to calculate the amount of SO_2 emitted. To estimate the total emissions, it will therefore be necessary to have a certificate of analysis of the sulphur content for each fuel delivery. Fugitive emissions of SO_2 should be negligible. The sources of SO_2 are the heavy and light vehicles, equipment, and power generating sets.

Nitrogen oxides (NO_x)

Emissions of nitrogen oxides (NO_x) come from burning fuel. They can be estimated by using emission factors according to the type of equipment involved (power generating sets, heavy vehicles, light vehicles, other equipment).

No source should produce NO_x fugitive emissions.

Particulates

Particulate emissions from the sources of the project are:

- Power generating sets;
- Particulate emissions from combustion of fuel in light vehicles, heavy vehicles, and equipment;
- Fugitive emissions related to movement of light vehicles, heavy vehicles, and equipment;

- Fugitive emissions due to wind erosion.

Greenhouse gases

The greenhouse gas (GHG) emissions result from the combustion of fuels (gasoline, diesel, kerosene, and propane), the decomposition of organic matter, and the release of halocarbons. In the case of the Renard Project, the emissions to be considered are those that will be emitted during the combustion of fuel in the power generating sets and vehicles, and other motorized equipment. In addition, an estimate can be made of the quantities of GHG annually produced from the trench landfill site and from fugitive emissions of halocarbons.

For fuel combustion, emissions can be estimated from a model combining the total fuel consumed and the percentage use of various pieces of equipment. Since fixed equipment generates less greenhouse gas than mobile equipment, it is important to take this factor into account in the total estimate.

For the trench landfill site, a characterization of materials for disposal will quantify the proportion of buried organic matter, thereby estimating with a simple conversion factor the amount of methane generated through the anaerobic decomposition of these materials.

As for halocarbons, an assessment of the quantities consumed and eliminated will estimate the quantities of these substances leaking into the atmosphere to contribute to the greenhouse effect.

Finally, the majority of the data is already compiled in the framework of environmental monitoring or the monitoring of operations. It will suffice to centralize this data and maintain records of emissions from the project since it will be subject to mandatory reporting, given the volume of CO_2 eq estimated (> 50,000 tonnes).

11.4.1.3 Acoustic Monitoring

➢ *MONITORING PROGRAM*

Acoustic monitoring will be conducted during the operation phase of the project. This monitoring can be done at the limit of the accommodation and services complex area.

Before the construction phase, a baseline condition of the ambient noise level will be established to provide a basis for the monitoring program during the operation phase. Despite the lack of permanent housing, the short duration of the construction phase, and the localized nature of noise sources, acoustic monitoring during construction will nonetheless be carried out.

The sampling period will be quarterly during the first year of operation. These measures will help to validate the mitigation measures put in place and to make corrections if necessary. Thereafter, monitoring may be done on an annual basis.

Measuring noise levels will consist of readings taken continuously over 24 hours. These readings will establish the daily progression of noise on an hourly basis, the acoustic measures for each hour, and

noise levels over a total period of 24 hours, as well as the graphical display of the evolution of noise over a day.

- *ASSURANCE AND QUALITY CONTROL*

Standards and measurement methodology will be consistent with the procedure described in the MDDEP's *Note d'instruction 98-01*.

11.4.1.4 Liquid Effluents

The project includes two discharge points into Lake Lagopede: the effluent of the mine wastewater treatment plant and the effluent of the domestic wastewater treatment plant whose location is provided in Section 3.10. The mine wastewaters includes mine waters, and leachates from the processed kimberlite confinement area, the waste rock, overburden and ore stockpiles, and all runoffs from the mine site, with the exception of the water from the accommodation complex, which will be captured and routed to an independent sedimentation pond. The mine wastewaters will therefore be collected and redirected to a sedimentation pond in pit R-65 and treated if necessary, before being discharged into Lake Lagopede. The runoffs from the periphery of the mine site will be captured by drainage ditches to prevent them from coming into contact with sources of contamination and will be subsequently released into the environment (see Section 3.11).

The design flows for the mine and domestic wastewater treatment plants are 16,350 m^3/day for the mine effluent and 165 m^3/day for the domestic effluent. Leachates from the trench landfill site will also be monitored, which is described in the section on groundwater monitoring (Section 11.4.7).

The monitoring of liquid effluent aims at ensuring compliance with applicable standards and requirements and at gathering information that will help to evaluate and interpret the results of biological monitoring of the aquatic environment (benthos and fish). Moreover, it will also be possible to verify the effectiveness of mitigation measures implemented to reduce the potential impacts of mining activities. The monitoring of domestic and mine effluents includes the periodic characterization of effluents and conducting tests on the acute and sublethal toxicity of mine effluent samples.

It should be noted that the quality of surface waters of Lake Lagopede will also be monitored in addition to monitoring domestic and mine effluents. Sampling stations for surface water will be located in the initial mixing zone for the domestic and mine effluent discharge and also in a less exposed area, close to the effluents' plume (see Section 11.4.6).

- *PROTOCOL FOR MONITORING THE DOMESTIC EFFLUENT*

The plan for monitoring the effluent sewage generated by the project is based on guidelines from the MDDEP (MDDEP, 2008a, 2009). For a system of domestic wastewater treatment with a design flow less than 100 m^3/day, the MDDEP recommends harmonizing the monitoring program with the one established by the *Ministère des Affaires municipales et des Régions* (MAMR, 2006).

The purpose of the domestic effluent monitoring plan is to ensure the smooth operation of the treatment system and the compliance with discharge requirements which will be established later by the MDDEP, including rejection loads (except for fecal coliforms) and maximum effluent concentrations.

Parameters, frequency, and duration of monitoring

The monitoring parameters include those for the control of the influent and effluent from the domestic wastewater treatment plant (Table 11.4.1). Other parameters may be added depending on the discharge requirements to be established by the MDDEP.

Flow measurement at the tributary used for load calculations as well as a report on liquid precipitation (rain, slush) will also be made on a daily basis.

In general, the domestic effluent monitoring program will include biannual monitoring of the tributary and a monthly monitoring of the effluent (Table 11.4.1). This corresponds to the MAMR (2006) guidelines for a treatment system with optional aerated ponds and a capacity of less than 750 m^3/d.

Monitoring of the treated domestic wastewater effluent will be made throughout the whole construction, operation, and closure phases of the mine, during which the effluent will be discharged into the host environment.

Method of measurement, sampling, and laboratory analysis

Sampling and measuring will take place directly at the discharge pipe for the treated domestic wastewater effluent. The measurement of flow and pH, and sampling from the affluent and effluent will be in accordance with the requirements of Guideline 019, the MDDEP *Sampling Guide for Environmental Analysis* (2008b, 2009).

At the tributary, a 24-hour composite sample will be collected during low flow periods when no overflow will occur, while the effluent will be spot sampled and pH and flow measured occasionally (MAMR 2006).

Table 11.4.1 Parameters and Monitoring Frequencies of the Domestic Wastewater Effluent

Parameter	Unit	Sampling and Measurement Frequency per Type of Monitoring [a]			
		Affluent Control		Effluent Control	
		Parameter included in monitoring (yes/no)	Frequency	Parameter included in monitoring (yes/no)	Frequency
Flow Rate	m^3/j	**yes** [1]	**To be determined**	**yes**	**1/day (at a set time)**
pH	-	**yes**	**1/month** [4]	no	n.a.
Chemical Oxygen Demand (COD)	mg O_2/l	**yes**	**1/month**	**yes**	**6 / year**, including **3 consecutive days in winter** (in January or February) and **3 consecutive days in summer** (in July or August)
Biochemical Oxygen Demand (BOD_5)	mg O_2/l	**yes**	**1/month**	**yes**	
Total Suspended Solids (TSS)	mg/l	**yes**	**1/month**	**yes**	
Total Phosphorus	mg P/l	**yes** [2]	**1/month** [3]	**yes** [2]	
Ammonia Nitrogen	mg N/l of NH_3-N	**yes**	**1/month** [4]	no	n.a.
Fecal Coliforms	UFC/100 ml	**yes** [2]	**1/month** [3]	no	n.a.
Petroleum Hydrocarbons (C10-C50)	mg/l	**yes** [5]	**2/year**	**yes** [5]	**2/year**

Source

[a] *MAMR, 2006.* ***Programme de suivi de la station d'épuration. Suivi des ouvrages municipaux d'assainissement des eaux (SOMAE)*** *. 5 p. + appendices*

Notes

n.a.: Does not apply.

[1] Measurement of effluent flow rate is not required by the MAMR (2006).

[2] In general, this parameter is excluded from analyses when a water treatment plant is not subjected to a requirement regarding this parameter. However, the Ministère du Développement Durable, de l'Environnement et des Parcs (MDDEP) may nonetheless ask that this parameter be monitored.

[3] Only if the water treatment plant is subjected to a requirement regarding total phosphorus and/or fecal coliforms, or for which total phosphorus and/or fecal coliforms monitoring was specified and only during the specified period of time.

[4] The pH must be measured every time ammonia nitrogen is measured.

[5] C_{10}-C_{50} are not recommended by the MAMR (2006). However, they are included in domestic wastewater effluent monitoring because of greywater to be treated resulting from washing the workers' clothing likely to be soiled with oils and greases during vehicle maintenance operations on the mine site.

The effluent discharge objectives for treated domestic wastewaters that will be set by the MDDEP must be respected in the final effluent. The detection limits of laboratory analytical methods will aim to allow comparison between results obtained and discharge objectives.

Strict measures to ensure quality control will be implemented for sampling and laboratory analysis.

Sample analysis will be performed by a laboratory accredited by the MDDEP and in compliance with the latest standards of analytical methods recommended by the *Centre d'expertise en analyse environnementale du Québec* (CEAEQ).

- *PROTOCOL FOR MONITORING MINE EFFLUENT*

The mine effluent will result from the collection of leachates from the processed kimberlite confinement area, the waste rock, overburden, and ore stockpiles, and all runoffs from the mine site, with the exception of the water from the accommodation complex, which will be captured and routed to an independent sedimentation pond. The mine wastewaters will therefore be collected and redirected to a sedimentation pond in pit R-65 and treated if necessary, before being discharged into Lake Lagopede. The runoffs from the periphery of the mine site will be captured by drainage ditches to prevent it from coming into contact with sources of contamination and will be subsequently released into the environment (see section 3.11).

The monitoring plan for the Renard Project mine effluent is based on the requirements of Guideline 019 (MDDEP, 2005) and the *Metal Mine Effluent Regulations* (MMER), as well as recommendations from the Metal Mining Environmental Effects Monitoring Program (Environment Canada, 2011a).

The quality of the final mine effluent will comply with applicable regulations (see details in Section 3.11 on water management of the mine), i.e. Guideline 019. Moreover, according to effluent discharge objectives (EDOs) to be defined by the MDDEP, other requirements at the discharge point of the final effluent could be added under Article 20 of the EQA when issuing a certificate of approval (MDDEP, 2005). Theoretical EDOs have been included in the design criteria of the waster treatment plant as well as in the modelling of the effluent dispersion plume.

Parameters, period, and frequency of monitoring

As recommended in Guideline 019, the final effluent from the mine will be monitored regularly for a short list of physico-chemical parameters as well as annual monitoring for a more comprehensive list of parameters. The frequency of monitoring for each parameter is provided in Table 11.4.2. It is worth mentioning that the monitoring parameters and frequencies of sampling and measurements meet the requirements of Guideline 019.

For information purposes, parameters and recommended frequency of monitoring in the MMER and the EEM monitoring program are added.

In monitoring mine effluent, a minimum period will be observed in taking measurements and samples: that is 24 hours between samplings for TSS and flow measurements and pH that are performed three times per week; four days between samples (As, Cu, Fe, Ni, Pb, Zn) and measures (flow) made once a week; and a delay of 15 days between the monthly measurements of flow (MDDEP, 2005). The frequency of regular monitoring of the effluent for arsenic, copper, iron, nickel, lead, and zinc may be reduced to at least once per calendar quarter if the results meet the requirements outlined in Guideline 019.

The calculation of total loads per month (kg/month) and regular annual (kg/year) monitoring of parameters (except for pH and flow rate) will be conducted according to the procedure given in Guideline 019.

The continuous measurement of pH and flow is required because the effluent generates more than 1,000 m^3/day and must be performed using a system for measuring and recording the flow rate and pH.

Table 11.4.2 Parameters and Frequency of Sampling and Measurement of Parameters included in the Monitoring Plan for the Renard Project Mine Effluent and those of MMER and the EEM Program for Metal Mining

Parameters	Units	Measurement and Sampling Frequencies of the Mine Effluent				Measurement and Sampling Frequencies of the MMER and EEM (for information only)	
		Guideline 019 [1]				MMER [2]	EEM [3]
		Regular Monitoring			1 time/year	1 time/week	4 times/year
		Ongoing	3 times /week	1 time/week [6]			
Basic Physico-chemical Parameters							
Alcalinity	mg/l of HCO_3				X		X [7]
Conductivity	µmhos/cm				X		
Flow	m^3/j	X [4]	X	X	X		
Turbidity	UTN				X		
pH	pH	X [4]	X		X	X	
Hardness	mg/l of $CaCO_3$				X		X [7]
BOD_5	mg/l				X		
COD	mg/l				X		
TSS (total suspended solids)	mg/l		X		X	X	
Total Dissolved Solids	mg/l				X		
Total Solids	mg/l				X		
Nutrients and Ions							
Ammonia Nitrogen	mg/l of NH_3-N				X		X [7]
Total Kjeldahl Nitrogen	mg/l N				X		
Nitrates + Nitrites	mg/l N				X		
Nitrates	mg/l N						X [7]
Total Phosphorus	mg/l P				X		
Chlorides	mg/l				X		
Fluorides	mg/l				X		
Sulphates	mg/l				X		
(Sulphids)	mg/l				X [5]		
(Thiosulphates)	mg/l				X [5]		
Metals and Metalloids							
Aluminium	mg/l				X		X [7]
Arsenic	mg/l			X	X	X	
Cadmium	mg/l				X		X [7]
Calcium	mg/l				X		
Chromium	mg/l				X		
Cobalt	mg/l				X		
Copper	mg/l			X	X	X	
Iron	mg/l			X	X		X
Magnesium	mg/l				X		
Manganese	mg/l				X		
Mercury	mg/l				X		
Molybdene	mg/l				X		X [7]
Nickel	mg/l			X	X	X	
Lead	mg/l			X	X	X	
Potassium	mg/l				X		
Silica	mg/l				X		
Sodium	mg/l				X		
Zinc	mg/l			X	X	X	
Organic Compounds							
Phenolic Substances	mg/l				X		
Hydrocarbons (C_{10}-C_{50})	mg/l				X		

Notes

[1] Based on Guideline O19 (MDDEP, 2005).

[2] Based on the *Metal Mining Effluent Regulations (Section 12(1) and Schedule 4)* .

[3] Based on the *Metal Mining Environmental Effects Monitoring (EEM)* protocol (Environment Canada 2011). Metal Mining Environmental Effects Monitoring (EEM) Technical Guidance Document (2011). Chapter 5: Effluent Characterization and Water Quality Monitoring.

[4] In the case of an ore processing plant generating effluent or a mine generating over 1,000 m^3/day of effluent, ongoing pH and flow measurements are required.

[5] Required when the mineral is sulphurous (Guideline 019).

[6] After monitoring during an ongoing period of at least six months, the operator can submit a request to reduce the frequency to once per calendar quarter if the results from monthly average mathematical content calculations for those parameters are still below one-tenth of the monthly discharge requirement (Guideline 019).

[7] Shaded cells mean that the monitoring frequencies for those parameters differ from the MDDEP's.

The period or the timing of the sampling will consider the following factors (Environment Canada, 2011a):

- Changes in the composition and flow of the effluent;
- The time of year when the sampling was done previously (when available);
- The time of the year during which the water quality of the host environment is monitored;
- The period during which the concentrations of contaminants are likely to be highest in the exposed area (e.g. low water period).

➢ *METHOD OF MEASUREMENT AND SAMPLING AND LABORATORY ANALYSIS*

Sampling and measuring will take place directly at the final effluent discharge. The measurement of flow and pH, and sampling from the effluent will be done in compliance with the requirements of Guideline 019 and the *Sampling Guide for Environmental Analysis* (2008b, 2009*).*

The criteria and standards to be respected at the final mine effluent combine the requirements of Guideline 019 as well as the effluent discharge objectives that will be set by the MDDEP. The parameter analysis will be performed by a laboratory accredited by the MDDEP and in compliance with analytical methods recommended by the CEAEQ. These laboratory analyses will meet the analytical requirements (e.g. MDL, analytical methods) prescribed in Guideline 019 in order to allow a comparison with the quality requirements of the effluent.

Strict measures of control and quality assurance will be implemented to achieve the sampling and laboratory analysis.

➢ *SUBLETHAL AND ACUTE TOXICITY TESTING OF FINAL MINE EFFLUENT*

The quality of the mine effluent will also be evaluated using tests of sublethal and acute toxicity to determine whether mine effluent has the potential to affect fish, invertebrates, algae, and aquatic plants from the host environment.

As required by Guideline 019, the acute toxicity tests will be conducted in order to demonstrate that the final mine effluent is not rejecting water whose toxicity is above the acute lethal level for rainbow trout (*Oncorhynchus mykiss*) and daphnia (*Daphnia magna*) (MDDEP, 2005). Additional tests of complementary acute toxicity could be made on a plant species and algae in order to comply with the MMER. Finally, the EEM program for metal mining (Environment Canada, 2011B) requires four sublethal toxicity tests on species of fish, invertebrates, algae, and plants.

- *FREQUENCY OF TESTING FOR ACUTE AND SUBLETHAL TOXICITY*

The acute toxicity tests will be performed at a rate of once per month for the first twelve months of monitoring when effluent is flowing. It should be noted that there will be no mine effluent released during winter (November-March). The frequency may be reduced to once every three months if the effluent does not present positive results for acute toxicity (MDDEP, 2005). A minimum period of 15 days will be observed between samplings for acute toxicity testing (MDDEP, 2005).

The sublethal toxicity tests will be performed at a frequency of two times per year during the first three years of operation of the mine (with mine effluent discharge) and once a year for subsequent years (Environment Canada, 2011b).

Toxicity testing will be undertaken for the duration of mine operations when there is discharge of mine effluent.

- *METHOD OF MEASUREMENT, SAMPLING, AND LABORATORY ANALYSIS*

Testing of acute and sublethal toxicity will be performed on the aliquots of an effluent sample collected for effluent characterization. The mine effluent sampling and method to be used for testing will follow the requirements of the MDDEP, the MMER and the EEM for mines (MDDEP 2009, CEAEQ, 2005, Environment Canada, 2000, 2011b).

Quality control and assurance

Strict measures of quality control and assurance will be implemented for the realization of sampling, laboratory analysis, and toxicity testing. The objective of monitoring and quality assurance is to ensure that all sampling activities in the field and analyses in the laboratory produce valid technical and scientific results. (Environment Canada, 2011). Quality control measures will follow the specific recommendations of the EEM program (mines) for monitoring water and effluent quality and those for the toxicity tests (Environment Canada, 2011).

11.4.1.5 Hydrology and Sediment Transport

- *MONITORING PROGRAM*

A sediment and surface water quality monitoring program has been implemented as part of the environmental monitoring program. The hydrological regime will be monitored in parallel with the surface water quality monitoring program. Mine effluents will be collected, treated and controlled before being discharged into Lake Lagopede. The main changes to the hydrological regime resulting from the Renard mine operations are the dewatering of lakes F3302 and F3303, partial derivation of SBVR2 subwatershed runoffs (upstream from pit R-65) toward the lake F3295 of the SBVR1 subwatershed, development of drainage ditches and culverts, development of storage areas, and flooding of pits R-2/R-3 and R-65.

The choice of the mine effluent discharge point in Lake Lagopede was based on measurements of water levels and flow velocity within Lake Lagopede. Measurements taken to date as part of the environmental baseline study and environmental impact assessment have revealed seasonal variations in Lake Lagopede flow velocity between autumn 2010 and autumn 2011. However, more measurements are recommended to validate the anticipated impact of discharges and bring about corrective measures if required. The data collected will also help estimate peak flows and low flows entering Lake Lagopede and refine the level-flow patterns in Lake F3294 to help characterize inflows into Lake Lagopede.

The recommended hydrological monitoring program must also include further local meteorological data records. This weather data will help validate predictions for ice and snow thickness at the site.

Better weather data records, as well as water level and lake flow data will help to better characterize the mining project's impacts in the operation and closure phases and thereby assist in site rehabilitation when the mine is closed.

- *QUALITY CONTROL AND ASSURANCE*

Hydrological parameter measurements such as water levels and flows, as well as ice and snow thickness must be done using recognized procedures documented in the *Guide to Hydrological Practices* (WMO, 1994).

11.4.1.6 Sediment and Surface Water Quality

A sediment and surface water quality monitoring program will be implemented so that during the construction and operation phases, changes in sediment and water quality may be observed and changes that may be attributed to the project or to natural factors (hydrology, climate, etc.) may be quickly detected. The program will help ensure aquatic environment use protection (wildlife and human uses).

- *MONITORING OBJECTIVES*

Water quality will be monitored as a complement to the characterization of mine effluents required by the provincial government's Guideline 019 for the mining industry. Sediment and water quality monitoring will also follow the guidelines in the Metal Mining Environmental Effects Monitoring (EEM) technical guidance documents (Environment Canada, 2002 and 2011).

The specific objectives of the monitoring plan are:

- To assess the effectiveness of the design and mitigation measures implemented to minimize the project's impact on the water environment;
- To monitor potential changes to the mine operation or any other component of the project that might alter water or sediment quality;
- To monitor the performance of ore, processed kimberlite, and waste rock infrastructure management;
- To observe trends in environmental conditions in host environment waters;
- To monitor the quality of raw water sampled at the drinking water station and the quality of treated water to ensure safe consumption;
- To obtain measurements of support environment variables that might facilitate the interpretation of biological monitoring results (benthic invertebrate community and fish studies).

➢ *SEDIMENT AND WATER QUALITY INDICATOR*

Table 11.4.3 specifies site monitoring parameters. The physical and chemical parameters were selected, taking into account:

- Contaminants that might be produced during the Renard Project;
- Parameters recommended in the protocol to monitor mine effluent effects on the water environment (Environment Canada, 2002 and 2011);
- MDDEP criteria (2009) for the prevention of contamination and protection of aquatic life;
- CCME recommendations (2007) for the protection of aquatic life;
- The *Regulation respecting the quality of drinking water* (c. Q-2, r.40) to define the parameters for the quality of treated drinking water.

Table 11.4.3 Parameters of the Renard Project Surface Water Quality Monitoring Plan per Sampling Site

Monitoring Indicator	Lake Lagopede (host milieu for treated mine effluent)	Lake Lagopede (host milieu for treated domestic wastewater)	Lake Lagopede (raw water intake for the production of drinking water)	Drinking Tapwater (treated water)	Lakes and Watercourses near the Airstrip
Basic Physico-chemical Parameters					
Alcalinity	a				
Conductivity	b				
Biochemical Oxygen Demand (BOD_5)	c	d			
Chemical Oxygen Demand (COD)	c	d			
Total Hardness	a				
Total Suspended Solids	a	d			i
Dissolved Oxygen	a	e			i
pH	a	d	g	h	
Total Dissolved Solids	c				
Water Temperature	a	e			i
Transparency	b	f			
Turbidity	c	e		h	i
Ions and Nutrients					
Ammonia Nitrogen (in N)	a	d	g		
Total Kjeldahl Nitrogen (in N)	c				
Calcium	b	e			
Free Residual Chloride				h	
Chlorides	b	e	g		
Cyanides				h	
Fluorides	c	e		h	
Magnesium	c				
Nitrates (in N)	a	e	g	h	
Nitrites (in N)	c	e	g	h	
Total Phosphorus (in P)	b	d			
Potassium	b				
Sodium	b		g		
Sulfates	b	e	g		
Total Metals					
Aluminium	a		g		
Antimony			g	h	
Arsenic	a		g	h	
Barium				h	
Boron				h	
Cadmium	a		g	h	
Chromium	c		g	h	
Cobalt	c				
Copper	a		g	h	
Iron	a		g		
Manganese	b		g		
Mercury	a		g	h	
Molybdenum	a		g		
Nickel	a		g		
Lead	a		g	h	
Selenium	b		g	h	
Silica	c				
Uranium				h	
Zinc	a		g		
Organic Compounds					
Dissolved Organic Carbon	b				
Total Organic Carbon	b				
Petroleum Hydrocarbons	c	e			i
Propylene Glycol					i
Phenolic Substances	c				
Trihalomethanes				h	
Other Parameters					
Total Coliforms				h	
Fecal Coliforms		d		h	
Radium 226	a				

Sources:

a Parameters required pursuant to Section 7 of Schedule 5 of the MMER (*Metal Mining Effluent Regulations*). In spite of the fact that the Renard mine is not a metal mine, it will monitor these parameters in the host environment anyway.

b Other parameters are proposed in the *Metal Mining Environmental Effects Monitoring (EEM) Technical Guidance Document (2011) - Effluent Characterization and Water Quality Monitoring* by Environment Canada. Some are for a more in-depth characterization of the host environment. Others are needed to assess the toxicity of metals (chlorides, calcium, magnesium, potassium, sodium, sulfates, COD).

c Parameters monitored yearly in compliance with Guideline 019 of the MDDEP (2005), but not addressed in the Environment Canada Guideline.

d Parameters monitored as part of the Treatment Plant Monitoring Program - Monitoring Municipal Water Treatment Plants (SOMAE)(MAMR, 2006). Please note that ammonia, nitrogen and fecal coliforms are only measured in the plant affluent, not in the effluent. However, they have been saved for monitoring the quality of surface waters.

e Parameters of interest for the protection of aquatic life likely to be affected by domestic wastewater effluent

f Parameters of interest allowing to assess the overall trophic condition of the environment or the toxicity of other contaminants, such as metals.

g Contamination prevention criteria for sites with water intake, drawn from *Surface Water Quality Criteria, Ministère du Développement Durable, de l'Environnement et des Parcs*. 2009. Department of environment condition monitoring. MDDEP, Government of Quebec. 506 pages and 16 appendices.

i Parameters of interest for the protection of aquatic life (CCME, 2007 or MDDEP,2009) likely to be affected by airstrip operations.

h Parameters required under the *Regulation respecting the quality of drinking water (c. Q-2, r.40)*

Table 11.4.4 provides the parameters that will be measured as part of the sediment quality monitoring program. These parameters were selected following the recommendations of the EEM Guideline (Environment Canada, 2002 and 2011), the MDDEP criteria for sediment quality (Environment Canada and MDDEP, 2007) and the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME, 2007).

➢ *SAMPLING SITES*

Sampling sites will be positioned so as to monitor the quality of water and sediments in areas that might be impacted at the same time as stations upstream from the project that are not likely to be impacted. The project components considered are mine and domestic effluents, drinking water intake and the discharge point for runoffs from the airstrip and waterways. The following criteria were generally used to determine the location of the sampling sites:

- They are located as close as possible to the stations visited during the Environmental Baseline Study (Roche, 2011) for comparison purposes with the baseline conditions of the environment before mine construction and operation;
- Water and sediment samples were taken from the sampling sites selected in parallel with the biological monitoring studies (benthic invertebrates and fish communities).

For the time being, the positioning of the monitoring stations is indicated according to the main sources of impact. The number of sampling stations and their positioning will be determined when the definite locations of the infrastructure are set.

Particular attention will be paid to Lake Lagopede during monitoring, because this lake will be affected by different components of the project, namely treated mine and domestic effluent discharge and changes to the watershed's hydrographic network. The environmental study will target other water bodies and streams. These include lakes and streams near the processed kimberlite confinement area and the airstrip area. In addition, stations will be positioned upstream from the mine site for comparison with an aquatic environment that has not been altered by the project.

Mining and domestic effluents

With regard to mine and domestic effluents, a water quality monitoring program is required for Lake Lagopede, since the lake will be the host environment. The stations monitored will be located near the treated effluent discharge point and subwatersheds of which the hydrographical network has been altered.

Table 11.4.4 Renard Project Sediment Quality Monitoring Parameters

Monitoring Indicator	Parameters Required per the EEM Guidance	Other Parameters of Interest
Grain Size Distribution (Based on the Wentworth Scale)		
Clay (<0.0039 mm)	x	
Loam (0.0039 to 0.062 mm)	x	
Fine Sand (0.062 to 0.2 mm)	x	
Coarse Sand (0.2 to 2 mm)	x	
Gravel (2 to 16 mm)	x	
Nutrients		
Total Nitrogen (in N)		x
Total Phosphorus (in P)		x
Total Metals		
Arsenic	x	
Cadmium	x	
Chromium	x	
Cobalt	x	
Copper	x	
Iron	x	
Magnesium	x	
Manganese	x	
Mercury	x	
Molybdenum	x	
Nickel	x	
Lead	x	
Selenium	x	
Zinc	x	
Organic Compounds		
Total Organic Carbon		x
Petroleum Hydrocarbons (C_{10}-C_{50})		x
Volatile Solids (at 550°C)		x

Stations will be placed at the discharge point for domestic and mine effluents, in their initial mixing zone. A second series of stations will be located in a less exposed area near the effluents' plume.

Drinking water sampling

A station will be placed at the drinking water intake sampling point to monitor the quality of raw water sampled at this station. With regard to treated water monitoring, tapwater will be monitored in compliance with the recommendations in the *Regulation respecting the quality of drinking water.* Monitoring is important to ensure drinking water consumption safety, since mine and domestic effluents are discharged into the water body that provides drinking water.

Airstrip

A station will be located at the discharge point of runoffs from the airstrip (runoffs from the area where airplanes are deiced, to see the concentration of propylene glycol in the host environment). The station will be located near the discharge point, in the water body that ultimately receives airstrip runoffs. A second station will be located in an area less exposed to this effluent, but located nearby (hydraulically downstream from the discharge point or in a control zone).

Control zones

The EEM guideline advises the use of a large number of control zones to improve the capacity of measurement of the natural variations in water quality and to better breakdown the influence of certain natural phenomena on trends in water quality.

Reference stations will be located in water bodies or streams comparable to water levels in the exposed areas. Sampling stations will be located in the northern part of Lake Lagopede, because they are located upstream from any direct effluent influence.

- *MONITORING PERIOD, FREQUENCY AND DURATION*

Surface water

Mine and domestic effluents and drinking water samples

The EEM guideline recommends monitoring water quality four times per year, at intervals of at least one month. In summer and fall, samples will be collected at the same time as the monitoring of fish and benthic invertebrate communities. Samples must be taken the same day as mine effluent samples.

To facilitate data interpretation and ensure uniformity, water sampling at the discharge point of treated domestic water and the sampling point of raw water for consumption will be done at the same time and frequency.

The recommendations of the *Regulation respecting the quality of drinking water* will be applied to treated drinking water sampling. Table 11.4.5 summarizes the sampling frequency for each measured parameter. To facilitate interpretation where possible, samples will be taken at the same time as other samples for surface water quality monitoring.

Table 11.4.5 Sampling Frequency per the Post-treatment Drinking Water Monitoring Parameter

Parameter	Sampling Frequency
Basic Physico-chemical Parameters	
pH	4 times per year
Turbidity	Once a month
Ions and Nutrients	
Nitrates	4 times per year
Nitrites	4 times per year
Chloramines	Once a year
Free Residual Chlorine	Once a year
Cyanide	Once a year
Fluoride	Once a year
Metals and Metalloids	
Antimony	Once a year
Arsenic	
Barium	
Boron	
Cadmium	
Chromium	
Copper	
Selenium	
Lead	
Uranium	
Organic Compounds	
Trihalomethanes	4 times per year
Bacteriology	
Total Coliforms	Once a month
Fecal Coliforms	Once a month

Airstrip

The use of propylene glycol to deice airplanes may affect aquatic organisms when used in sufficient concentration. The CCME recommends a concentration below 500 mg/L of propylene glycol in freshwater; the MDDEP has not established a specific criterion for this substance. To verify compliance, sampling will be done every year in spring or fall, as it is during these periods that this deicer is most commonly used and most likely to be found in these waters.

Control zones

The stations located in control zones will be sampled four times per year, at the same time as surface water is sampled near the mine and domestic effluent discharge points. Simultaneous sampling is done

to facilitate the interpretation of discrepancies observed between the results from impacted and reference areas.

- *SEDIMENT*

Sediment sampling will be done in the fall, at the same time as benthic invertebrate sampling. This is the best time to sample benthos because this is the period when most taxa are present in lotic environments or have reached a sufficient development stage and size to be more easily identified and because flow patterns are favourable. Sediment sampling will be done at the same time as surface water sampling, in the fall.

- *DURATION OF MONITORING*

The first sample should be taken no later than six months after mining operations have started. The duration of the sediment and water quality environmental monitoring will cover the project's total lifetime and the closure phase.

At the provincial level, Guideline 019 requires that water quality monitoring continues during post-operation and before rehabilitation work is complete. The monitoring program must be designed so that the qualitative and quantitative changes in the discharge into the environment during the transition phase preceding complete site rehabilitation can be monitored and that the appropriate rehabilitation methods to implement be adjusted.

- *SAMPLING METHOD*

The sampling method is based on the recommendations in Chapter 6 of the EEM guideline (Environment Canada, 2002).

Water quality

Parameters measured in situ

Some parameters, such as dissolved oxygen, water temperature, pH, conductivity, turbidity and water transparency will be measured *in situ*.

In lakes less than 2 metres deep and in streams, *in situ* measurements will be taken in the centre of the water column. In water bodies 2 to 4 metres deep, measurements will be taken at two depths, i.e., approximately 25 cm from the bottom and 25 cm from the surface. In deeper lakes, a measurement will be taken every metre. All measuring devices will be verified and calibrated the day they are used.

Parameters measured in the laboratory

The other parameters will be measured in the laboratory. The analysis methods used will comply with the reference methods recommended by the *Centre d'expertise en analyse environnementale du Québec* (CEAEQ, 2010).

Where water depth is equal to or less than 2 metres, samples will be taken in the centre of the water column or at least 15 cm from the water surface. Where the water is deeper than 2 metres, samples at the subsurface (epilimnion) and near the bottom (hypolimnion) will be taken. Samples taken directly under the surface will be collected manually directly into a sample bottle. Samples taken near the bottom will be collected with a Kemmerer bottle.

Sediment quality

Sediment samples will be taken from the shore using a shovel or small bucket. The different parameters will be analyzed by an accredited laboratory.

The analysis methods used will comply with the reference methods recommended by the *Centre d'expertise en analyse environnementale du Québec* (CEAEQ, 2010).

The sediment will be analyzed in accordance with the prescribed timelines and required preservation measures, particularly the preservation of samples at 4°C.

To maintain sampling method quality control, samples will be replicated at 10% of the stations (grab samples).

- *DATA ANALYSIS*

The data obtained at the monitoring stations will be analyzed in compliance with the EEM guide (Environment Canada, 2002).

To this end, the sediment and water quality data from the exposed area will be compared with the data from the control zone. This comparison will cover all measured sediment and water quality monitoring parameters.

In addition to being compared against the MDDEP and CCME aquatic life protection recommendations and criteria, the results obtained from drinking water samples will be compared with the MDDEP's contamination prevention criteria for sites with drinking water intake. Finally, particular attention will be paid to propylene glycol concentrations at the airstrip area.

To determine whether concentrations differ between the exposed area and the control zone, the mean value of at least four samples taken over a period of 12 months at the same locations in the exposed and control zones will be compared. If the number of data points in each area is above 4, a statistical test may be used (e.g., average or mean above the confidence interval of 95% at two standard

deviations, ANOVA by ranks or Kruskall-Wallis tests) to determine whether the concentrations in the exposed area are above those measured in the control zone. Where there are acceptable data on water quality in the exposed area prior to mining operations, these may be used as a basis for comparison.

Particular attention should be paid to the parameters measured when one or more of the following situations arise when results are interpreted:

- A difference of a factor higher than 2 is observed between the exposed area and the control zone;
- A quality objective for clean water at the site is exceeded in the exposed area, regardless of the value measured in the control zone;
- If there is a recommendation or criterion for water quality and the concentration of this parameter in the exposed area exceeds this value, and this value is more than twice that observed in the control zone, the spread over which this excess is observed must be determined.

It is important to pay attention to particular situations such as:

- Where the water quality objective is near the method detection limit (MDL) and the concentrations of the parameter considered in the area under study is close to this objective. In this situation, it may be that a difference of a factor of two is insignificant given the degree of uncertainty of the analysis at a level near the detection limit. As the MDL/water quality objective ratio decreases, the uncertainty of the measurements increases; beyond a 1:2 ratio, the results obtained are not considered statistically significant. This situation would apply to certain parameters measured in the surface water such as arsenic, cadmium, mercury, selenium, silver and cyanide, for which it is not currently possible to obtain a method detection limit of at least ten times less than that indicated in the objectives. The EEM guideline recommends consulting with the authorization agent under these circumstances;
- Given that the pH scale is a logarithm, in the case of pH, a difference of a factor of two is insignificant. If a pH recommendation exists for a particular site and the pH value measured in the exposed area falls outside the interval specified in this recommendation, it is best to determine the geographical spread over which the pH values remain outside the interval. If no pH recommendation exists for a particular site and the pH value measured in the exposed area is more than 0.5 units away from the pH value measured in the control zone and falls outside the interval specified in the recommendations for water quality (e.g., the interval of 6.5 to 9.0 specified in the EEM recommendations), the geographical spread of the exposed area over which the pH is more than 0.5 units away from the value measured in the control zone should be determined.

➢ *QUALITY CONTROL AND ASSURANCE*

To be representative, water samples must not be contaminated or altered during sampling operations or transportation to the analysis laboratory. Great care will therefore be taken to identify, prevent and rectify anything that might alter the integrity of the samples.

To avoid any sample contamination, the following procedures will be taken:

- The stations of the control zone will be sampled before the stations of the exposed area;
- Samples will be collected from the station the least likely to be contaminated to the station the most likely to be contaminated;
- The introduction of a concentrated preservation agent into sampling bottles before sampling is to be avoided, because the agent may cause metals in the plastic walls of the containers to

leach. The laboratory should be informed of this procedure when ordering bottles, because some laboratories supply pre-loaded bottles;

- Sampling bottles and caps will be rinsed three times before any sample is collected;
- During sampling, the opening of the bottle will face the current so as the sample does not come into contact with the hand holding the bottle;
- The sampling team will wear non-lined latex or nitrile gloves to avoid contaminating samples;
- Samples will be analyzed within prescribed timelines and following required preservation measures, including preserving samples at 4°C and using preservation agents.

The sampling method will be quality controlled by collecting additional samples. For the 10 water samples, one replicate[1], one field blank[2] and one transport blank[3] will be prepared and analyzed by the laboratory to assess any errors or inaccuracies due to sampling and the homogeneity of the sample matrix.

11.4.1.7 Response Mechanism Implemented in Case of Unforeseen Environment Degradation

When the quality of water or sediment degrades unexpectedly or when there is a problem with a mitigation measure during the water and sediment quality monitoring program, the following steps will have to be considered:

- Keeping a register of any accident or accidental spill of contaminants (e.g., hydrocarbons, anti-freeze, deicer, explosives, etc.) that may affect the quality of water or sediment, describing the quantities of substances, circumstances, and response measures taken to collect the substances;
- Notifying the MDDEP of any degradation of the environment within prescribed timeframes;
- Seeking the source of the problem while verifying the effectiveness of mitigation measures;
- Notifying the Ministry of corrective measures to be taken or work to be carried out;
- Measuring the effectiveness of corrective measures and reporting to the Ministry.

11.4.1.8 Groundwater Level and Quality

Although several planned mitigation measures help to prevent and mitigate project impacts on groundwater, mine site construction and operation can affect the quality and flow regime of groundwater in various ways. For instance, the activities taking place on the site of certain facilities (ore processing plant, processed kimberlite confinement area, petroleum and chemical product storage area, etc.) may cause the occasional degradation of the quality of soil and water in case of leakage or accidental spill. In addition, the dewatering of mine pits for their operation will influence the level of groundwater close to the site. Hence, certain activities carried out as part of the Renard Project could influence groundwater.

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1 A replicate is a sample collected twice at the same station. It allows assessing the homogeneity of the sampling site and consistency of sampling equipment.

2 A field blank is collected to ensure that samples are not contaminated by one of the many potential contamination sources, such as sample containers, caps, preservation agents, equipment, filter paper (in the case of samples that must be filtered), ambient air, or sampling and analysis techniques. Field blanks containing Milli-Q water from the laboratory in charge of analyses are transported on site and submitted to the same sampling, handling and treatment procedures as samples intended for analysis (e.g., transfer into a sample container, preservation and exposure to the environment). They are then transported, stored and analyzed using the same methods as field samples intended for analysis.

3 A transport blank is used to verify the presence of eventual contamination from sample containers, caps or preservation agents during transportation, storage and analysis.

This section describes the groundwater monitoring program to be implemented during the Renard Project, primarily during the operation and closure phases. The environmental issues identified during the impact assessment (see Chapter 6) were taken into account in the selection of monitoring indicators and the positioning of sampling stations. The quality and level of groundwater will therefore be monitored in order to measure the real impacts of construction and operation on the initial hydrogeological conditions of the area. The groundwater will also be monitored during the closure phase.

➢ *GROUNDWATER MONITORING NETWORK*

Environmental issues specifically associated with groundwater that require monitoring include the protection of groundwater near facilities at risk and in the area where water table lowering related to the dewatering of pits is observed. Under Guideline 019 for the mining industry (MDDEP, 2005), the following infrastructure are included in facilities at risk: ore processing plant, processed kimberlite confinement area, petroleum and chemical product storage areas, etc. The Guideline specifies that: « All facilities likely to represent a risk as per the definition of Guideline 019, must be developed and operated in order to prevent any significant degradation of groundwater resources during and following operations. »

As part of the Renard Project, a few mine infrastructure can be considered as facilities at risk. In fact, a ore processing plant, a processed kimberlite confinement area (PKC), a petroleum product storage area, a hazardous material storage area, a trench landfill site and a mechanical workshop are to be developed and operated.

Under Guideline 019, a groundwater monitoring program must be implemented in the surroundings of facilities at risk, unless all the underlying hydrogeological bodies are Class III without any hydraulic links. However, in the presence of high-risk tailings (which is not the case here), a groundwater monitoring network must be set up. Based on the classification of groundwater on the site (Classes II and III) and considering Guideline 019 requirements, groundwater in the surroundings of the facilities at risk aforementioned will have to be monitored. In addition, groundwater monitoring will also be needed to measure the effects of water table lowering around the open pits.

The groundwater quality monitoring program will particularly involve the areas where the following facilities are located:

- The ore processing plant;
- The petroleum product storage area;
- The hazardous material storage area;
- The mechanical workshop;
- The airstrip area;
- The processed kimberlite confinement area;
- The trench landfill site.

A monitoring network comprised of several observation wells will therefore be established to adequately manage the problems that may arise. The network will be used during site operation and the closure and post-rehabilitation phases. A few wells will be installed upstream of the facilities at risk to obtain a value of the natural geochemical background contents (test sites), but most of them will be positioned at strategic locations downstream of the facilities at risk, particularly depending on the topography and the flow direction of groundwater. The wells located downstream will be installed at less than 150 m from the facilities at risk in order to intercept the groundwater flowing across the surficial deposits and the shallow rock. These wells will allow the monitoring of the levels and quality of groundwater downstream of facilities at risk.

The monitoring network will be completed on the perimeter of the pits by installing a few observation wells. They will be positioned in the rock, but also in the surficial deposits, particularly in the areas close to certain bodies of surface water deemed more sensitive. The wells will serve to confirm the projections related to water-table lowering around the pits following dewatering operations, in order to implement mitigation and management measures if needed. The monitoring parameters selected on the basis of the different at-risk sites as well as the sampling frequency are presented in Table 11.4.6.

Table 11.4.6 Groundwater Monitoring Parameters and Frequency per Sampling Sites

Project Components	Monitoring Site	Type of Monitoring	Monitoring Frequency	Monitoring Parameters	Analysis methods recommended by the *Centre d'expertise en analyse environnementale du Québec* (CEAEQ)
Ore Processing Plant	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer	Metals (As, Cu, Fe, Ni, Zn); petroleum hydrocarbons; major ions (Ca+2, HCO3-, K+, Mg+2, Na+, SO4-2); pH and electrical conductivity	Metals (MA. 200 - Met 1.2); petroleum hydrocarbons (MA. 400 - Hyd. 1.1); major ions (MA. 300. Ions 1.2); pH and electrical conductivity (MA.303 -TitrAuto 1.1)
Processed Kimberlite Confinement Area (PKC)	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer	Metals (As, Cu, Fe, Ni, Zn); petroleum hydrocarbons; major ions (Ca+2, HCO3-, K+, Mg+2, Na+, SO4-2); pH and electrical conductivity	Metals (MA. 200 - Met 1.2); petroleum hydrocarbons (MA. 400 - Hyd. 1.1); major ions (MA. 300. Ions 1.2); pH and electrical conductivity (MA.303 -TitrAuto 1.1)
Petroleum Product Storage Area	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer	Metals (As, Cu, Fe, Ni, Zn); petroleum hydrocarbons; major ions (Ca+2, HCO3-, K+, Mg+2, Na+, SO4-2); pH and electrical conductivity	Metals (MA. 200 - Met 1.2); petroleum hydrocarbons (MA. 400 - Hyd. 1.1); major ions (MA. 300. Ions 1.2); pH and electrical conductivity (MA.303 -TitrAuto 1.1)
Hazardous Material Storage Area	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer	Metals (As, Cu, Fe, Ni, Zn); petroleum hydrocarbons; major ions (Ca+2, HCO3-, K+, Mg+2, Na+, SO4-2); pH and electrical conductivity	Metals (MA. 200 - Met 1.2); petroleum hydrocarbons (MA. 400 - Hyd. 1.1); major ions (MA. 300. Ions 1.2); pH
Trench Landfill Site	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer for the parameters of Section 57 of the RLIRM	Ammonia nitrogen, BTEX, metals (B, Cd, Cr, Fe, Mn, Hg, Ni, Pb, Zn), chlorides, fecal coliforms, total cyanides, nitrates + nitrites, Sodium, total sulphates, total sulphides	Ammonia nitrogen (MA 300 - N. 1.1); BTEX (MA. 403 – COV 1.1); metals (MA. 200 - Met 1.2); chlorides & sulfates (MA. 303 – Anions 1.0); Fecal coliforms (MA. 700 – Ecct 1.0); total cyanides (MA. 300 - CN 1.2); nitrates + nitrites (MA. 303 – NO3 1.1); total sulphides (MA 300 - S 1.1)
			3 times a year for the parameters of Section 66 of the RLIRM	Electrical conductivity; phenolic compounds; BOD_5; OCD and iron	Electrical conductivity (MA.303 -TitrAuto 1.1); phenolic compounds (MDA. 400 – Phe 1.0); BOD_5 (MA. 315 – DBO 1.1); OCD (MA. 315 – DCO 1.1); iron (MA. 200 - Met 1.2)
Mechanical Wokrshop	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer	Metals (As, Cu, Fe, Ni, Zn); petroleum hydrocarbons; major ions (Ca+2, HCO3-, K+, Mg+2, Na+, SO4-2); pH and electrical conductivity	Metals (MA. 200 - Met 1.2); petroleum hydrocarbons (MA. 400 - Hyd. 1.1); major ions (MA. 300. Ions 1.2); pH and electrical conductivity (MA.303 -TitrAuto 1.1)
Airstrip area	One observation well hydraulically upstream and two observation wells hydraulically downstream	Groundwater Sampling; Groundwater Level Survey	Biannually in spring and summer	Metals (As, Cu, Fe, Ni, Zn); petroleum hydrocarbons; major ions (Ca+2, HCO3-, K+, Mg+2, Na+, SO4-2); pH and electrical conductivity; propylene glycol	Metals (MA. 200 - Met 1.2); petroleum hydrocarbons (MA. 400 - Hyd. 1.1); major ions (MA. 300. Ions 1.2); pH and electrical conductivity (MA.303 -TitrAuto 1.1)

RLIRM = *Regulation respecting the landfilling and incineration of residual material*:

Ore processing plant, petroleum product, hazardous material and explosive storage areas, mechanical worshop, and airstrip area

Several facilities at risk planned for the Renard Project site raise similar problems. Therefore, they may be grouped together to describe their monitoring programs. They include the process plant, the petroleum product and hazardous material storage areas, the mechanical workshop and the airstrip area. The activities to take place at the sites will generate metals or petroleum products that may contaminate groundwater. In addition, at the airstrip, propylene glycol will be used to deice aircrafts and aircraft fuel will be stored on site.

A network of at least three observation wells will be set up in the area around each facility at risk to verify the level and quality of groundwater hydraulically upstream and downstream from the sites. The monitoring network will include the installation of observation wells hydraulically downstream from each site at a distance not exceeding 150 metres from the facilities at risk. The location of wells will depend on the final configuration of the mine infrastructure, accessibility to existing wells, and the interpretation of new hydrogeological data to be collected during the future project development phases.

Monitoring frequency and duration

The frequency of groundwater sampling and piezometric measurement specified in Guideline 019 is twice a year during site operation, preferably in spring and summer to characterize the flood and low-flow periods. Determining the natural background content of groundwater at each facility at risk before operation starts is also required.

If groundwater monitoring shows the presence of any contaminants in the groundwater after the operation phase is over, the monitoring program will continue at a rate of twice a year, in spring and summer, over a five years period. After that period of time, the program may be interrupted if groundwater quality criteria are not exceeded or if the Ministry agrees that additional monitoring is no longer justified.

Monitoring parameters and threshold values

The parameters to be analyzed during each monitoring program are those prescribed in Guideline 019 (MDDEP, 2005), including certain metals (As, Cu, Fe, Ni, Zn), petroleum hydrocarbons (C_{10}-C_{50}), major ions (Ca^{+2}, HCO_3^-, K^+, Mg^{+2}, Na^+, SO_4^{-2}), along with pH and electrical conductivity. Total cyanides will not be analyzed since this substance is not part of the diamond mine treatment process. The criteria of copper, nickel and zinc will be adjusted based on total hardness values to be obtained from surface water monitoring. The piezometry will also be monitored before samples are collected where observation wells were installed.

Values obtained during the groundwater monitoring program conducted near at-risk facilities will be compared with warning thresholds identified based on the decision-making flowchart shown in Figure 2 of Guideline 019 and the criteria applicable to cases of groundwater contamination presented in Schedule 2 of the *Soil Protection and Contaminated Sites Rehabilitation Policy*. In cases of groundwater contamination, the criteria to be met are the criteria specified in the *Resurgence of Groundwater into Waterways or Infiltration into Sewers* section of the Policy, whereas the warning thresholds are set at 50% of the criteria to be met. Warning thresholds are used to protect surface waters that may come into contact with resurgence waters or to prevent loss of use. Warning thresholds correspond to preventive limits or concentrations from which loss of resource use can be anticipated.

As specified in Guideline 019 (MDDEP, 2005), the background content of local groundwater must also be identified for the aforementioned substances before operation starts. This value will be calculated for the selected parameters based on a minimum of eight analysis results of samples taken from at least three observation wells. To determine the natural background contents, the 90th centile of data will be selected in order to reduce the potential influence of inconsistent data and characterize maximum natural contents, by excluding samples that may have been the object of analytical or sampling errors. Water samples will be collected during at least two sampling programs.

Trench landfill site

Operating a trench landfill site involves the implementation of a groundwater monitoring network to control the quality of groundwater that migrates in the ground where the trench landfill site is located. Therefore, an observation wells system will be set up on the perimeter of the trench landfill site built for the needs of the Renard Project, in compliance with the following provisions of Section 65 of the *Regulation respecting the landfilling and incineration of residual materials* (RLIRM):

- "No observation well is to be situated beyond the outside perimeter of a buffer zone established pursuant to Section 18";
- "The observation wells must be situated at a maximum distance of 300 m hydraulically downstream from the disposal areas […] so that the [quality of the] groundwater at that distance can be monitored";
- "The network of observation wells must consist of at least 3 wells for the first 8 ha of land";
- "At least one additional observation well to monitor the quality of groundwater before its migration into the [established monitoring perimeter] must be installed hydraulically upstream […] or at any other location making it possible to ascertain the quality of the groundwater representative of the groundwater migrating into the monitoring perimeter established under this section".

The final location of wells will depend on the surface area occupied by the trench landfill site.

Monitoring frequency and duration

Samples of groundwater will be collected in the observation wells at least three times a year during site operation, in the spring, summer and fall, pursuant to Section 65 of the RLIRM. During each sampling, the piezometric level of the groundwater will also be measured.

After a minimum monitoring period of two years, the monitoring parameters may be scaled down in accordance with the provisions of Section 66 of the RLIRM. Following the closure and post-closure management of the trench landfill site, the groundwater monitoring program could be extended in accordance with the provisions of Sections 80 to 85 of the RLIRM.

Monitoring parameters

Collected samples of groundwater will be analyzed to control the parameters or substances listed in Section 57 of the RLIRM and in compliance with the provisions of Section 58 of the same regulation. In addition, the parameters or substances, and indicators prescribed in Section 66 of the RLIRM must be measured at least three times a year, in the spring, summer and fall. The parameters or substances, and indicators are the following: electrical conductivity, phenolic compounds, the five-day biochemical oxygen demand (BOD_5), the chemical oxygen demand (COD) and iron.

Processed kimberlite confinement area

Assessment testing for potential acid mine drainage, along with leaching static and kinetic testing conducted on different materials have confirmed that processed kimberlite does not pose any risks of acid mine drainage and is not likely to leach metals at concentrations that may represent a risk to aquatic fauna or the consumption of water or aquatic organisms. Consequently, the processed kimberlite confinement area is considered a low-risk site according to the Guideline 019 classification (MDDEP, 2005). However, the hydrogeological conditions of the site require the set-up of a groundwater monitoring network. The network will serve to verify the quality of groundwater hydraulically upstream and downstream from the confinement area to confirm results from leaching tests and results from particle tracking modelling carried out by Golder (2011f).

The monitoring network will include the installation of observation wells hydraulically downstream from the site, at a distance not exceeding 150 metres from the confinement area. The location of the wells will depend on the final surface area occupied by the confinement area.

Monitoring frequency and duration

Water samples will be collected from the monitoring network wells based on the frequency and physico-chemical parameters specified in Guideline 019. The frequency of sampling and piezometric measurement will be twice a year, either in spring or summer, during the entire use of the facilities.

With regard to the closure phase during the post-operation and post-rehabilitation period, the parameters will be the same as those specified for the operation phase (except for total suspended solids) and the sampling frequency will be maintained at twice a year. The groundwater monitoring program will be maintained for a period of five years, after which it may be interrupted, if groundwater quality criteria are not exceeded or if the Ministry approves that additional monitoring is no longer justified. The monitoring program during the post-rehabilitation period may be terminated when the quality of groundwater meets the criteria set out in the MDDEP's *Soil Protection and Contaminated Sites Rehabilitation Policy*.

An annual report describing monitoring results will be submitted every year to the MDDEP. The report will address elements specified in detail in Guideline 019, including the date of each sample collection, results from the annual sampling of parameters, and their interpretation.

Monitoring parameters and threshold value

The parameters to be analyzed at each monitoring program will be those specified in Guideline 019 (MDDEP, 2005), including certain metals (As, Cu, Fe, Ni, Zn), petroleum hydrocarbons (C_{10}-C_{50}), major ions (Ca^{+2}, HCO_3^-, K^+, Mg^{+2}, Na^+, SO_4^{-2}), along with pH and electrical conductivity. Total cyanides will not be analyzed since this substance is not part of the diamond mine treatment process. The criteria for copper, nickel and zinc will be adjusted based on total hardness values obtained from surface water monitoring. The piezometry will also be monitored before samples are collected where observation wells were installed.

Values obtained during the groundwater monitoring programs conducted near the processed kimberlite confinement area will be compared with warning thresholds identified based on the decision-making flowchart shown in Section 2.3.2.4 of Guideline 019 (MDDEP, 2005) and the criteria applicable to cases of groundwater contamination presented in Schedule 2 of the *Soil Protection and Contaminated Sites Rehabilitation Policy*. In cases of groundwater contamination, the criteria to be met are the criteria specified in the *Resurgence of Groundwater into Waterways or Infiltration into Sewers* section of the Policy, whereas the warning thresholds are set at 50% of the criteria to be met. Warning thresholds are used to prevent loss of use or to protect surface waters that may come into contact with resurgence waters. Warning thresholds correspond to preventive limits or concentrations from which loss of resource use can be anticipated.

As specified in Section 2.3.2.3 of Guideline 019, the background content of local groundwater will also have to be determined for the aforementioned substances before processed kimberlite is stored.

- *GROUNDWATER LEVEL MONITORING PROGRAM*

Open Pits

In order to determine if the hydrogeological conceptual model used to assess the project impacts on groundwater table draw-down, is accurate, groundwater will be monitored. Water levels will be monitored daily using automatic data loggers installed in three boreholes located on the perimeter of the first pit under operation. The loggers will be move to other boreholes when the other pits are under operation in order to continue monitoring during further operation phases.

If the observed groundwater table level values or changes are less significant than initially anticipated in the conceptual model, then measurements may be taken less frequently. Conversely, if the observed water level values are more significant than anticipated, then measurements may be taken more frequently. If needed, the hydrogeological conceptual model may be adjusted based on the data collected during monitoring.

Before mining operations start, an initial piezometric measurement will be carried out using all the observation wells available. Water level measurements could be done simultaneously to the collection of water samples to determine the geochemical background variability. Results will be integrated into the annual report to be submitted to the MDDEP.

- *QUALITY CONTROL AND ASSURANCE*

Before each groundwater sampling program is conducted, a quality control and assurance program should be developed to meet the concepts prescribed in the latest versions of the MDDEP's *Sampling Guide for Environmental Analysis*. These quality control and assurance procedures are required to ensure the validity of results and reduce sampling uncertainty.

Each well will be purged and sampled using sampling pumping equipment assigned to each of the wells to prevent risks of cross-contamination.

Water samples analyzed for dissolved metals must be filtered at the sampling site using 0.45 um filters. This procedure must be done immediately after sampling to prevent precipitation and metal adsorption.

A minimum 10% of samples will be collected as duplicate samples to ensure the scientific reliability of the interpretation of results from this control. In addition, to prevent contamination of containers or samples likely to occur during transportation and sampling, at least one transport blank per sampling program and one field blank per sampling day will be prepared by the laboratory and analyzed for target parameters. The container of the transport blank must never be open before analysis, whereas containers of field blanks must be opened on site during about the same time as the sample containers used during collection. All the duplicates and blanks for quality control will be identified separately from the samples using encrypted numbers.

Samples will be preserved at a temperature of about 4°C at all times, as prescribed in the MDDEP's document entitled *Water Conservation Methods Specific to Groundwater Sampling* (2009).

During sampling, a field log will be held to record the activities and all the relevant facts concerning sampling operations. In the log, the following information should be recorded: the sampling method, the location of sampling points, sampling time, climatic conditions (rain, snow, etc.), high flow or low flow events and a visual description of samples (colour, odour, visual turbidity, etc.).

11.4.2 Biological Environment

11.4.2.1 Benthos and Fish

Due to various project components' anticipated impacts on fish and fish habitat, some of the study area's streams and water bodies will have to undergo environmental monitoring (fish and benthos). The objective of this monitoring is to assess the effects[4] of treated mine and domestic effluent on fish and fish habitats and the effectiveness of the mitigation measures implemented.

Studying benthic invertebrates is a recognized monitoring tool used widely as a fish habitat status indicator. The main advantage of including benthos in the environmental monitoring plan is that these organisms integrate the cumulative and synergic short-term and long-term (up to several years) effects of physical (habitat modification), biological and chemical disturbances in streams (Moisan and Pelletier, 2008). Benthic community monitoring completes water/sediment quality monitoring.

The project's effects on fish habitat will be assessed using various indicators, notably by comparing benthic invertebrate communities that are exposed to treated mine and domestic effluent with communities that are not (control zone). A study of the benthic invertebrate community will be conducted in Lake Lagopede, where sampling has been carried out in the past.

Lake Lagopede is the study area's largest body of water and is used by the Cree for subsistence fishing activities. Comparing data acquired during monitoring and data gathered for the EBS will enable to assess the real effects of the project components on fish and fish habitats. The compensation measures envisaged (as discussed in Section 7.3.5) will also undergo environmental monitoring.

The fish and benthos monitoring plan described here is based on the recommendations of the *Metal Mining Environmental Effects Monitoring (EEM) Technical Guidance* (hereafter referred to as the "EEM guide") (Environment Canada, 2002; 2011). Although the EEM guide does not apply to treated domestic

[4] In the MMER, an "*effect on the fish population"* means the statistical difference between measurements for the fish population taken in the impact zone and the fish population taken in the control zone; an "*effect on fish tissue"* means measurements of concentrations of total mercury that exceed 0.45 µg/g wet weight in fish tissue taken in an impact zone and that are statistically different from and higher than the concentrations of total mercury in fish tissue taken in a control zone; and an "*effect on the benthic invertebrate community"* means a statistical difference between measurements for a benthic invertebrate community taken in the impact zone and a benthic invertebrate community taken in the control zone in a control/impact plan (Environment Canada, 2002).

wastewater discharge, the same recommendations will be used in the monitoring plan to ensure standardization and scientific rigour.

The sampling plan for fish and benthos monitoring will be a control/impact type plan in which the study area is divided into control zones ("reference areas" in the MMER) and impact zones ("exposure areas" in the MMER).[5] The following summary of the fish and benthos monitoring plan describes the monitoring indicators to be used, the methods, stations, sampling periods and measurement frequency envisaged.

- *BENTHOS*

Monitoring Indicators

To determine whether there are structural differences between the invertebrate communities located near the final effluent discharge point and the control communities, the following descriptors will be used to determine potential effects on benthic communities:

Indicator	Description
Total benthic invertebrate density	Number of individuals per surface unit
Species richness	Number of taxa
Simpson's diversity index	Measurement of uniform breakdown of individuals among taxa
Bray-Curtis index	Measurement of community's total composition
Relative taxum density	Number of individuals of a given taxum per surface unit
Relative taxum abundance	Total number of individuals of a given taxum
Taxum absence/presence	-
ETP index	Groups together the Ephemera, Trichoptera and Plecoptera that are among the biotic indicators of the most sensitive aquatic environments' health
Substrate	Particle grain size distribution and sedimentology

Sampling Sites and Stations

The sectors that will undergo benthic community monitoring are presented below. The control zones will be identified later in the detailed monitoring plan. The benthic invertebrate community study will be conducted in Lake Lagopede to assess the effects of treated mine and domestic effluent on fish habitat. The different benthic communities will be compared with those sampled in the EBS and the control zones using the above-mentioned benthic community descriptors.

[5] "Exposure area" (impact zone) means all fish habitat and waters frequented by fish that are exposed to effluent. "Reference area" (control zone) means water frequented by fish that is not exposed to effluent and that has fish habitat that, as far as practicable, is most similar to that of the exposure area. (MMER, Schedule 5, section 1).

At least one benthos sampling station will be set up in the high-effluent exposure (near-field) area, i.e. as near as possible to the effluent discharge point but located outside the initial discharge zone[6] (Environment Canada, 2011). In subsequent monitoring, sampling stations could also be added in lower effluent exposure (far-field) area for water, sediment and benthos sampling to measure the scope (variation in indicators, e.g. benthic richness and abundance) and the geographic extent (spatial scope) of the effluent effects detected during initial sampling (Environment Canada, 2011).

The number of benthos sampling stations (sample size) and sub-samples taken at each station in the control zone and impact zone will ultimately be determined based on a statistical power analysis. Sampling will be conducted in the most ecologically relevant sectors, i.e. habitats with the greatest benthic invertebrate richness (e.g. sills for streams with coarse substrates (Moisan and Pelletier, 2008); banks, woody debris (trunks, branches) and submerged portions of macrophytes in substrates with unconsolidated substrates (Moisan and Pelletier, 2011); and, for lacustrine environments, riparian sites with exposed bedrock, cobbles, sand, mud, organic debris and macrophytes, among other things (Rosenberg *et al*., 2001)).

To reduce data variability, the sampling stations selected will be representative of the impact zone or control zone's dominant habitat category. Otherwise, a greater sampling effort than the one recommended by the EEM guide could be required.

The EEM guide advises using a large number of control zones to enhance the capacity for assessing problems linked to natural variability, ecological relevance and confounding factors, as well as the capacity to properly assess the control zone chosen. Control stations will be positioned in habitats that are representative of zones exposed to effluents. Sampling stations will be positioned in the northern and eastern bays since they are located upstream of all project infrastructure-related direct influences. An additional control station will be situated in Lake Lagopede so as to have a control station representative of this location.

Monitoring Period, Frequency and Duration

According to the EEM guide, benthic invertebrate sampling should be done in the most ecologically relevant season, i.e. the time of year when benthic invertebrate diversity is highest. Therefore, benthos sampling will be conducted in the fall since this is when most taxa are present in lotic environments, or have reached sufficient size to be sampled, and flow patterns are favourable. In lakes, the sampling period chosen is less critical. Sampling will be performed after the receiving environment has been exposed to the effluent long enough for effects to occur (generally from three to six months) (Environment Canada, 2011).

[6] The initial discharge zone is the area where the effluent often exceeds the velocity of the receiving water and the effluent is buoyant. The initial discharge zone is often characterized by visual turbulence and typically does not extend more than 5 to 50 m from the outfall (Environment Canada, 2011).

The results obtained (effect observed or not) during initial benthos monitoring and the final project calendar will determine monitoring frequency. Environmental monitoring of benthos will be conducted throughout the project's entire duration and in the closure phase.

Sampling Method

The detailed macrobenthos sampling protocol will comply with the recommendations made in MDDEP guides (Moisan and Pelletier, 1998; 2011), the EEM guide (Environment Canada, 2002; 2011) and other complementary guides, if need be (e.g. US EPA, 1997; Rosenberg *et al.*, 2001). Quality assurance and quality control (QA/QC) procedures will be integrated into the macrobenthos sampling plan. Water and sediment samples (particle grain size and total organic carbon) will also be taken at each benthic invertebrate sampling station, as recommended in the EEM guide (Environment Canada, 2011) (see Section 11.4.6).

- *FISH*

Monitoring Indicators

Fish Population

Fish population monitoring consists in determining, if applicable, differences in individuals' abundance, size structure, condition and degree of contamination. Based on these measurements, the following indicators will be used to determine whether fish populations are affected or not.

Indicator	Description
Fish population abundance	Number of fish caught per unit effort (CPUE) and biomass of fish caught per unit effort (BPUE).
Fish population size structure (distribution and average size)	Total fish length and weight by species
Fulton's condition factor (K)	Physiological condition indicator $K = \frac{Mass(g) \times 10^5}{Total_length(mm)^3}$
Health status	Physical anomaly (lesion, tumour or malformation), presence of parasites (in abdomen, on gills or skin), etc.
Fish mercury content and heavy metal levels in the liver	Concentration in mg of mercury and total heavy metals/kg of flesh (or liver) in fish (Lake Trout, Northern Pike and Lake Whitefish)

Fishing yield, i.e. the number of fish caught for a given fishing effort, is the approach used to obtain fish population abundance indices. These yield values can be used to cross-compare environments and monitor a given environment's evolution.

Fish size classes for the fish caught help determine population structure. Among other things, this allows the level of recruitment of juveniles into the population to be assessed. Fulton's condition factor

(K) can be calculated easily using fish length and weight. Sometimes called the girth factor, it permits documentation of the shape (more or less elongated) and "fatness" of fish of a given population. This indicator makes it possible to verify whether the project's environmental impacts cause differences in the availability of food resources.

Verifying a fish's health status allows us to detect the onset of diseases or parasites resulting from modification of fish habitat quality. A visual external examination of the individuals caught live permits detection of tumours, malformations, lesions or external parasites on the gills, fins, skin and even in the abdomen. Dissection of individuals caught dead enables detection of the presence of internal parasites.

Mercury concentrations in fish flesh and heavy metal levels in fish livers constitute potential indicators for fish consumption. Fish mercury levels allow us to determine consumption safety levels and monitor their evolution over time. Heavy metal levels in the liver are an indication of fish contaminant integration through bioconcentration[7] and biomagnification.[8]

Fish Habitat

For fish monitoring, assessment of changes in fish habitat quality will be based on the following indicators:

Indicator	**Description**
Substrate type	Description of the type of substrate in different sites to validate whether its composition changed through the deposit of fine-grained sediment on spawning substrates.
Physical and chemical measurements	Dissolved oxygen, water temperature, pH, total suspended solids (TSS) and turbidity measurements.
Presence and quality of aquatic vegetation	Determine whether water quality modifications will affect existing aquatic vegetation or whether vegetation will develop in new sectors
Benthos	Comparison between benthic invertebrate communities
Free passage	Assess whether fish can move freely in streams affected by the project

The substrate type in certain sections of streams or bodies of water affected by the project will be assessed under the fish habitat monitoring plan. This indicator will make it possible to identify changes in substrate composition and, therefore, to assess whether fine-grained sediment have been deposited on spawning substrates. Fine sediment deposition can potentially seal up gravelly or rocky substrates, causing fish eggs to lack oxygenation or preventing them from adhering to the substrate.

[7] Bioconcentration is a phenomenon by which living beings absorb substances that occur naturally in their habitat and accumulate them in their body at concentrations exceeding those observed in the natural environment.

[8] Biomagnification is a phenomenon by which the concentration of a natural substance or contaminant present in the environment increases at each stage in the food web (food chain).

The physical and chemical quality of water will be monitored to determine whether it has changed and led to changes in fish habitat. For example, an increase in water temperature is likely to cause a decrease in dissolved oxygen concentrations. These changes could alter habitat use by sensitive species, such as Brook Trout and Lake Trout.

The presence and quality of aquatic vegetation will be monitored to determine whether changes in water quality will affect the aquatic vegetation. This indicator will also help verify whether vegetation develops in new sectors due to an increase in nutrients inputs and water temperature.

Studying benthic invertebrates is an indicator that is widely used to assess fish habitat quality. The effect on fish habitat will be assessed by comparing benthic invertebrate communities that are exposed to treated mine and domestic effluent and communities that are not (control zone). This indicator is targeted by a monitoring plan under Section 11.4.8.1.

Free fish passage will be assessed in streams where new culverts have been installed and in streams where a modification of the hydrological regime is expected. This monitoring will make it possible to assess whether fish can travel freely in the stream.

Sampling Sites and Stations

The different sectors targeted for fish monitoring are presented below. The control zones will be identified later in the detailed monitoring plan.

Lake Lagopede

Fish population and fish habitat monitoring is required in Lake Lagopede because it will be affected by the different project components, notably treated mine and domestic effluent, and by changes in some subwatersheds hydrological network. The main sites to be monitored will be located near the effluent discharge point and the sub-watersheds whose hydrological network is modified. Fishing stations will have to be positionned as close as possible to those used as part of the EBS for comparison purposes with the initial state of the environment before mine construction and operation.

In Lake Lagopede, it is planned to position fishing stations near the treated mine and domestic effluent discharge points. Fishing gear position will be based on spring surveys (2011) and fishing conducted by Roche in 2010, and the definitive location of mine infrastructures. Monitoring will focus on certain preferential fish habitats, such as pools and aquatic vegetation.

A first fishing station will be set up near the effluent discharge point (near-field area) but outside the initial mixing zone. A second fishing station will be located in a low-exposure (far-field) area situated nearby. For the domestic effluent discharge point located in the southern section of Lake Lagopede, a first fishing station will be positioned near the discharge point (near-field area) but outside the initial mixing zone. A second fishing station will be located in a low-exposure (far-field) area.

The EEM guide advises using a large number of control zones to enhance the capacity for assessing issues linked to natural variability, ecological relevance and confounding factors, as well as the capacity to properly assess the control zone selected. Control stations will be positioned in habitats that are representative of zones exposed to effluents. Sampling stations will be positioned in the northern part of the lake since they will be located upstream of all direct effluent influences.

Other bodies of water

Other bodies of water could be targeted by environmental monitoring. Among others, the streams and lakes that are located near the processed kimberlite confinement (PKC) area and those affected by a modification in their hydrological regime. Sampling stations will be positioned in the same locations as for the EBS and additional surveys carried out in summer 2011.

The position of fishing stations for environmental monitoring is indicated for information purposes based on key impact sources and will be defined precisely in the detailed monitoring plan. The number of sampling stations and their location will be determined during the first monitoring campaign.

Monitoring Period, Frequency and Duration

For various reasons, summer is the best season for fish monitoring. When water temperatures rise slightly (a few degrees), fish are more active. Their movement increases the probability that they will be caught by stationary fishing gear. Further, since studies of this type are generally conducted in summer, comparison with studies carried out in other environments will be easier (comparison of abundance, size, condition, etc.).

The results obtained (effect observed or not) during initial fish monitoring and the final project schedule will determine monitoring frequency. Environmental monitoring of fish will be conducted throughout the project's entire duration and in the closure phase.

Sampling Method

The fishing methods used in fish monitoring will be based on fishing carried out for the EBS and ESIA, and on the recommendations of the Guide de normalisation des methodes d'inventaire ichtyologique en eaux interieures (Inland water fish monitoring standardization guide) (MRNF Service de la faune aquatique (SFA), 2010) and metal mining EEM guide (Environment Canada, 2002; 2011). Quality assurance and quality control (QA/QC) procedures will be integrated into the fish monitoring sampling plan.

Fish Habitat Compensation Measures

Given the permanent habitat losses generated by the project, various compensation measures are proposed in Section 7.3.5. Fish habitat compensation measures will be monitored during the operation

phase. This twofold program will monitor the measures' integrity and habitat use by fish. To meet Fisheries and Oceans Canada (DFO) requirements, the environmental monitoring program will begin as soon as fish habitat developments have been built. Monitoring periods and number will be determined by DFO.

- *Quality Assurance and Quality Control*

As indicated, quality assurance and quality control (QA/QC) procedures will be integrated into the benthos and fish monitoring plans. The goal of the QA/QC program is to ensure that all field sampling activities produce technically and scientifically valuable results (Environment Canada, 2011). The quality control measures will be based on the EEM (mine) program's specific recommendations for monitoring impacts on fish and benthic communities (Environment Canada, 2011).

For fish, the survey methods recommended are those of the Guide de normalisation des methodes d'inventaire ichtyologique en eaux interieures (Inland water fish monitoring standardization guide) (MNRF, 2011) and the Proponent's Guide to Information Requirements for Review Under the Fish Habitat Protection Provisions (*Fisheries Act,* Fisheries and Oceans Canada (DFO, 2009)).

11.4.2.2 Vegetation and Terrestrial Wildlife

- *Vegetation*

Rehabilitation involves restoring disturbed land to its initial characteristics, as much as possible. This activity will occur during mine operations (progressive rehabilitation) or after mine closure.

The agronomic monitoring program seeks to assess the effectiveness of the revegetation activities carried out during mine rehabilitation.

When the mine site is in operation, agronomic monitoring will be conducted following the settlement of the plant cover installed on the area targeted by the progressive rehabilitation program. This monitoring will occur twice a year the first year (June and August) and then annually for the next four years.

Once the mine site has shut down, the rehabilitation plan will be implemented and the vast majority of the site will be permanently revegetated.

Long-term agronomic monitoring (5 year; annual) of plant populations will then be initiated to verify the survival and condition of the individuals planted. Monitoring will occur in the spring. Permanent quadrats will be set up to measure the following variables for herbaceous land species:

- Number of plants (alive and dead) and their spatial distribution;
- Number of seedlings;
- Presence of outside disturbances (browsing, competing or invasive species, etc.).

For trees and shrubs, the number of individuals (alive and dead), height, base height diameter (BHD), crown width and any sign of disease (yellowing leaves, evidence of browsing, scars, etc.) will be noted. This data could be used to assess the dynamics of new colonies and measure plant growth.

If need be, reseeding will be carried out in areas where regrowth is insufficient. If necessary, topsoil will be spread to facilitate revegetation in these sectors.

- *MAMMALS*

Assessment of impacts and cumulative effects have determined that mammals present could be affected by habitat loss and fragmentation, disturbance, the land's opening up and the mine site's attractive effect due to the landfill and food smells.

The overall objective of the large mammals monitoring plan is to assess the accuracy of the impact assessment and the effectiveness of the mitigation measures implemented. Revegetation effectiveness will be assessed separately by the rehabilitation activity monitoring plan.

More specifically, mammal monitoring seeks to:

- Document Woodland Caribou presence;
- Determine how the Moose population is affected by the mine site's presence;
- Assess the effectiveness of mitigation measures designed to minimize the number of traffic accidents involving large mammals;
- Assess the effectiveness of mitigation measures designed to avoid the presence of unwanted animals on the mine site and to avoid any and all forms of poaching.

Documenting Caribou Presence

The Caribou survey and regional species-related knowledge show that Caribou (woodland forest-dweling ecotype) do not currently use the mine or airstrip areas although historically, small numbers were present in the region of the future mine. Should this ecotype recolonize northward while the mine is operating, it would be important to monitor its presence and the mine's impact on local populations in order to implement species-specific mitigation measures (reduction of traffic during calving season and telemetric monitoring). To document the presence of caribou in the sector, all employees will be informed of the procedures to follow should they sight one or more individuals and of their obligation to report any Caribou sighting to the mine camp (date, observation site, kilometre point on road, presence of young, etc.) in writing or by satellite phone on the observation site. If Caribou are sighted regularly, large mammals experts could be asked to come on-site to determine the ecotype (forest-dwelling or migratory) and the relevance of telemetric monitoring. Since the Woodland Caribou has not been observed in the study area to date, there is currently no reason to make other recommendations for this species.

Despite the current decline of the Rivière aux Feuilles Migratory Caribou herd, it is possible that, in future, its members will enter the region. However, individuals from this herd will be encountered less

and less often. Due to the herd's significant decline and the few mitigation measures that are currently effective for this ecotype, Stornoway will consider making a financial contribution to Caribou-Ungava to promote scientific development of effective mitigation measures or to other MRNF programs in collaboration with Cree populations.

Moose Population Monitoring

Due to the moose's importance for the territory's Cree population and the concerns expressed about the mining project's impact on this species, it will be subject to special monitoring.

During the aerial survey conducted as part of the Environmental Baseline Study (EBS) in March 2011, no moose were observed in the study area's mine or airstrip sectors. However, since moose wintering grounds can change from year to year, it is possible that some individuals might be observed while the mine is operational. During the EBS aerial survey, a control zone was selected more than 8 km from the Renard Project study area. This sector was chosen in consultation with the area's land users and using topographical maps after overflying areas likely to be comparable to the Renard Project study area. The sector resembles the study area in terms of forest stand composition and topography. During the control zone survey, 4 individuals (i.e. two males, a female and a calf) were observed.

An aerial survey of the study area's (127 km²) mine and airstrip areas and the control zone (100 km²) covered by the Environmental Baseline Study will be performed according to the protocol recommended by the MRNF (Courtois, 1991). Population evolution in the control zone will help monitor the influence of natural factors on the moose population.

This survey will be carried out twice a year during the construction phase (2 years) and during the operation phase. Based on the results observed during the first few years of operation, survey frequency will be reassessed.

The work will be done in a helicopter by a survey team composed of two observers experienced in trail sighting and a navigator. All trail systems, isolated single-pass trails, (recent and old) and animals observed during the surveys will be sited on maps and their positions recorded using a GPS. Trail systems will be identified for the species. The habitat encountered in recent trail systems will be described by hovering and collating data on plant composition of the forest cover, slope, exposure and general topography.

Indicators like population density, the calf / female ratio, and habitat use will be used to assess changes in moose populations.

Because the area will open up, more moose are likely to be harvested. To properly document the mine site's impact, the support and collaboration of users of the territory and the MRNF will be essential to document harvesting in the mine and airstrip areas and the control zone.

Wildlife Observation Log

During mine construction and operation, all of the following wildlife observations will be documented:

- Traffic accidents involving large animals, including accident location and severity;
- Sightings of animal pests (e.g. black bear) or any other incident involving employees' actions;
- Any other unusual observation such as death or disease observed on or around the site;
- To avoid chance moose harvesting, moose sightings will be transmitted using a form. This will avoid radio observations being heard by all workers.

This log will determine whether the mitigation measures implemented are sufficient or whether other actions are needed to limit impacts on wildlife.

- *Quality Assurance and Quality Control*

To ensure consistency in monitoring methods and successive monitoring phases, data collection forms will be prepared in advance so that each monitoring phase will be carried out in exactly the same manner (uniform, standardized methods). The moose survey will be performed using the MRNF-recommended protocol (Courtois, 1991) with flight lines spaced every 500 m in the mine area (100 km²) over a slightly larger area than in the airstrip area (29 km²). A 100 km² control zone with similar characteristics to the mine area will also be surveyed. The work could be done using a helicopter. The method currently suggested for woodland caribou surveys is that of Courtois *et al*. (2001). Both of these protocols are MRNF-developed and MRNF-recommended. If possible, the large mammal survey should be conducted in March–April, when observation conditions are most favourable (favourable snow conditions, longer daylight hours and warmer temperatures).

11.4.3 Human Environment

11.4.3.1 Land Use

The Renard Project footprint and the mining operations will be the sources of various impacts and nuisances to affect the use of trapline M11, but these will be rather circumscribed in space. The use of the trapline during the construction, operation and closure phases will be monitored to validate the assessment of the impacts' significance.

The monitoring will specifically concern the use of trapline M11 by the Swallow family members. Its purpose will be to properly identify the impacts of construction work and mining activities on hunting, fishing and trapping, and to collect the users' comments on the different mitigation measures implemented by Stornoway to facilitate the pursuit of their traditional activities.

The follow-up will take place through regular contacts between Stornoway representatives and users of trapline M11. Under the Impact and Benefit Agreement (IBA), the mining company will cooperate with the tallymen concerning the mining activities that could affect the pursuit of their traditional activities.

More particularly, the follow-up will serve to document, using a certain number of indicators, the changes resulting from the Project with regard to all the facilities and activities related to the use of trapline M11.

Table 11.4.7 Proposed Indicators for Monitoring the Use of Trapline M11

Indicator	Description
Camps	Camp locations, number of camps and stays
Access	Use of hunting and trapping routes, snowmobile trails, and navigation courses
Hunting, Trapping and Fishing	Success in big game hunting, fur-bearing animal harvesting and fishing
Valued Sites	Application of IBA provisions concerning burial sites and other sites of cultural interest

It should be highlighted that the IBA includes specific provisions (Sections 9.3.2 and 9.4.1) to involve the Crees and, more particularly, the trapline M11 users, in the actitivies of the environmental monitoring program. The contribution of these users will include the identification of the most relevant follow-up indicators, such as those related to the use of the land and the exploitation of wildlife and plant resources, and building upon their traditional knowledge.

11.4.3.2 Training, Jobs and Economy

As specified in Sections 8.3 and 8.4 of the ESIA, the implementation of the Renard Project will have positive spinoffs in training, jobs and the economy, for the Crees and the region.

With a view to enhancing such spinoffs, Stornoway has taken a set of commitments concerning Cree training to improve their employability, as confirmed in the IBA where job and business opportunity objectives for the Crees have also been established.

The purpose of the preliminary monitoring program described below is to validate the assessment of economic spin-offs and gauge the effectiveness of selected enhancement measures.

The data needed to follow-up on the economic spinoffs will be gathered by Stornoway's Human Resources Service. They will be collected in the specific perspective of following up on the spinoffs at the regional level and within the Cree communities. Three subjects will be documented:

- Training;
- Jobs;
- Service contracts and goods and services procurement.

The data to be gathered will highlight the regional and Cree distribution and will concern the indicators in Table 11.4.8 below.

Table 11.4.8 Proposed Indicators for the Monitoring on Training, Employment and Economy

Indicator	Description
Training Programs	Types of programs implemented, school clientele and completion rate
Jobs	Part relative portion of Cree regional jobs, type and extent of jobs, sociodemographic profile of workers
Regional Spin-offs	Value of supply and services contracts and portion of regional suppliers
Work Experience	Appreciation of the experience and level of post-project employability

These data will serve to validate, every year, during the construction phase, achieving job objectives for the Crees as established by the Training and Employment Committee (part of the Renard Committee). Such validation will be carried out every three years during the operation phase. The data will also allow to identify problems related, for instance, to employee hiring, attendance at work, competence, workers satisfaction or retention, and to identify areas of improvement.

Given the objectives defined to this effect in the IBA, Cree participation, more particularly, trapline M11 users, will also be considered in the environmental monitoring.

As communications already initiated by Stornoway will continue with regional stakeholders, the data collected will be submitted for comment and discussion to the Renard Committee and the Training and Employment Committee as provided by the Impact and Benefit Agreement (IBA). Under the IBA, the Renard Committee must meet at least four times a year. This information will also be shared with the Chibougamau and Chapais authorities.

The relevant information will be mainly collected by Stornoway using appropriate data collection tools upon hiring and job termination in cooperation with local and regional institutions.

In order to include the spinoffs of the Renard Project in a perspective of long-term regional cumulative effects, Stornoway will set aside appropriate funds for a post-closure monitoring on employment conditions. The amount of funds required for the follow-up will be established jointly with the Renard Committee and will be part of a fund similar to the financial guarantees deposited for the rehabilitation of the site upon closure of the mine.

The topics likely to be analyzed during the post-closure monitoring will include the following:

- Hiring procedures;
- Training programs;
- Advancement opportunities;
- Working conditions;
- Strong and weak points of employment conditions;
- Post-closure employability.

11.4.3.3 Health and Well-being

The monitoring program relating to health and well-being will focus on these two themes in particular:

- Trapline M11 users' perception of the project;
- The integration of Cree workers.

➢ *PERCEPTIONS*

Consultations conducted during the environmental and social impact assessment (see Chapter 4) clearly highlighted the importance of the population's concerns. These concerns are the very foundation of the social acceptability of the project and justify that Stornoway extends the consultation process already implemented, during the course of the Project.

Follow-up on perceptions will be carried out at the same time as the land use monitoring (see Section 11.4.3.1).

The purpose will be to document the concerns and comments of trapline M11 users, particularly with regard to the implementation of mitigation measures, including land use measures and measures implemented for other components such as wildlife habitats. The monitoring program will contribute to validate on site, based on local Cree knowledge, the capacity of the environment to adjust to the Project and the effectiveness of the mitigation measures.

In addition, Stornoway will keep a register of complaints thay may be made with regard to project operations by trapline M11 users or any other stakeholder in the region. A complaint processing flowsheet will be submitted to the MDDEP with the request to obtain the certificate of authorization in compliance with Section 22 of the *Environment Quality Act.*

Stornoway is also willing to transmit all the relevant information on the perception and concerns to any regional organization monitoring the parameters characterizing the population's overall well-being, such as the Cree Board of Health and Social Services of James Bay (CBHSSJB) or the James Bay Regional Health and Social Services Centre (JBRHSSC). In this respect, a similar follow-up has been ensured in recent years by the government of the Northwest Territories as part of a socio-economic agreement with the three local diamond companies, including BHP Billiton, Diavik (Rio Tinto) and De Beers. The monitoring is conducted by an independent organization of the mining companies and involving government analysts[9]. It covers 17 indicators accounting for community, family and individual well-being (see Section 8.3.5.1). As part of the planned mine development for the James Bay territory, such a follow-up conducted by an external organization at the mining companies could eventually be desirable. Stornoway is willing, in cooperation with other mining companies, to support the effort of such an organization that could act, for instance, under the aegis of the future regional *Eeyou Istchee* James Bay government. Similar to the experience conducted in the Northwest Territories, the monitoring could

[9] The administrative units concerned are related to education, culture and employment, finances, health and social services, industry, tourism and investment, justice, statistics and accommodation.

be based on a set of indicators provided either by the public authorities or the mining companies. The purpose of the monitoring would be to validate the assessments conducted as part of the ESIAs and to separate what falls under the mining economy from other socio-economic factors. Table 11.4.9 provides a list of potential indicators. Ideally, those indicators should be documented to include the entire *Eeyou Istchee* James Bay territory, more particularly, the Mistissini, Chibougamau and Chapais communities.

- *INTEGRATION*

As experienced recently in three other projects implemented in the *Eeyou Istchee* James Bay region (the Eastmain-1 and Eastmain-1-A-Sarcelle-Rupert hydro-electric projects and the Troilus mining project), the integration of Cree workers on industrial worksites and operations is an issue that continues to justify a monitoring of the measures implemented under such circumstances.

Table 11.4.9 Potential Indicators of Socio-economic Impact Monitoring on the Mining Projects across the *Eeyou Istchee* James Bay Territory

Indicator	Source
Social Data	
Population and Age Group	Statistics Canada, Institut de la statistique du Québec (ISQ), Indian Affairs (AANDC)
Newborns	Local Hospitals
New Residential Constructions	Cree Cities and Communities
Value of the Housing Inventory	Cree Cities and Communities
Schooling and Earling-school leaving	Ministère de l'Éducation, du Loisir et du Sport (MELS) and School Boards
Income per Houshold and Resident	Statistics Canada and ISQ
Economic Data	
Unemployment and Employment Rates	Emploi-Québec
Jobs per Industry and Profession	Emploi-Québec
Number and Specialities of Regional Businesses	Emploi-Québec, ComaxNord, Cree Cities and Communities
Investments in Municipal Infrastructures	Cree Cities and Communities
Number and Types of Mining Industry Jobs	Stornoway and Other Mining Industries
Value and Type of Regional Service and Procurement Contracts	Stornoway and Other Mining Industries
Health and Well-being Data	
Life Expectancy	Statistics Canada and Ministère de la Santé et des Services sociaux (MSSS)
Suicide Deaths	Institut national de santé publique du Québec (INSPQ)
Infectious Diseases	ISQ
Teen Pregnancy	Statistics Canada and MSSS
Single-parent Families	Statistics Canada
Spousal Abuse	Ministère de la Sécurité publique (MSP)
Crime against Persons and Properties	Ministère de la Sécurité publique (MSP)
Integration and Social Support	Statistics Canada and INSPQ
Homeownership Rates	Statistics Canada

The data on the integration of Cree workers will be documented by Stornoway's Human Resources Department using the comments collected by staff. If the need arises, the company will also conduct surveys with the workers or organize workshops to allow for the documentation of relevant aspects.

The themes likely to be documented include the following:

- Reasons motivating employment;
- Appreciation of work experience;
- The difficulties and obstacles encountered;
- Appreciation of life at the mining camp;
- Acquired skills;
- Certain aspects related to employability;
- Family contacts;
- The presence of family problems;
- Close relatives' reactions;
- Working relations between Cree and non-native workers;
- Appreciation of measures implemented to facilitate the integration of Cree workers.

11.4.3.4 Archeological, Historical and Cultural Resources

Archeological and historical resources do not justify the need for any follow-up program in particular.

As mentioned in Section 8.6.2.1, site preparation and development work will have no effects whatsoever on the archeological resources of the land, given the distribution of potential archaeological sites. Any archaeological chance find during work will be treated in compliance with the provisions of the *Cultural Property Act* of Quebec. With regard to burial sites, management provisions with trapline M11 users are provided in the IBA.

11.4.3.5 Quality Assurance and Control

Quality assurance and quality control (QA/QC) procedures will be integrated into the human environment monitoring program. The selected measures will mainly involve controlling documentary sources, validating statistical references, and recording observations.

11.4.4 Follow-up on the Impact and Benefit Agreement (IBA)

During the different phases of project development, a follow-up will be carried out on the IBA. The mecanisms for this process are yet to be defined, but the main themes to be explored are the following:

- Jobs;
- Training;
- Workers' integration;
- Communication;
- Environment.

Such a follow-up will likely be conducted by various committees, including the Renard, the Employment/Training and Environment committees, with the participation of the Crees.

Chapter 12

Assessment of Technological Risks and Management of occupational Health

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12 Assessment of Technological Risks and Management of occupational Health and Safety

This chapter reviews aspects relating to technological risks and the management of occupational health and safety. The design, equipment supplies and construction phases described in the project implementation plan, together with the operation phase described in the operation plan, are covered in this chapter.

The project management team are committed to continuous improvement so as to achieve the highest possible health, safety and environmental standards (HSE) during the construction phase. All labour practices will comply with current legislative requirements and with the project implementation plan, as regard to health, safety and the environment. Every contractor working on the site will be required to ensure environmental protection measures and the ongoing health and safety of their employees. The HSE risk management plan will comply with all applicable statutes and regulations, as well as OSHA and ISO 14001 standards that will be used as guidelines in the pursuit of the continuous improvement of health, safety and the environment.

Implementation of the health, safety and environmental management plan will be the responsibility of the Director of Health, Safety and Environment, who will report to the Project Director. Nonetheless, in the interests of achieving the highest possible environmental standards, both the site construction manager and the entire construction management team will be expected to work in close collaboration with the HSE Director and its staff.

The plan for the operation phase is designed to create an effective management strategy that can ensure compliance with the health, safety and environment standards. The philosophy behind the operations plan recognizes the need to promote the implementation of robust systems governing health, safety and the environment. The programs targeting preventive maintenance and continuous improvement will be designed to ensure that high standards are applied and built on over the course of the project. A commitment to training is also an important aspect of the operation plan.

12.1 Health Management

This section deals with occupational health and issues relating to potential food poisoning and health hazards link to drinking water.

12.1.1 Occupational Health

The industrial health program for the project is designed to ensure that workers at the site are not exposed to contaminants or chemical agents that could potentially affect their health or physical well-being. It involves the identification and tracking of these contaminants and physical agents so that recommendations can be made as to how they should be controlled at their source and/or what appropriate personal equipment must be provided to ensure the protection of workers. The program

was developed to ensure compliance with the requirements of the Regulation respecting the quality of the work environment (c. S-2.1, r.15).

Airborne workplace contaminants to be monitored are:

- Concentrations of respirable dusts such as that from crystalline silica;
- Combustible gases, carbon monoxide, nitrogen dioxide, hydrogen sulfide and radon, in the underground mine; and
- Carbon monoxide in the process plant and in the accommodation and service complex.

Physical agents to be monitored are:

- Noise;
- Exposure to X-rays; and
- High or low temperatures.

The occupational health program also includes monitoring and documenting levels of ventilation in the underground mine.

The occupational health program will be administered by staff from the occupational health and safety department.

12.1.2 Food and Drinking Water

This aspect of the program is designed to ensure that the quality of drinking water is regularly monitored and the information collected properly documented.

The emergency response plan will include specific provisions regarding the steps to be taken in response to any incident of food contamination or any potential epidemic at the camp.

12.2 Safety, Health and Environmental Management

This section deals with the management of worker's health and safety and protection of the environment. It has two distinct parts: a safety program for the construction phase of the project and a safety program for the operation phase.

12.2.1 Specific Risk Management during the Construction Phase

Stornoway Diamond Corporation (Canada) Inc. and the Representative of the prime contractor (composed of the companies responsible for the engineering, administration and management of the construction phase) of the Renard Diamond Project are committed to make occupational health and safety a paramount and ongoing concern. No production target or expected return on investment will be allowed to justify actions that could endanger the physical or mental well-being of people at the site or risks that could potentially lead to occupational injuries.

In more concrete terms, the Renard Project team undertakes, in full compliance with related legislative requirements, to ensure and maintain a healthy and safe work environment for all its employees as well as for anyone involved in the project implementation (contractors and subcontractors, for example).

To this end, a workplace safety program has been prepared, based on a strict and rigorous application of Health and Safety regulations and in accordance with the procedures established by Stornoway and the Contract Team Representative.

Responsibility for application of the prevention program guidelines includes all levels of decision-making, right down to the workers themselves. All workers on the site have an obligation to perform their duties without endangering their own safety or that of any other person. All activities carried out must comply with the rules established by the worksite management team and health and safety standards.

The overarching goal of the prevention program is to eliminate at their source any risk factors for the health and physical well-being of workers.

Figure 12.2.1 provides a schematic overview of the different facets of the occupational health and safety program during the construction phase.

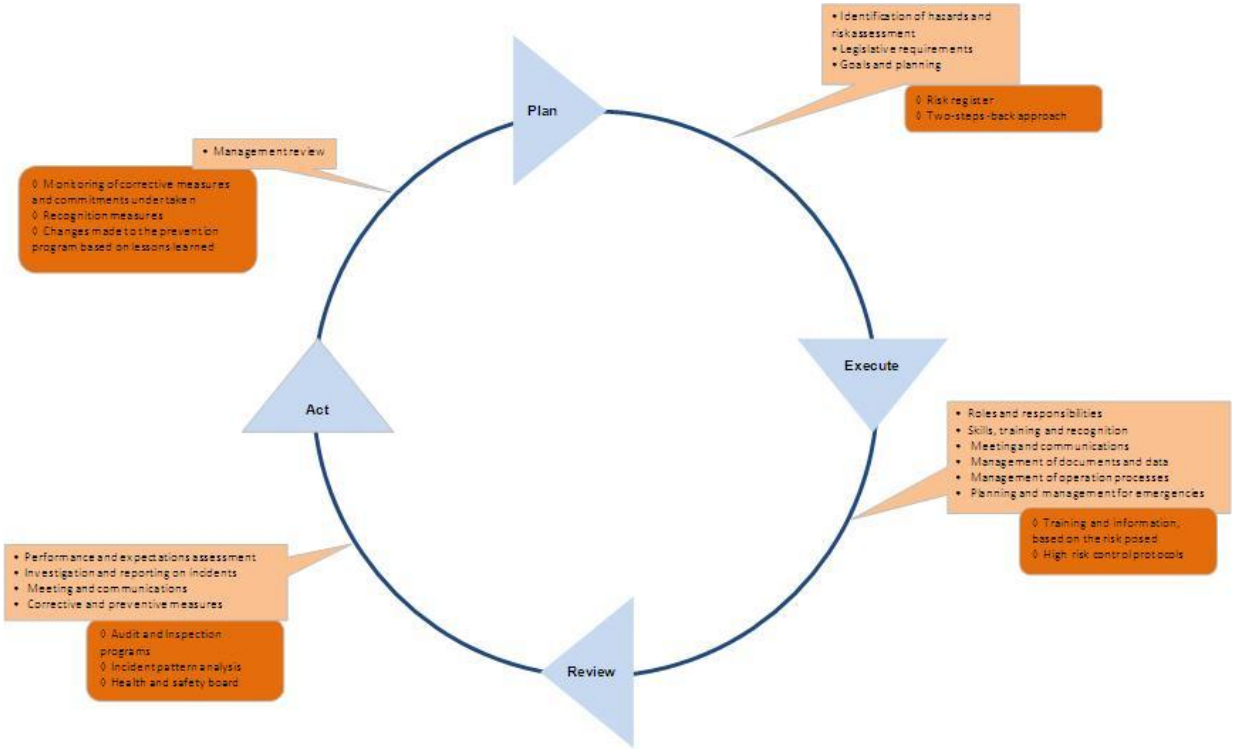


Figure 12.2.1 Schematic representation of the worker risk prevention program during construction phase

12.2.1.1 Employer obligations

Contractors must adopt and apply those principles of the risk management process that apply to their field of operation. If necessary, specific risk prevention provisions can be incorporated into contracts with contractors and subcontractors.

Contractors must be able to demonstrate that safety is a top priority for their organization. The risk manager of the prime contractor will be required to proactively assess the capacity of each contractor to provide services consistent with the project risk management objectives and ensure that corrective measures are taken as needed.

The Project Director will have the responsibility to request risk management verifications that he or she deems necessary.

12.2.1.2 Criteria as low as reasonably practicable

It is important to note that risk tolerance criteria include requirements for risk mitigation measures. Stornoway Diamond Corporation (Canada) Inc. has established as its overriding goal for risk management on the Renard project the reduction of risks to the lowest possible levels at all times during the construction, operation and closure phases. Lowest possible levels are defined by the ALARP principle (as Low as Reasonably Practicable). The ALARP principle is illustrated in Figure 12.2.2. This principle is widely used and recognized by the competent authorities in risk management. Its goal is the development of a continuous improvement process over the course of each phase of the project. Stornoway Diamond Corporation (Canada) Inc. will apply this principle to achieve the objectives established through the use of a risk management process.

12.2.1.3 Risk register

A risk register is the primary tool used for monitoring risks identified and corresponding appropriate actions. It contains the following details:

- Identification and description of risk factors;
- Assessment of levels of risk and the main risk factors, with their potential consequences and probability of occurrence;
- Summary of control, safety and recovery measures needed to maintain risks at ALARP levels (As Low as Reasonably Practicable);
- Risk reduction and control measures and identification of those responsible for their implementation; and
- Assessment of expected levels of risk after implementation of control and risk mitigation measures.

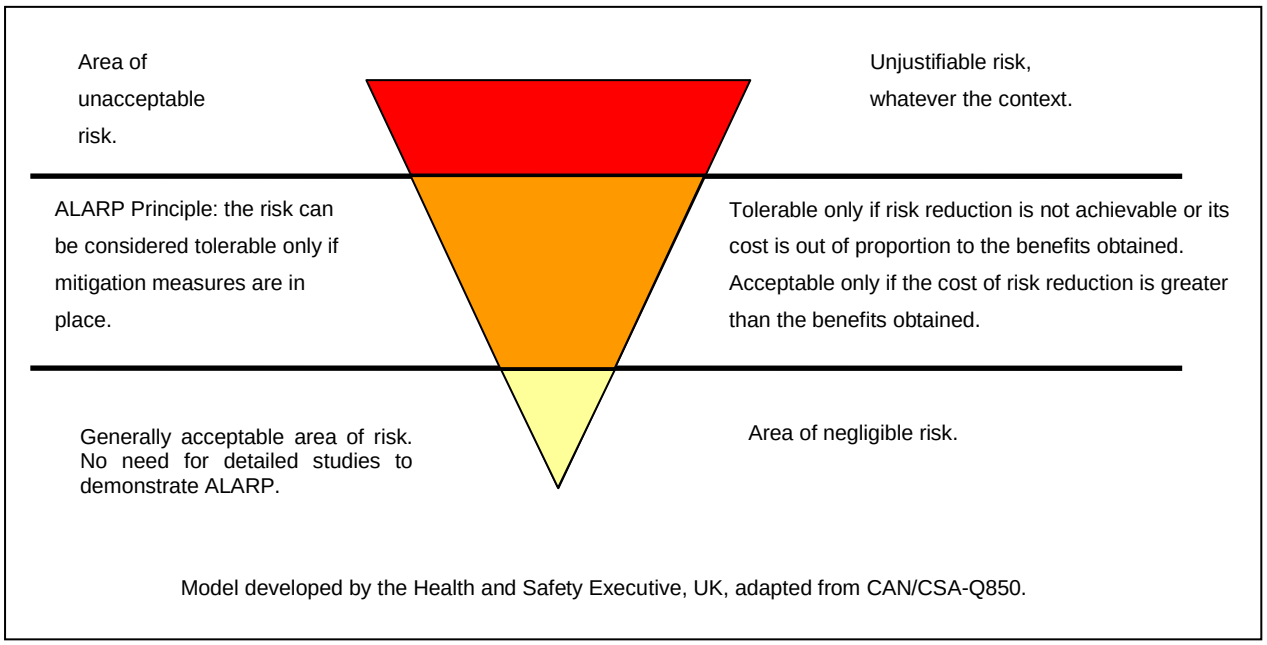


Figure 12.2.2 ALARP Principle

The risk register is an essential tool for the identification of all anticipated risks and the attribution of resources to eliminate or manage them until they reach an acceptable level as defined by the ALARP principle.

The risk register is an indispensable monitoring tool that will be used during the construction phase of the Renard Project. It will continue to be used during the operation phase.

Information contained in the risk register will be updated whenever an action is completed or corrected.

The final version of the risk register for health, safety and the environment can be found in Appendix 12.1.

12.2.1.4 Organization and responsibility

A risk manager will be appointed to the project services team to oversee the risk management process for all the phases of the project. The Project and Operations Directors will be responsible for the risk management process and will receive reports directly from the prime contractor Risk Manager. The Project Director will be responsible for establishing and maintaining an organizational culture characterized by efficient work processes that encompass risk management objectives, and for implementing recommendations to improve risk management.

Specific responsibilities of the Risk Manager reporting to the Project Director will be as follows:

- Ensure application of the risk management strategy using a risk management process;
- Ensure that the organization has adequate funds and resources to carry out the risk management process;
- Establish and maintain a risk management program;

- Establish and maintain a risk register;
- Apply the information obtained from the HAZID and HAZOP risk analyses as a means to reduce the frequency and consequences of incidents to levels deemed to be as low as reasonably practicable (ALARP principle);
- Ensure that actions designed to achieve risk reduction are defined, approved, assigned to those responsible and acted upon;
- Set up processes that ensure that needed decisions on risk mitigation measures are actually taken;
- Design, organize and carry out studies on safety pertaining to major and minor accidents;
- Update technical risk analyses when changes are made to project design or when other incidents occur that could have an impact on the existing analyses;
- Ensure that risks are adequately taken into account when emergency response plans, operating procedures and training programs are being prepared;
- Ensure that all possible options are given consideration in order to achieve the highest possible level of technological security and incorporate fail-safe design principles;
- Ensure that the results and effects of the risk management process are communicated to the group responsible for health, prevention, the environment and risk management during the operation phase;
- Ensure that the organization and application of risk management processes are carried out in ways that allow for periodic reviews by a third party; and
- Seek to continually improve procedures and work methods so as to maximize the efficiency of the risk management process.

12.2.1.5 Performance indicators in HSE management

Both retroactive and prospective performance indicators will be used for the construction phase in order to identify any deviations from HSE programs and to implement corrective measures. Shown below is a partial list of the performance indicators that will be used.

Prospective performance indicators:

- Checks (audits, inspections) completed;
- Awareness campaigns;
- Training of subcontractors in HSE and assessment;
- HSE meeting;
- Practices of the emergency response plan;
- Training in first aid and CPR;
- Work permit;
- Training in risk assessment;
- Observation of safe practices; and
- Training for specific tasks.

Retrospective performance indicators:

- Rate of accidents logged;
- Rate of lost time accidents;
- Level 1 environmental incidents;
- Level 2 environmental incidents;
- Level 3 environmental incidents;
- Lost workdays;
- Number of first aid cases;
- Number of cases of modified work tasks;
- Number of modified workdays;
- Number of near-misses; and
- Number of occupational illnesses.

12.2.2 Specific Risk Management during the Operation Phase

This section deals specifically with the operation phase of the project.

The health and safety policy for the operation phase is a continuation of the policy applied during the construction phase. The policy complies with the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.1 r.14). The ALARP principle and the risk register described above will continue to apply for the entire lifetime of the project.

The goal of the prevention program is to eliminate at the source any hazards to the health, safety and well-being of workers.

The elements in the list that follows are included in the workplace health and safety program. They concern mining activities and are required for mining operations.

- Individual protective equipment:
  - Safety harness;
  - Safety belt;
  - Hard hat;
  - Safety goggles;
  - Protective footwear;
  - Close-fitting clothing;
  - Quality of air feeding personal respiratory protective device that respects breathable air quality standards; and
  - Self-contained breathing apparatus.
- Specific activities and resources:
  - Monitoring of mine workstations at a predetermined frequency;
  - Access to an abandoned underground mine; and
  - Number of self-contained breathing devices.
- Minimum equipment:
  - Self-rescue-type of self-contained breathing apparatus;
  - Instant-read gas measuring device, with detectors for carbon monoxide, nitrogen dioxide, oxygen and combustible gases;

- Positive pressure oxygen unit;
- Stretcher;
- Suitable supply of rope.

- Mine rescue stations;
- Trained mine rescue teams;
- First-aid equipment;
- Obligation to report certain incidents to the CSST (Quebec commission responsible for occupational health and safety).

12.2.2.1 Specific elements of the prevention program

➢ *ACCOUNTABILITY*

As stated above, responsibility for application of the prevention program guidelines includes all levels of decision-making, right down to the workers themselves. All workers on the site have an obligation to perform their duties without endangering their own safety or that of any other person. All activities carried out must comply with the rules established by the site management team and current health and safety standards.

Clear leadership must be shown by company senior executives to ensure continuing improvements in prevention performance through their policy development, and also by encouraging employee involvement, communicating needed information and allocating appropriate resources.

A health and safety committee will be established and a prevention representative appointed, as stipulated in the Act respecting occupational health and safety (R.S.Q., chapter S-2.1) and the corresponding Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1). Minutes of the committee meetings will be publicly available.

The different elements of the operations safety program are described below.

Process-related knowledge

The following documents or plans will be prepared, kept up-to-date, and communicated to anyone needing to know:

- Hazards posed by the process;
- Normal and abnormal operating conditions;
- Protection systems, including the consequences of their malfunction;
- Electrical layout plans, process control diagrams; and
- Ventilation systems.

The following activities will be carried out:

- Keep of up-to-date records on equipment design and modifications;
- Identification of safe operating conditions; and
- Establishment and regular updating of operating procedures.

➢ *ON-SITE HAZARDS*

Comprehensive and ongoing documentation about on-site hazards will be prepared, kept up-to-date, and made available to employees. The documentation will include the Material Safety Data Sheets for chemical products, the HAZOP reports and the specific instructions provided by suppliers of equipment at the mine. A HAZOP study was carried out by SNC-Lavalin during the project design phase. This HAZOP study will need to be updated and amended whenever changes are made at the site.

- Site risk reviews will be carried out at pre-determined time intervals, recorded and added to the risk register;
- Corrective measures will be implemented when deemed necessary.

Job Safety Analysis (JSA)

In a job safety analysis, the risks or hazards of each specific job task during operation activities, including maintenance, are identified, as well as corresponding mitigation measures. Job safety analysis is a valuable tool in an effective workplace safety planning process of work:

- The sector supervisor, backed up by the Health and Safety Coordinator, carries out the JSA in liaison with workers in the sector;
- A JSA must be carried out before any new activity begins or when changes are introduced (new tools, equipment, materials, procedures, workplace organization, etc.).

➢ *CHANGE MANAGEMENT*

Change management is a process designed to ensure strict control and appropriate communication around all changes involving equipment, work methods, procedures, organizational structures, etc.

Before any change is introduced, a hazard identification and risk analysis should be completed to ensure the change will not result in injury to people or damage to property or equipment. This process should give consideration to both planned and unexpected changes.

Changes must be communicated to the workers they will affect.

➢ *MANAGEMENT OF SUBCONTRACTORS*

Subcontractors must, at the very least, demonstrate compliance with Stornoway Diamond Corporation (Canada) Inc.'s health and safety program. Stornoway Diamond Corporation (Canada) Inc., for its part, is responsible for communicating to them the necessary information to ensure their own safety and that of Stornoway employees and to avoid any damage to company facilities. The activities listed below are part of the subcontractor management process:

- Development of a safety program for subcontractors;
- Providing subcontractors with safety-related information held by Stornoway;
- Development of an orientation program for subcontractors to be distributed to those subcontractors whose services are used by Stornoway; and
- Assessment of the safety performance of subcontractors and implementation of any needed corrective measures.

➢ *PRE-STARTUP REVIEWS*

Safety reviews will be conducted for all facilities during their design phase and before their startup. Inspections and controls will be carried out to ensure that equipment installed complies with plans and specifications. A complete official list of inadequacies will be drawn up and these inadequacies managed according to the level of risk they represent. Checks and critical tests will be completed prior to use of the equipment.

Mechanical reliability of equipment

The goal of the monitoring program for the mechanical reliability of equipment is the prevention of equipment breakdowns that could pose a risk to health and safety of worker or result in economic loss to the company. The program consists of the following elements:

- Design, build and maintain facilities using sound engineering practices consistent with codes and standards;
- Apply the relevant regulations;
- Take into account , any voluntary or agreed-upon standards, in addition to equipment manufacturers' instructions for design, construction and maintenance;
- Choose sub-contractors familiar with the relevant codes;
- Carry out equipment inspections and tests that meet the requirements of the applicable codes;
- Develop a documented maintenance and inspection program to ensure the integrity of facilities; and
- Develop a preventive maintenance program that includes inspections, testing and maintenance procedures, and define the appropriate intervals for carrying them out.

➢ *CRITICAL SAFETY PROCEDURES*

A certain number of procedures and safe work practices will be implemented to ensure the safe operation and maintenance of project facilities. Clearly formulated written procedures for safe practices will be prepared. The following critical safety procedures will be put in place:

- Working at heights;
- Working in confined spaces;
- Isolation and lockdown;
- Trenches and excavation;
- Hot work;
- Electrical work; and
- Handling of heavy loads or at-risk lifting practices.

➢ *TRAINING*

The Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1) specifies the training in health and safety that workers must have received, as defined in the modules of the training course published by the l'Or-et-des-Bois School Board.

In the case of workers who will not be working in the underground mine, a specific training program targeted to their different workplace occupations and assigned duties will be developed. Initially, the skills and knowledge required to carry out their duties will be identified, in particular, duties of critical importance for health and safety. The job safety analyses previously carried out will be among the tools used for this training. The knowledge and experience needed to perform work safely will be emphasized. Critical safety procedures and the emergency response plan are also crucial aspects of the training program. Participants will be taught how to use personal respiratory protective devices and sensors for detecting contaminants in the air. The training program will include both classroom-type (theory) and on-the-job (practical) training. Evaluations will be carried out to ensure the workers have acquired the needed knowledge and skills. They will be required to demonstrate their knowledge before being assigned any duties. Training files for employees will be kept up-to-date.

Information

Every person entering the project site will be informed on arrival of the safety rules governing the site and the emergency response plan, including the warning systems, evacuation procedures and other actions to be taken, hazards due to working in the cold (outdoor work) or in hot work, and risks associated with wild animals, including bears. It should be noted that high temperatures are not expected to be a factor in the underground mine at the projected depths. Furthermore, several types of meetings and the use of noticeboards are planned to enable relevant and up-to-date information to be communicated. This strategy will be documented in a communications plan which will provide details on the activities, responsibilities, frequency of incidents and groups targeted. A partial listing of planned information sessions is shown below:

- Health and safety meetings at predetermined intervals;
- Review of work procedures;
- Review of hazards represented by controlled products;
- Review of lessons learned from accident inquiries, near-accidents; and
- Review of routes and methods of evacuation from the underground mine.

➢ *INVESTIGATION OF INCIDENTS*

A policy for investigation of incidents will be instituted. The policy will cover incidents resulting in injuries, loss of containment for controlled materials, damage to equipment and loss of production. It will also cover near-incidents that could constitute highly valuable lessons. Investigations of incidents will be carried out for the purpose of identifying their causes, especially root causes, and determining the corrective measures required. Investigations of incidents will be carried out immediately following an incident. The lessons learned from these investigations will be shared with the people who need to learn the results of the investigations, including workers who could be potentially exposed to the same risks.

Inspections and compliance audits

A number of different kinds of inspections and audits are planned to ensure that all aspects of the health and safety program are in place and functional, and to corrective measures, where necessary. The list below identifies certain types of inspections and audits:

- Inspections of emergency equipment, the protection measures of evacuation systems, intervention measures in the event of fire;
- Testing of work practices;
- Equipment inspections;
- Preventive maintenance inspections;
- Inspection and maintenance of heavy equipment;
- Tool inspections;
- Inspections by government authorities;
- Health and safety audit to examine the application of programs;
- Fire protection audit; and
- Insurance company audit.

➢ *PERFORMANCE INDICATORS*

Retroactive and prospective performance indicators will be established to identify any deviations from the programs and institute corrective measures.

➢ *RETROACTIVE INDICATORS*

- Rate of accidents logged;
- Rate of lost time accidents; and
- Number of losses of confinement of controlled products that affected the environment.

➢ *PROSPECTIVE INDICATORS*

- % of planned inspections that took place after the scheduled period;
- % of planned training programs that were not implemented;
- % of corrective measures identified during investigations of incidents, inspections or audits that did not take place within the period identified in the corresponding action plans; and
- Number of process malfunctions that could potentially affect the environment.

➢ *FIRE PROTECTION*

The fire protection system is designed to protect both above-ground and underground facilities. The equipment complies with the following National Fire Protection Association (NFPA) codes: NPPA 13 - Sprinkler Network, NFPA 14 - Fire System Network, NFPA 20 - Fire Water Pumps, NFPA 10 - Portable Fire Extinguishers, NFPA 30 - Flammable and Combustible Liquids Code, the 2005 National Building Code of Canada and the relevant FM Global Property Loss Prevention Data Sheets covering automatic sprinklers, mine conveyors, automatic fire detection systems, ore process facilities, flammable liquid

storage tanks, hydraulic systems, etc. Fire protection systems for the underground mine comply with the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1).

The ground-level buildings covered by the fire protection measures are: the accommodation and service complex, the offices, the mine dry room or changehouse, maintenance facilities, the garage, the storage depot, the fuel storage area and the gas or diesel filling station, the water pumphouse, the water treatment plant, the wastewater treatment plant, the solid waste management area, the power generating nets, the ore process plant, the cold-storage warehouse, and the core sample storage depot.

A fire protection water supply system, connected to fire hydrants, will be constructed nearby of project buildings. The distance left between hydrants will be based on the location of the different buildings.

Fire hydrants will be installed 60 m from the fuel storage area. They will be positioned so that either flexible hoses or water cannons supplied by two hydrants can be used to protect each tank.

Fuel storage tanks will be located in a retention basin.

Supply lines for the fire-retardant foam for petroleum-based fires, with feed points outside the retention basin, will facilitate its use for firefighting.

A reserve supply of AFFF firefighting foam, the exact quantity of which will be established during completion of the engineering of site facilities, will be stored on site.

An emergency vehicle equipped with a fire-fighting water pump will be kept on site.

For the airstrip and terminal, firefighting equipment, including a suitably sized wheeled fire extinguisher will be parked on site and housed in the mobile equipment garage.

- *FIRST AID*

The company will establish a first aid station staffed by qualified medical personnel, with the supplies and equipment needed in the context of mining operations. Medical staff will implement the specific medical program required for mining operations.

Medical staff at the site will be able to provide emergency care. However, if the situation warrants it, they may call for a doctor from an emergency clinic.

Any person who has been injured or who experiences symptoms of physical discomfort should go to the first aid station to receive medical attention.

- *FIRST RESPONDERS AND FIRST AID KITS*

The number of first aid workers and first aid kits required under the Regulation respecting occupational health and safety in mines will be made available, in addition to a first responders and mine rescue team (R.S.Q. c. S-2.2 r.19.1).

➢ *TRANSPORTATION TO A HOSPITAL CENTRE*

Any injured worker requiring emergency evacuation to a hospital facility will be transported by plane or helicopter using the airstrip.

The Renard Project emergency plan will contain a description of the steps and measures to be taken in such circumstances.

➢ *HUMAN ERROR*

Particular attention will be paid when the detailed design of the facilities is being prepared, so as to reduce to a minimum the potential for human error.

A program to reduce the potential for error or for behaviours that could potentially cause accidents will be developed and applied for the operation phase of the project.

12.3 Management of Technological Risks

This section identifies the technological risks associated with the construction, operation and closure phases of the Renard Project, more specifically, with the mine (underground and open pit mines), the process plant, road access, the airstrip and the processed kimberlite management. The different areas covered by the assessment of technological risks include:

- Extraction, handling and storage (underground and open pit mines);
- Process plant and the different equipment used;
- Processed kimberlite management;
- Storage of petroleum products;
- Storage of chemicals;
- Explosives storage facility (magazine);
- Power generating sets;
- Domestic and mine wastewater treatment plants;
- Equipment maintenance facilities;
- Airstrip;
- Accommodation and service complex; and
- Secondary mining roads, use and maintenance of machinery and road traffic.

This assessment was used to identify the major risks, their consequences, the occurrence probability, prevention or mitigation measures established, and safety management. The Renard Project is located at a considerable distance from any permanent human settlement and does not present any risk for local population, if an accident were to occur. Nevertheless, an accident could affect site workers and the environment. The site is also at a great distance from resources that could potentially be called on in the event of a major accident and then would need to be able to draw on its own emergency response capacity. This demonstrates the importance of identifying risks that could be encountered so that

resources for addressing emergency situations are available and can be deployed rapidly and with confidence in the event of a major accident.

Stornoway Diamond Corporation (Canada) Inc. considers that the assessment of technological risks is a crucial element in the risk management process that has been adopted and applied for this project. This risk management process will ensure that the probable consequences of previously-identified accident scenarios will be reduced so as to keep risk levels as low as is reasonably practicable (ALARP).

Appropriate intervention measures will be chosen for inclusion in the emergency response plan. During the construction phase, any incidents that could constitute a threat to the environment, or any aspect of it, will lead to the application of the specific emergency response for that phase. An appropriate emergency response plan will also be prepared for the permanent closure of the facilities. The operation phase calls for a more detailed technical risk analysis in light of the potential hazards at the mine site.

12.3.1 Why Assess Technological Risks?

The distance between the operations of the projected Renard mine and available public resources means that the mine operator will be responsible for carrying out initial emergency response if a technological accident, an accidental spill, etc. were to occur. The assessment provides information on intervention measures and procedures to adopt in the following cases:

- Transport of hazardous materials (petroleum products, chemicals, explosives, etc.) or potentially dangerous material;
- Spills of hazardous materials on the access road or on secondary mining roads, or on the site itself, with particular emphasis on speed of intervention and the emergency response resources available on site;
- Storage of hazardous materials (propane), petroleum products or other such substances;
- Fire risk during transport of materials or on site;
- Risk of forest fires around the site or along the access road; and
- Risk of leakage from the processed kimberlite confinement area, or from overburden a waste rock or ore stockpiles.

Stornoway Diamond Corporation (Canada) Inc. has factored in the probability of accidents of this kind.

12.3.2 Risk Management System

Stornoway Diamond Corporation (Canada) Inc. already uses a system for health and safety, accident prevention, environmental and risk management.

In line with the goals of this management system, management and employees at Stornoway Diamond Corporation (Canada) Inc. have made a commitment to reducing risks to as low as is reasonably practicable and managing residual risks so as to ensure a safe working environment and the protection of the environment at all times.

Stornoway Diamond Corporation (Canada) Inc. is committed to providing a safe and healthy workplace environment by establishing, maintaining and promoting safe and productive work practices in all its operations.

Stornoway will comply with all specific or prescribed regulations on health and safety established by the different jurisdictions and applicable to its operations.

To this end, Stornoway will:

- Make occupational health and safety considerations an integral part of its operations, from their design to their completion;
- Employ every possible reasonable and practical means to eliminate potentially dangerous workplace situations;
- Provide the information, training, techniques and protective equipment needed by employees to work productively in a safe environment;
- Ensure that all employees understand and respect the safe work practices and techniques established for the project;
- Ensure that all contractors working for Stornoway and its subsidiaries act in accordance with this policy;
- Employ and retain people or teams with the capacity to intervene in medical or emergency situations;
- Improve occupational health and safety through continuous evaluation and improvements to instructions given in the work context; and
- Ensure that all workplace incidents are followed up with a full investigation designed to eliminate or reduce the likelihood that such incidents occur again.

12.3.3 Risk Assessment Methodology and Tolerability Criteria

12.3.3.1 Assessment process

The methodology for risk assessment is shown in Figure 12.3.1. This process complies with the Guideline from MDDEP (Ministère du Développement durable, de l'Environnement et des Parcs). The first step involves the identification of hazards that could be caused by the equipment or infrastructures under consideration and the development of corresponding accident scenarios. This step is followed by an estimate of the potential consequences of the scenarios, based on simulations using mathematical models or other tools. Estimations of the probable frequency or likelihood of accidents are then made, with reference to an existing accident database or the judgement of experts. As a final step, the risks are first estimated, then assessed.

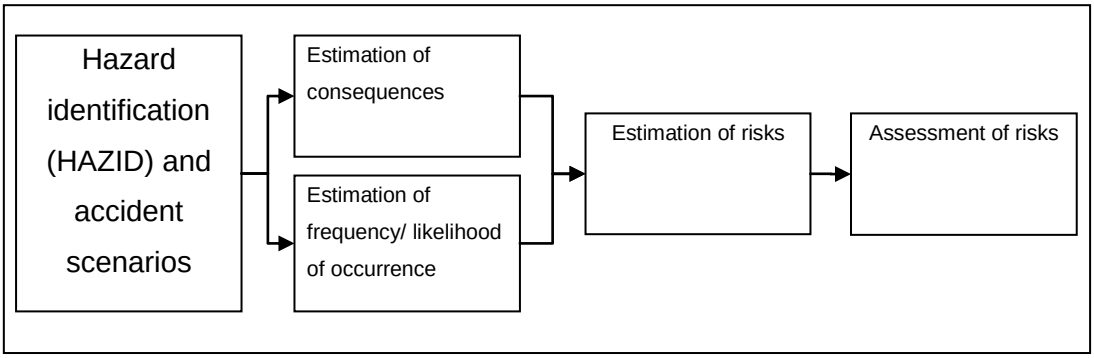


Figure 12.3.1 Risk assessment methodology

12.3.3.2 Methodology for hazard identification and development of scenarios

The hazard identification process is shown in Figure 12.3.2. It is used to identify the sources of hazards that could be posed by the equipment and infrastructures under consideration. A hazard identification (HAZID) analysis was carried out to identify sources of hazards, their causes and mitigation measures adopted. This identification includes sources of chronic existing hazards posed by normal or near-normal operation of facilities, as well as the sources of hazards associated with degraded operations and mine hazard incidents. It should be stressed that prevention measures for normal or near-normal facilities operations are generally well-referenced with respect to consensual norms and standards, as well as regulatory requirements. In theory, the number of accident scenarios is practically infinite. In practice, assessments need to focus on the most-likely scenarios.

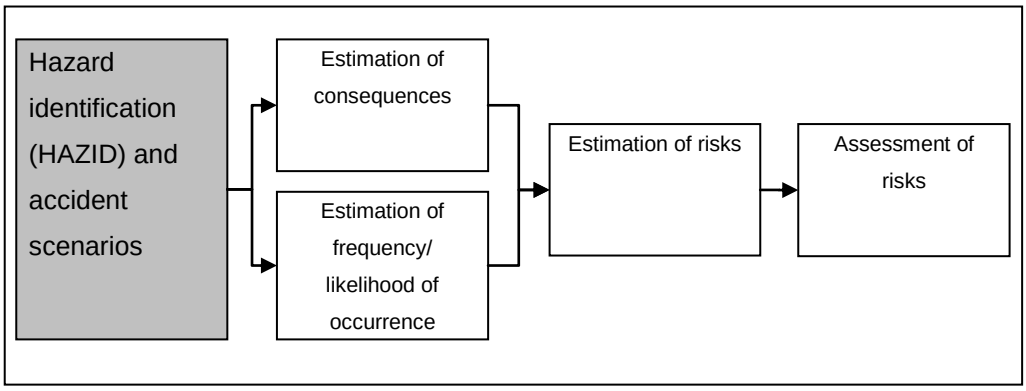


Figure 12.3.2 Hazard identification

The information obtained from the HAZID sessions and an analysis of experience gained from incidents that occurred in similar facilities was used as a basis for the development of accident scenarios. The results of the HAZID analysis can be found in Appendix 12.2.

12.3.3.3 Methodology for estimating potential consequences of incidents

The process for estimating the consequences of incidents is shown in Figure 12.3.3. The consequences of scenarios of incidents involving propane were simulated using version 6.7 of Det Norske Veritas (DNV) *PHAST* software. *PHAST* is state-of-the-art technology currently used for this kind of simulation. The consequences of incidents that could not be simulated using this software were estimated on the basis of the expert judgement.

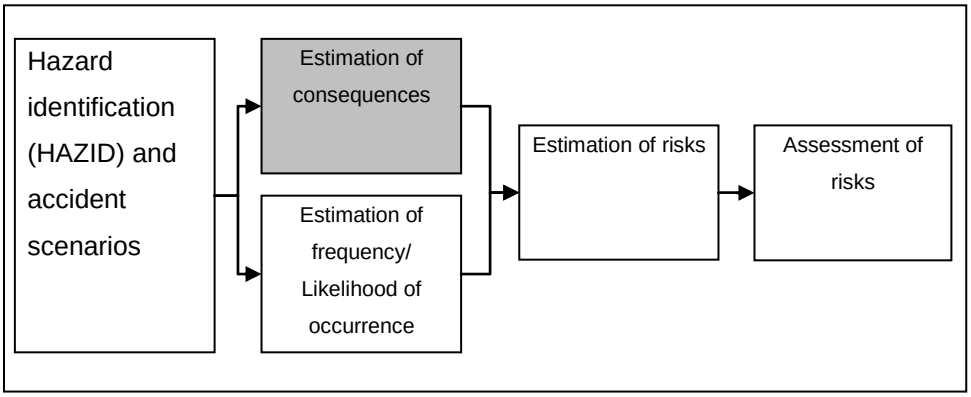


Figure 12.3.3 Estimation of consequences

12.3.3.4 Methodology for estimating potential frequency of incidents

The process for estimating the potential frequency of incidents is shown in Figure 12.3.4. The accident scenarios retained for a quantitative analysis of consequences were also analyzed for the likelihood of their occurrence. Likelihood and potential frequency estimates were established with reference to the frequency of the occurrence of such incidents in similar facilities.

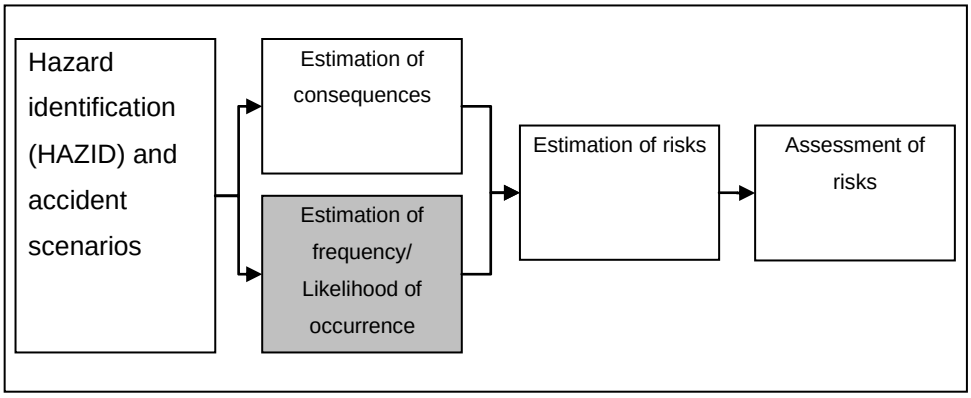


Figure 12.3.4 Estimation of frequency

12.3.3.5 Methodology for estimation and assessment of risks

The process for estimating and assessing risks is shown in Figure 12.3.5. These estimations and assessments were made using criteria that take into consideration the severity of the consequences of undesirable incidents, the probability of the occurrence of those incidents and the level of uncertainty associated with their consequences and their probability.

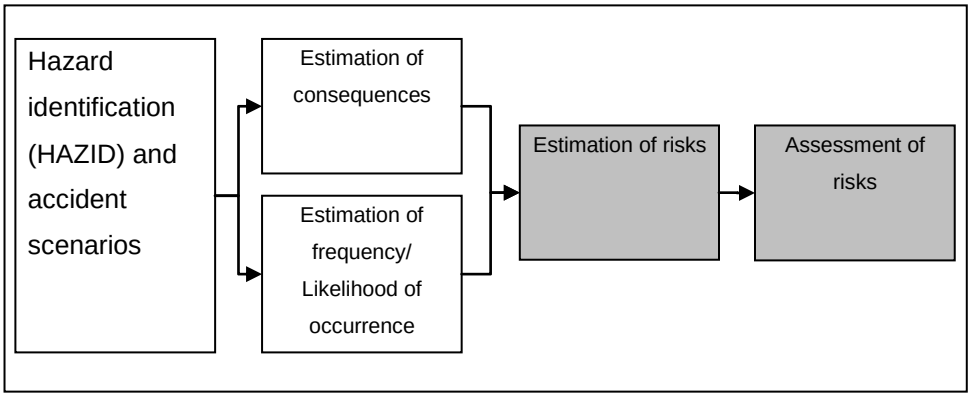


Figure 12.3.5 Estimation and assessment of risks

These criteria are set out in the following subsections, tables and figures:

- Figure 12.3.6 Risk assessment matrix
- Table 12.3.1 Severity levels of consequences
- Table 12.3.2 Probability-of-occurrence classes
- Table 12.3.3 Levels of uncertainty associated with their consequences and probability
- Table 12.3.4 Severity level of risk

The risk levels identified should take into account existing prevention and mitigation measures, to the extent that such measures are deemed to be robust and reliable.

Consequence severity						
	Extremely severe	Moderate	Severe	Extremely severe	Extremely severe	Extremely severe
	Severe	Moderate	Moderate	Severe	Extremely severe	Extremely severe
	Moderate	Low	Moderate	Moderate	Severe	Extremely severe
	Low	Low	Low	Moderate	Moderate	Severe
	Extremely low	Extremely low	Low	Low	Moderate	Moderate
		Extremely low	**Low**	**Moderate**	**High**	**Extremely High**
		Likelihood of occurrence				

Figure 12.3.6 Risk Assessment Matrix

Severity levels are described in Table 12.3.1 and cover the following elements:

- Employees / General public: Health and safety of people in the area at the time of the incident;
- Environment: environmental impact, and
- Assets: Damage to property, production interruption.

Likelihood of occurrence is an indication of the probability that a hazard that has been determined to exist will result in an accident. Indexes to reflect the probability or potential frequency of hazards were developed by extrapolating, past incidents in the same industry or estimates based on engineering studies, where no existing baseline data were available. Hazard scenarios were assessed with reference to probability of occurrence classes. Table 12.3.2 illustrates the probability of occurrence classes.

Table 12.3.1 Severity levels of consequence

Severity of consequence	Employees/General public	Environment	Assets
Extremely severe	Numerous fatalities caused by direct exposure.	•Major uncontained spill of hazardous substances; •Elimination of regional species; •Contamination of the aquifer and of drinking water.	Major property damage that makes buildings unusable / Month-long production interruption
Severe	A fatality caused by direct exposure.	•Significant uncontained spill of hazardous substances •Elimination of regional species •Contamination of the aquifer and of drinking water	Major property damage that makes buildings unusable / Week-long production interruption
Moderate	Injuries; and serious illnesses.	•Minor uncontained spill of hazardous substances; •Elimination of local species •Contamination of drinking water wells.	Significant damage / Week-long production interruption
Low	Injuries and illnesses that do not result in disability; Significant loss of quality of life; Minor illnesses.	•Confined major spill of hazardous substances; •Negative impacts on certain local organisms.	Minor damage / Day-long production interruption
Extremely low	Minimal impact on quality of life	Confined minor spill of hazardous substances; No measurable impact in the area.	No damage / 12-hour production interruption

Table 12.3.2 Probability-of-occurrence classes

Probability of occurrence	Definition
Extremely high	Will probably occur in most circumstances
High	Can occur in most circumstances
Moderate	Can occur within a certain period of time
Low	Could occur within a certain period of time
Extremely low	May occur in exceptional circumstances

Risk assessment carries with it a certain degree of uncertainty. Table 12.3.3 defines the levels of uncertainty surrounding risk assessments in each case.

Table 12.3.3 Levels of uncertainty

Probability of occurrence	Definition
Extremely high	No information available: new technology, new configuration
High	Some available information: adaptation of a technology to a new field
Moderate	Considerable amount of information available: application of a technology used elsewhere, with some changes
Low	Considerable amount of information available: application of a technology used elsewhere, with few changes
Extremely low	Considerable amount of information available: application of a technology used in identical setup, with no changes

Table 12.3.4 defines the severity level of risk.

Table 12.3.4 Severity level of risk

Level of risk	Definition
Extremely severe	Unacceptable risk – The company's most senior manager is informed of the risk and ensures that mitigation and risk reduction measures are implemented
Severe	Unacceptable risk – The Vice-President with responsibility for the sector ensures the ongoing application of preventive control and risk mitigation measures, in addition to reassessment of the risks at regular intervals
Moderate	Risk that needs to be reduced to the ALARP level of 'as low as reasonably practicable'. Company managers are responsible for ensuring that risk monitoring activities, control measures and risk mitigation plans are being implemented and that procedures are being followed
Low	Acceptable levels of risk. Front-line supervisors must ensure that employees and sub-contractors are aware of the risks and that established procedures and control measures are being followed
Extremely low	Minimal risk

12.3.4 Specific Risks

The following sections contain a risk summary based on the risk register, the findings of SNC-Lavalin's HAZOP study, a summary of the risks assessed during the hazard identification process described in Appendix 12.2, and a detailed summary of each risk identified in Appendix 12.2.

12.3.4.1 Risk register summary

Risk analysis sessions were held at different moments of the Renard Project design phase. The level of risks identified is consistent with the current development phase of the project.

The risk register identifies 10 risks with consequences rated as “Extremely severe”. They are described in the list below:

- Potential conflicts arising from cross-contacts between different kinds of workers: During the operation phase, the project will be divided into two areas, the first being “Construction Work” and the second being “Mining Work”. There exists a potential for conflict as a result of cross-contacts between the construction workers “under a decree” and the mine workers, who are not covered by any decree. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence as “Moderate” and the manageability challenge as “Moderate”.
- Any shift or potential change in the scope of the project between the end of the feasibility study and the start of the detailed engineering phase carries with it an “Extremely severe” inherent risk consequence rating, a likelihood of occurrence rated as “Moderate” and a manageability challenge considered “Significant”.
- There could be delays in the construction schedule if access to the site by means of the permanent road which is an extension of Route 167 is not available as planned. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence rated as “Moderate” and the manageability challenge as “Low”. All projected mitigation measures have been completed and the risk level is now on “Watch” status, rather than “Active”. The Ministère des Transports du Québec expects to complete the permanent road by August 1, 2013.
- Delays in receiving the required permits and Certificates of Authorization could delay the construction schedule. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence as “Moderate” and the manageability challenge “Moderate” as well. All projected mitigation measures have been completed and the risk level is now on “Watch” status.
- The quality of water at great depth may well be different from near-surface water and this situation could affect the design of the mine wastewater treatment facility. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence as “Moderate”; the manageability challenge has not been assessed. No mitigation measures have been completed and the risk level is now on “Watch” status.
- The shortage of workers trained to carry out this kind of construction project could be a source of delays. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence as “High” and the manageability challenge “Moderate”. Projected mitigation measures include early-stage hiring and training approaches to be included in the construction strategy, in addition to potential recourse to prefabrication.
- Poor process design could potentially reduce the value of diamonds recovered after the ore has been crushed. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence rated as “Moderate” and the manageability challenge “Moderate” as well. All projected mitigation measures have been completed and the risk level is now on “Watch” status.
- Delays until after 2011 for the outcomes of the Impact and Benefit Agreement could have consequences for the entire project. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence as “Moderate” and the manageability challenge as “Low”. Mitigation measures and strategies include the signature of the Impacts and Benefits Agreement. Mitigation measures are currently under way and are identified in the risk register.
- The characteristics of the water recovered during the drilling of the shaft may not meet environmental standards for its release into the environment. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence rated as “Moderate” and the manageability challenge “Moderate” as well. Mitigation measures are currently under way and are identified in the risk register.
- Encountering high hydraulic conductivity structures and poor ground conditions during construction of the ramp and the shaft could lead to a need for increased levels of pumping. The potential consequences of this risk are rated as “Extremely severe”, the likelihood of occurrence

rated as “Moderate” and the manageability challenge “Moderate” as well. Mitigation measures are currently under way and are identified in the risk register.

12.3.4.2 Findings of the HAZOP study

SNC-Lavalin carried out a HAZOP study of the project’s ore treatment facilities. The risks assessed are:

- Operation interruption;
- Leakages or rupture of supply lines;
- Release of toxic substances;
- Hazards endangering employees or the environment; and
- Damage to property.

Table 12.3.5 provides a summary of the most significant risks identified and the recommended mitigation measures to be carried out.

Table 12.3.5 Description of the most significant risks and associated mitigation measures

Scenarios	Consequences	Recommendations
Primary crusher – Underground mine: Hydraulic oil leak	Environmental impact, Fire.	Consider adding a retention basin to hydraulic systems.
Conveyor – Underground mine	Friction due to poor alignment of conveyor belt causes a fire.	Consider adding a fire detection and protection system.
Nip point injuries – process plant	Injuries caused to workers caught by conveyor belts or other equipment.	Install protective devices where needed to prevent injuries.
Ore-sorting equipment	Unsatisfactory performance due to poorly adjusted equipment.	Put procedures in place to clearly define methods of operation.
Storage and use of acid	Acid spill with environmental consequences, burns to people exposed.	Develop operating procedures, including provision of emergency drench showers and eyewash stations.
Transformers, lubricating oil, pulleys and belts	Fire.	Firefighting resources, including sprinklers, fire hydrants and portable fire extinguishers.

12.3.5 Summary of the HAZOP Study

The HAZOP study also contained recommendations for improving the reliability of equipment.

12.3.5.1 Technical risks

The technical risks identified during the HAZID analysis are summarized in Table 12.3.6a. The levels of consequence severity, probability of occurrence, uncertainties and risks were assessed using the risk matrix shown in Figure 12.3.6, the consequence severity levels in Table 12.3.1, the probability-of-occurrence classes in Table 12.3.2 and the levels of uncertainty in Table 12.3.3, in association with the consequence or probability-of-occurrence levels and the level of severity of risk in Table 12.3.4.

A more extensive analysis of each risk is provided in sections 12.3.5.2 to 12.3.5.14.

Table 12.3.5a Summary of Technological Risks

N°	Area of Risk	Nature of Risk	Consequence Severity	Probability	Degree of Uncertainty	Level of Risk	Recommendations
12.3.4.4	Open pit mine	1. Flooding	S	L	M	M	
		2. Rock falls	ES	L	M	M	
		3. Poorly managed blasting operation	ES	EL	M	M	
12.3.4.5	Underground mine	1. Flooding	S	L	M	M	
		2. Fire	S	L	L	M	
		3. Rock collapse or subsidence	S	L	L	M	
		4. Uncontrolled explosion	S	L	L	M	
12.3.4.6	Process plant	1. Fire	S	L	L	M	
		2. Exposure to X-rays	S	EL	M	M	It is recommended that a radiation level surveillance program be implemented for the plant and a surveillance of employees health working there until such time as a low potential risk can be established.
		3. Nip point injury	S	L	L	M	
12.3.4.7	Propane storage and handling	1. Fire that could involve propane tanks	ES	EL	L	M	It is recommended that flexible hose such as Smart-Hose[tm] with automatic isolation of leaks in the event of hose ruptures be used.
		2. Propane vapour cloud	ES	EL	L	M	It is recommended that the supply line for the gas used for heating ventilated air in the mine be fully protected from shocks.
	Petroleum fuel products, diesel and gasoline	3. Spills	M	L	L	M	It is recommended that systems be installed to contain any spills that could occur when daily supply tanks are being filled with petroleum products**.**
	Petroleum fuel products, diesel and gasoline	4. Fire	S	L	L	M	
	Oils and greases	5. Spills	L	L	L	L	
12.3.4.8	Miscellaneous chemical products	1. Spills	M	L	L	M	
12.3.4.9	Storage and handling of explosives	1. Ground-level explosion	M	L	L	M	
		2. Underground mine explosion	M	L	L	M	
		3. Theft of explosives	S	EL	L	M	
12.3.4.10	Confinement of processed kimberlite	1. Seepage of leachates into Lake Lagopede	L	L	L	L	
		2. Surface water runoff	L	L	L	L	
12.3.4.11	Power generating sets	1. Fires and explosions	L	L	L	L	
12.3.4.12	Wastewater and solid waste	1. Domestic wastewater	S	L	L	M	
12.3.4.13	Accommodation and service complex	1. Fire	S	L	L	M	
12.3.4.14	Airstrip and terminal	1. Aircraft accident	ES	EL	L	M	
12.3.4.15	Roads	1. Accident involving hazardous substances on Route 167	S	L	M	M	It is recommended that formal agreements be established with the Ministère des transports, other mining companies in the area, the Cree community and road users on how emergency equipment and other resources will be shared and deployed in the event of an accident.
		2. Disruption of traffic on Route 167	L	S	L	M	
		3. Maintenance of secondary roads on mine site	L	L	L	M	
12.3.4.16	Other hazards	1. Risks associated with snowmobile and boat traffic	M	M	L	M	It is recommended that, to avoid potential hazards to snowmobile or boat traffic, drill casings be identified and cut off at or below ground level.
		2. Forest fires	M	M	M	M	
		3. Risks associated with food and drinking water	M	L	M	M	

12.3.5.2 Open pit mine

This section deals with the risks associated with open pit mining. Three (3) hazards that could potentially result in major accidents have been identified:

- Flooding of the open pit mine;
- Rock falls from around open pit mine slopes; and
- Detonation of stored explosives or poorly managed blasting.

➢ *FLOODING OF THE PIT*

Infiltration by water is an inherent danger in mining operations. In open pit mines, surface or underground water can seep into the pit, as a result of damage to the rock caused by blasting or when faults in the rock structure create passages through which water can flow or seep toward the pit.

The following prevention and mitigation measures have been adopted:

- Geological and geotechnical studies of the site have been carried out to identify site characteristics;
- Monitoring of the effects of blasting procedures (in the pit or the underground mine) on the formation of hydraulic passages;
- Pumps to carry water to the surface; and
- Emergency response plan, including warning systems and training provisions.

The level of risk associated with flooding of the pit is shown in Table 12.3.6.

Table 12.3.6 Level of risk in open pit mine - Flooding

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Moderate	Moderate

This risk is on “Watch” status.

➢ *ROCK FALLS FROM AROUND MINE SLOPES*

Rock falls from open pit mine slopes can result in injuries, fatalities and economic losses. The following prevention and mitigation measures have been adopted:

- It has been determined that the slopes of pit walls comply with the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1).
- Monitoring to avoid potential landslides or rock falls into the pit.
- Emergency response plan, including warning systems and training.

The level of risk associated with rock falls is shown in Table 12.3.7.

Table 12.3.7 Level of risk in open pit mine – Rock falls

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Extremely severe	Low	Moderate	Moderate

This risk is on "Watch" status.

➢ *UNCONTROLLED EXPLOSION IN THE PIT*

An uncontrolled or unplanned explosion could be the result of the explosion of an explosives storage facility or a poorly managed blasting operation.

The following prevention and mitigation measures have been adopted:

- Control of blasting operations in compliance with the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1).
- Emergency response plan for the mine, including warning systems and training provisions (R.S.Q. c. S-2.2 r.19.1).

The level of risk associated with an explosion in the pit is shown in Table 12.3.8.

Table 12.3.8 Level of risk at open pit mine - Explosions

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Extremely severe	Extremely low	Low	Moderate

This risk is on "Watch" status.

12.3.5.3 Underground mine

This section deals with the risks associated with the underground mine. Three (3) hazards that could potentially result in major accidents have been identified:

- Flooding in the mine;
- Fire in the mine;
- Rock collapse or subsidence; and
- Detonation of explosives.

➢ *FLOODING IN THE MINE*

Infiltration by water is an inherent danger in mining operations. In underground mines, rock fractures connecting with sub-surface water tables located above excavation areas can result in flooding of the underground mine.

- The following prevention and mitigation measures have been adopted:
- Mine constructed in compliance with the requirements of the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1);
- Drilling carried out to identify site characteristics;

- Hydrogeological modelling of water infiltration and exfiltration (Itasca and Golder 2011);
- Geological study and adoption of an appropriate technique for the mining operation;
- Monitoring of water infiltration during shaft drilling work, and application of any needed corrective measures;
- Retention of a sufficient depth of the surface pillar to prevent surface water infiltration;
- Filling of the excavation site with waste rock;
- Pumps to carry water to the surface, and related monitoring measures; and
- Emergency response plan for the mine, including warning systems and training.l (R.S.Q. c. S-2.2 r.19.1).

The level of risk associated with flooding in the underground mine is shown in Table 12.3.9.

Table 12.3.9 Level of risk in underground mine - Flooding

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Moderate	Moderate

This risk is on "Watch" status.

➢ *FIRE IN THE MINE*

Fire in an underground mine can result in injuries, fatalities and economic losses. Sources of flammable materials include fuels (diesel), hydraulic oils and lubricants, vehicle tires, conveyors and explosives.

The following prevention and mitigation measures have been adopted:

- Mine constructed in compliance with the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1);
- Containment systems for spills and fuel;
- Mechanical maintenance of vehicles and conveyors;
- Smoke and flame detectors;
- Fire protection station with fire hoses;
- Portable fire extinguishers;
- Equipment to construct smoke barriers;
- Ventilation of the underground mine;
- Shelters; and
- Emergency response plan for the mine, including warning systems and training provisions (R.S.Q. c. S-2.2 r.19.1).

The level of risk associated with a fire in the underground mine is shown in Table 12.3.10.

Table 12.3.10 Level of risk in underground mine - Fire

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

➢ *ROCK COLLAPSE OR SUBSIDENCE*

Rock collapse in an underground mine can result in injuries, fatalities and economic losses. Unstable rock, rock faults and significant stresses in the rock mass are causes of rock collapse.

The following prevention and mitigation measures have been adopted:

- Mine operated in compliance with the requirements of the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1)
- Geological and geotechnical studies used to develop the mining plan;
- Mining plan;
- Mining techniques and training of the miners;
- Clean-up of loose rock;
- Inspection and monitoring of the underground mine;
- Shelters; and
- Emergency response plan for the mine, including warning systems and training (R.S.Q. c. S-2.2 r.19.1).

The level of risk associated with rock collapse in the underground mine is shown in Table 12.3.11.

Table 12.3.11 Level of risk in underground mine - Rock collapse

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

➢ *UNCONTROLLED DETONATION IN THE UNDERGROUND MINE*

An uncontrolled or unplanned detonation could be the result of the explosion of an explosives storage facility or poorly managed blasting operation.

The following prevention and mitigation measures have been adopted:

- Mine operated in compliance with the requirements of the Regulation respecting occupational health and safety in mines (R.S.Q. c. S-2.2 r.19.1);
- Sub-contractor with recognized expertise in the use of explosives;
- Storage of explosives in the underground mine respecting the requirements of the Regulation on mine health and safety;
- Shelters; and
- Emergency response plan for the mine, including warning systems and training (R.S.Q. c. S-2.2 r.19.1).

The level of risk associated with poorly managed blasting operations in the underground mine is shown in Table 12.3.12.

Table 12.3.12 Level of risk in underground mine - Explosion

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

12.3.5.4 Process plant

This section deals with the risks associated with the process plant. Three (3) hazards that could potentially result in major accidents have been identified:

- Fire;
- Exposure to X-rays; and
- Nip points.

➢ *FIRE*

A fire at the process plant could result in injuries, fatalities and economic losses. Potential causes could include hydraulic system or lubricating oil leaks or friction of conveyor belts.

The following prevention and mitigation measures have been adopted:

- Use of low flash point lubricating and hydraulic oils;
- Methods for containing spills of lubricating or hydraulic oils;
- Maintenance of conveyors to prevent belt displacement and resulting friction;
- Design based on NFPA standards;
- Fire-fighting water supply and fire hydrants;
- Fire-fighting water tank and emergency vehicle;
- Emergency response team;
- Emergency response plan for the mine, including warning systems and training (R.S.Q. c. S-2.2 r.19.1).

The level of risk associated with a fire at the process plant is shown in Table 12.3.13.

Table 12.3.13 Level of risk at process plant – Fire

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

➢ *EXPOSURE TO X-RAYS*

Exposure to X-rays can affect people's health. Possible causes would be leakage of X-rays caused by damage to equipment.

The following prevention and mitigation measures have been adopted:

- Use of weak X-ray sources;
- Equipment constructed to prevent X-ray leaks;
- Monitoring of X-ray levels at appropriate intervals.

The level of risk associated with exposure to X-rays is shown in Table 12.3.14.

Table 12.3.14 Level of risk at process plant – Exposure to X-rays

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Extremely low	Moderate	Moderate

This risk is on "Watch" status.

Recommendation:

It is recommended that a radiation level surveillance program be implemented for the plant and a health follow-up for employees working there until such time as a low level of risk can be established.

➢ *NIP POINTS*

Conveyors represent nip points that could result in injuries and fatalities.

- Nip points protected as required by CAN/CSA Standard Z-432 on the protection of machinery or an equivalent standard; and
- Training and information to employees on nip point hazards.

The level of risk associated with nip points is shown in Table 12.3.15.

Table 12.3.15 Level of risk at process plant – Nip points

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

12.3.5.5 Propane storage and use

Propane is a flammable, explosive liquefied gas. Two 30,000 USWG propane storage tanks will be used to supply gas to the ventilation air heating systems of the underground mine and two 5,000 USWG storage tanks for supplying the kitchen and the dry room. Two hazard scenarios that could potentially result in major accidents have been identified:

- Fire that could involve propane tanks; and
- A propane vapour leak.

➢ *FIRES THAT COULD INVOLVE PROPANE TANKS*

Fires that could involve propane tanks can occur as a result of propane leaks caused by a rupture of flexible transfer hoses, feed line breaks, an unexpected movement of a delivery vehicle during the transfer operation, collision with a vehicle travelling in the area, or the burning of combustible material, including brush and forest fires. The exposure of a propane tank to flames can result in increased pressure in the tank, weakening of tank walls and their subsequent rupture, producing a fire ball, a shock wave and the projection of tank fragments. An incident of this kind develops extremely rapidly and is short duration, about 20 seconds. The phenomenon is described with the acronym BLEVE, short for Boiling Liquid Expanding Vapour Explosion. The most appropriate criteria for measuring the effects of a BLEVE need to factor in both the intensity of the thermal radiation and its duration. Several countries, including the United Kingdom and France, measure the consequences of this radiation in $(kW/m^2)^{4/3}.s$, where:

- kW = kilowatt;
- m = metre;
- s = second.

This parameter is more adequate than simply measuring the level of thermal radiation; that latter measure would result in a distortion of the consequence severity assessment, given that it does not allow for the duration of the exposure, always an important factor in short-lived exposure.

The following criteria were used to define the size of the areas subjected to thermal radiation, using the methodology prescribed by the U.K. Health and Safety Executive.

Table 12.3.16 Criteria for exposure to thermal dose

Thermal dose		
1800 $(kW/m^2)^{4/3}.s$	1000 $(kW/m^2)^{4/3}.s$	500 $(kW/m^2)^{4/3}.s$
Thermal dose criteria representing a risk for an average clothed population. Thermal dose resulting in fatal burns for over 50% of the people exposed.	Thermal dose criteria representing a risk for an average clothed population. Thermal dose resulting in serious burns and a low death rate of 1 %.	Thermal dose criteria representing a risk for vulnerable population groups. Second degree burns could be fatal in certain cases, particularly for children.

Evacuation plans would need at the very least to provide for a greater distance than the area called for in the case of the 500 $(kW/m^2)^{4/3}.s$ thermal dose.

Scenarios for exposure of the 30,000 USWG and 5,000 USWG propane storage tanks to a fire resulting in tank rupture, a fire ball and a shock wave were simulated using version 6.7 of Det Norske Veritas (DNV) *PHAST* software. Results of the simulations are shown in Figure 12.3.7 for the 30,000 USWG tank supplying gas to the ventilation air heating system of the underground mine, Figure 12.3.8 for the 5,000 USWG tank that supplies gas to the kitchen, and Figure 12.3.9 for the 5,000 USWG tank supplying the dry room.

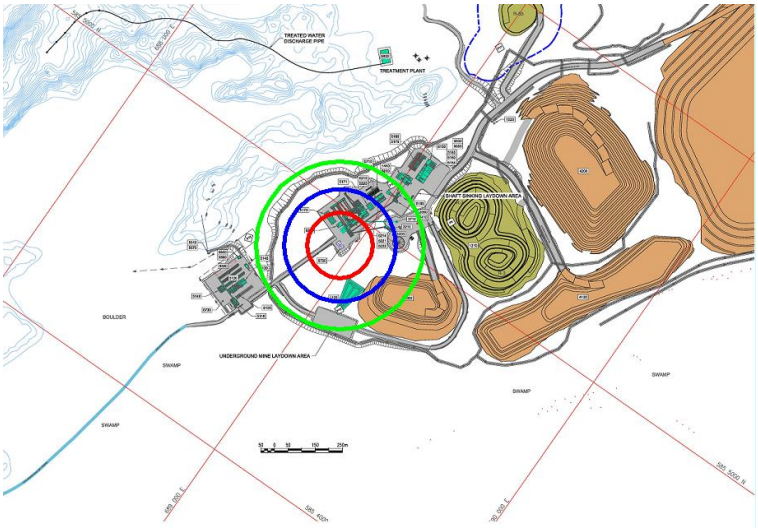
Where a fire could involve a 30,000 USWG storage tank, protection from thermal radiation would require the evacuation of people in a 305 m radius around any such tank.

Where a fire could involve a 5,000 USWG storage tank, protection from thermal radiation would require the evacuation of people in a 125 m radius around any such tank.

Furthermore, civil protection services in Quebec have issued a Directive specifying the evacuation distances required to protect the public from debris thrown by an explosion (Sécurité Publique, 2008). For tanks with a volume of 30,800 gallons (140 000 L) the recommended evacuation distance is 2,200 m and the minimum evacuation distance 1,715 m. Evacuation distances such as these are hardly feasible in the context of the Renard Project. To mitigate this limitation, evacuation assembly points will need to be located outside the radius set for the 500 $(kW/m^2)^{4/3}$.s thermal load but at the back of buildings, so they can act as barriers to debris from any explosion. Assembly points will be identified in the emergency response plan.

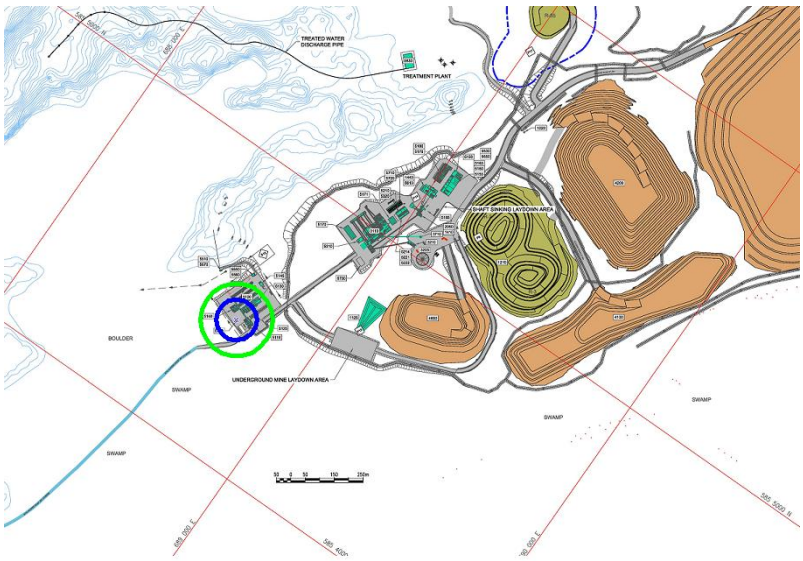
The following prevention and mitigation measures have been adopted:

- Facilities complying with CSA standard B-149.2-05 (Propane storage and handling Code);
- Qualified propane supplier;
- Area around the propane tanks is kept clear of combustible material, vegetation, debris, etc.;
- Ground under the storage tanks has a 1% downhill grade sloping toward the perimeter to avoid any buildup of combustible liquid under tanks if an accidental leak occurs;
- Storage tanks are protected by bollards to protect against collisions by vehicles;
- Portable fire extinguishers are in place;
- Fire protection water supply system;
- Emergency vehicle; and
- Emergency response plan with specific intervention procedures to follow for a propane-related incident.



Thermal dose		
1 8000 (kW/m^2) $^{4/3}$. s	1 0000 (kW/m^2) $^{4/3}$. s	500 (kW/m^2) $^{4/3}$. s
120 m	205 m	305 m

Figure 12.3.7 Thermal dose for a 30,000 USWG propane storage tank



Thermal dose		
1 8000 (kW/m^2) $^{4/3}$. s	1 0000 (kW/m^2) $^{4/3}$. s	500 (kW/m^2) $^{4/3}$. s
Dose not reach	70 m	125 m

Figure 12.3.8 Thermal dose for a 5,000 USWG propane storage tank - kitchen



Thermal dose		
1 8000 (kW/m^2) $^{4/3}$. s	1 0000 (kW/m^2) $^{4/3}$. s	500 (kW/m^2) $^{4/3}$. s
Dose not reach	70 m	125 m

Figure 12.3.9 Thermal dose for a 5,000 USWG propane storage tank - the dry room

The level of risk associated with a fire that could affect propane tanks is shown in Table 12.3.17.

Table 12.3.17 Level of risk posed by a fire that could affect propane storage tanks

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Extremely Severe	Extremely low	Low	Moderate

This risk is on "Watch" status.

Recommendations

It is recommended that flexible hose with automatic isolation of leaks from hose ruptures be used to prevent propane escaping and potentially igniting. Alternatively, flexible hose assemblies distributed by Smart-Hose^{tm} could be used.

- *PROPANE VAPOUR CLOUD*

Formation of propane vapour clouds can occur as a result of propane leaks caused by the rupture of flexible transfer hoses, feed line breaks, an unexpected movement of a delivery vehicle during the transfer operation or collision with a vehicle travelling in the area. Propane clouds are potentially explosive. They could be sucked into the mine ventilation system and create explosive concentrations of vapours there. The explosive range of propane are between 2.4% v/v and 9.5% v/v. Propane concentrations of under 2.4% v/v or over 9.5% v/v in air are not explosive.

The following prevention and mitigation measures have been adopted:

- Storage and receiving facilities located at a distance greater than 50 % of the lower explosion limit of propane from the ventilation intake of the mine (175 m);
- Facilities will comply with CSA standard B-149.2-05 (Propane storage and handling Code);
- Qualified propane supplier;
- Storage tanks are protected by bollards to protect against collisions by vehicles;
- Emergency response plan with specific intervention procedures to follow for a propane-related incident.

The level of risk associated with a propane vapour leak is shown in Table 12.3.18.

Table 12.3.18 Level of risk posed by a propane vapour leak

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Extremely Severe	Extremely low	Low	Moderate

This risk is on "Watch" status.

Recommendation:

It is recommended that the supply line for the gas used for the ventilation air heating system of the mine be fully protected from shocks.

➢ *PETROLEUM FUEL PRODUCTS, DIESEL AND GASOLINE - SPILLS*

Spills of petroleum fuel products such as diesel and gasoline, as a result of corrosion, ruptures of hoses or human error, can lead to the contamination of surface water, groundwater and soil.

The following prevention and mitigation measures have been adopted:

- Petroleum storage tanks located in a retention basin that can hold 110% of the volume of the largest tank;
- Tank liquid-level gauges and spill prevention devices;
- Concrete slab floor for petroleum receiving and distribution stations, with spill confinement capacity;
- Water/petroleum separator at the fuel storage area;
- Procedures for petroleum receiving and distribution and corresponding training;
- Double wall daily supply storage tanks;
- Cleanup kits, including absorbents;
- Emergency response plan.

The level of risk associated with a spill of petroleum fuel products is shown in Table 12.3.19.

Table 12.3.19 Level of risk posed by a spill of petroleum products

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Low	Low	Moderate

This risk is on “Watch” status.

Recommendation

It is recommended that systems be installed to contain any spills that could occur when daily supply tanks are being filled with petroleum products.

- *PETROLEUM FUEL PRODUCTS, DIESEL AND GASOLINE -- FIRE*

Petroleum product fires could occur in the fuel storage area, at the daily supply storage tanks, or during the transport and distribution of petroleum products and could potentially result in injuries, fatalities and economic losses, as well as surface water, groundwater and soil contamination.

The following prevention and mitigation measures have been adopted:

- Checks and maintenance of equipment to prevent leaks and spills of petroleum products;
- Cleanup kits, including absorbents;
- Fire and smoke detection systems;
- Readily available portable fire extinguishers;
- Reserve supply of foam to fight petroleum-based fires;
- Fire protection water supply system with fire hydrants close to the petroleum products storage area;
- Fire truck;
- Emergency response plan with specific intervention procedures to follow in the case of a petroleum-based fire.

The level of risk associated with a petroleum fuel fire is shown in Table 12.3.20.

Table 12.3.20 Level of risk posed by a petroleum product fire

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on “Watch” status.

- *PETROLEUM PRODUCTS, OILS AND GREASES - SPILLS*

Spills of petroleum products such as lubricant oils and greases, as a result of equipment damage or malfunction, mishandling, or spills from machinery on roads can potentially result in injuries, fatalities and economic losses, as well as surface water, groundwater and soil contamination.

The following prevention and mitigation measures have been adopted:

- Equipment to contain spills in areas where oils and greases are stored, distributed and used;
- Spill cleanup kits, including absorbents;
- Employee training including awareness-sessions regarding environmental protection; and
- Emergency response plan with specific intervention procedures.

The level of risk associated with an oil or grease spill is shown in Table 12.3.21.

Table 12.3.21 Level of risk posed by oils or greases spill

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Low	Low	Low	Low

This risk is on “Watch” status.

12.3.5.6 Miscellaneous chemical products

A number of chemical products, including some classed as dangerous goods under the Transportation of Dangerous Goods Regulations (SOR/2008-34), or controlled products (SOR/88-66) are used to fuel vehicles, for energy production, and used as lubricants, as explosives in blasting operations, as reagents or additives in ore processing at the process plant, or for the production of drinking water and the treatment of domestic and mine wastewater.

Table 12.3.22 Dangerous Goods and Controlled Products

									Use	
No.	**Phase**	**Chemical product**	**Dangerous goods N.B.: (-) indicates an unregulated product**		**Mode of transport**	**Quantity carried**	**Frequency**	**Remarks**	**Method of storage**	**Controlled Products Category N.B.: (-) indicates an unregulated product**
			Class	**Product ID No.**						
1	Operation	Diesel	3 Flammable liquid	1202	Tanker truck	50,000 L	11/wk		- Fuel storage area: Sixteen (16) 50,000 Litre tanks, sealed containment basin, 57m x 38 m x 0.5m (2200 sq. m. and 1,100 cu. m. with Solmax Texel Hazgard 1000 liner or equivalent. Québec Construction Code, Division VIII. - 12,500 L fuel storage tank at the terminal of the airstrip.	–
2	Operation	Gasoline	3 Flammable liquid	1203	Tanker truck	50,000 L	2/yr		- In the fuel storage area - Generator at the emulsion site	**B2** Flammable liquid **D2A** Extremely toxic substance with other toxic effects
3	Operation	Aviation fuel	3 Flammable liquid	1863	20,000 L	5/yr			Aviation fuel stored at the terminal of the airstrip. 25,000 L double wall fuel storage tank.	–
4	Operation	Explosives (bulk emulsion)	1 Explosives	–	20,000 kg	Tanker truck	60/yr		20,000 kg ground level ISO storage magazine that complies with Natural Resources Canada standards; subsequently, forty (40) 1,500 kg loads will be trucked to two underground magazines.	–
5	Operation	Explosives (packaged)	1 Explosives	–	20,000 kg	Truck (carry-boxes)			Magazine with a storage capacity of 40,000 kg of explosives, constructed in compliance with provincial standards. Magazine with a storage capacity of 10,000 kg of detonators (100,000 detonators). Type 4 and Category I magazines built to the standards set out in Schedule 5 of the Regulation under the Act respecting explosives.	–
6	Operation	Coagulant - $Fe_2(SO_4)_3$	8 Corrosive material	3264	Truck	45,000 kg	3/yr		Chemical storage tanks and supply systems will be made of construction materials that are the most appropriate to the hazards represented by the chemicals to be stored.	–
7	Operation	Polymers	–	–	Truck (45 gallon drums)			Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.		–
8	Operation	Ferrosilicon (FeSi) Composed of Iron (70-80%) and Silicon (10-20%)	–	–	Trucks (2,000 kg bags)	30,000 kg	14/yr		Stored in 2,000 kg bags in a dedicated area of the plant.	–
9	Operation	Flocculent (923 VHM)	–	–	Truck (large bags)	2,000 kg	4/yr	Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.	Stored in large bags in a dedicated area of the plant.	–
10	Operation	Sodium hydroxide (caustic soda)	8 Corrosive material	1824	Truck (25 kg drums)	3,000 kg		Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.	Stored in 25 kg drums	**E** Corrosive material
11	Operation	Hydrochloric acid (or hydrogen chloride) (HCl)	8 Corrosive material	1789	Truck (205 L drums)			Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.	Stored in acid cabinets in the diamond cleaning room.	**D1A** Extremely toxic substance with immediate serious effects **E** Corrosive material

									Use	
No.	**Phase**	**Chemical product**	**Dangerous goods N.B.: (-) indicates an unregulated product**		**Mode of transport**	**Quantity carried**	**Frequency**	**Remarks**	**Method of storage**	**Controlled Products Category N.B.: (-) indicates an unregulated product**
			Class	**Product ID No.**						
12	Operation	Grease (Grease Collector DB)	–	–	Truck (210 L drums)			Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.	Stored in 210 L drums	
13	Operation	12% Sodium hypochlorite (NaOCl)	8 Corrosive material	1791	Truck (drums)			Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.		**C** Oxidizing substance **E** Corrosive material **F** Dangerously reactive material
14	Operation	Alum (Operation phase)	–	–	Truck (drums)	2 000 kg		Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.		
19	Construction	Alum (Construction phase) (for precipitation of phosphorus)	–	–	Truck (drums)	3 000 kg		Products transported with deliveries of flocculants, caustic soda, hydrochloric acid and grease.		
20	Operation	Aircraft de-icing liquid (polypropylene glycol)	–	–	Truck (drums)	250 gallons	1/yr		Stored in a 500 gallon tank mounted on a light vehicle.	
21	Operation	Propane – for heating of the underground mine	2.1 Flammable gas	1075	Tanker truck	40,000 L	76/yr		(2) 113,560 L (30,000 USWG) tanks	**A** Compressed gas **B1** Flammable gas
22	Operation	Propane – for cooking ad laundry purposes	2.1 Flammable gas	1075	Tanker truck	40,000 L	1/10 days		(2) 18 930 L (5 000 USWG) tanks	**A** Compressed gas **B1** Flammable gas
23	Operation	Oil consumption – All types	–	–	Truck	Iso cube (1,000 L)	1.4/mo.		ISO Cube (1,000 L)	
23,01	Operation	Generator oil (10W30 engine oil, 400L/250hres)	–	–						
23,02	Operation	Extended-Life Coolant (400L/12,000hres)	9	–						
24	Operation	Oil for above ground equipment (open pit mine and service equipment)	–	–						
24,01	Operation	10W30 Motor	–	–					4 000 L - Bulk	
24,02	Operation	10W HYDO Hydraulic Oil	–	–					3 000 L - Bulk	
24,03	Operation	10W TDTO (Transmission Drive Train Oil)	–	–					600 litre drums/cubes	
24,04	Operation	30W Transmission Axle Oil	–	–					2 000 L - Bulk	
24,05	Operation	ISO 220 Compactor Oil	–	–						

									Use	
No.	Phase	Chemical product	Dangerous goods N.B.: (-) indicates an unregulated product		Mode of transport	Quantity carried	Frequency	Remarks	Method of storage	Controlled Products Category N.B.: (-) indicates an unregulated product
			Class	Product ID No.						
24,06	Operation	50W Axle/Drive Oil	–	–					500 litre drums/cubes	
24,07	Operation	Toyota SAE 5W30 Engine Oil	–	–					(100) 5 gallon containers	
24,08	Operation	Toyota ATF (Automatic Transmission Fluid)	–	–					(200) 5 gallon containers	
24,09	Operation	Toyota 75W85 Axle Oil	–	–					(50) 5 gallon containers	
24,10	Operation	Donax TX Transmission Fluid	–	–					(100) 5 gallon containers	
24,11	Operation	Tellus T37 Hydraulic Drill Oil	–	–						
24,12	Operation	AS 32 Rock Drill Compressor Oil	–	–					Drums/cubes	
24,13	Operation	80W90 Gear Oil	–	–					100 Drums	
24,14	Operation	Extended Life Coolant ELC	9	–					1,000 drums/cubes	

Table 12.3.22 provides a summary list of the dangerous goods and controlled products used on the site. A distinction is made between materials transported (Dangerous Goods) and those used on site (Controlled Products). Dangerous goods classes and their corresponding ID Number are particularly useful because they reference the emergency response actions identified in the 2008 Emergency Response Guidebook (GMU2008) developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT) and the Secretariat of Transport and Communications of Mexico (SCT). The quantities transported, method and frequency of transport are shown in the Table 12.3.22. It also provides information on the on-site storage and use of these products, their controlled product category, and the means used for their storage and protection.

Spills of dangerous goods as a result of equipment malfunctions or human error can result in the contamination of process or surface water, or soil, from acids (hydrochloric acid), bases (sodium hydroxide) or other chemical substances and pose a corresponding risk of burn injuries (hydrochloric acid, sodium hydroxide) or exposure to toxic gases (hydrochloric acid), as well as fatalities.

The following prevention and mitigation measures have been adopted:

- Maintenance program to prevent leaks due to corrosion or equipment malfunctions;
- Dedicated storage areas for chemical substances, and appropriate leak containment systems;
- Spill cleanup kits;
- Personal protective equipment to prevent direct contact with hazardous substances;
- Adoption of procedures for the safe handling and use of chemicals, and provision of corresponding training;
- Provision of emergency drench showers and eyewash stations in sectors where chemicals are used;
- First aid service; and
- Emergency response plan with specific responses.

The level of risk associated with miscellaneous chemical products is shown in Table 12.3.23.

Table 12.3.23 Level of risk associated with chemical products

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Low	Low	Moderate

This risk is on “Watch” status.

12.3.5.7 Storage and handling of explosives

This section deals with the risks associated with explosives. Three (3) hazards that could potentially result in major accidents have been identified:

- Ground-level explosion;
- Explosion in the underground mine; and
- Theft of explosives.

➢ *GROUND-LEVEL EXPLOSION*

A fire in an explosives storage area, poor handling of explosives or the impact of debris on explosives stores could lead to an explosion and a resulting flying of debris, causing potential injuries, fatalities and material damage.

The following prevention and mitigation measures have been adopted:

- Explosives storage areas constructed in compliance with the Explosives Regulations (C.R.C., c. 599) of the Explosives Act (C.R.C, c..599) and related Directives;
- Permit from the Sûreté du Québec;
- Separation distances between explosives storage areas in compliance with the Regulations;
- Heating and lighting equipment specific to the explosives storage areas;
- Specialized sub-contractors trained in the handling of explosives;
- Fenced-in explosives storage areas; and
- Emergency response plan for the mine, with warning systems and appropriate training of personnel. (R.S.Q., c. S-2.2 r.19.1).

The level of risk associated with a ground-level detonation of explosives is shown in Table 12.3.24.

Table 12.3.24 Level of risk associated with the ground-level detonation of explosives

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Low	Low	Moderate

This risk is on “Watch” status.

➢ *EXPLOSION IN THE UNDERGROUND MINE*

A fire in an explosives storage area, poor handling of explosives or the impact of debris on explosives stores could lead to an explosion and a resulting flying of debris, causing potential injuries, fatalities and material damage.

The following prevention and mitigation measures have been adopted:

- Permit from the Sûreté du Québec;
- Heating and lighting equipment specific to the explosives storage areas;
- Specialized sub-contractors trained in the handling of explosives;
- Underground explosives storage area that comply with the Regulation respecting health and safety in mines (R.S.Q. c. S-2.2 r.19.1)
- Emergency response plan for the mine, with warning systems and appropriate training of personnel (R.S.Q. c. S-2.2 r.19.1.).

The level of risk associated with the detonation of explosives in the underground mine is shown in Table 12.3.25.

Table 12.3.25 Level of risk associated with the detonation of explosives in the underground mine

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Low	Low	Moderate

This risk is on "Watch" status.

➢ *THEFT OF EXPLOSIVES*

Any theft of explosives could put them into the hands of individuals who could potentially use them for criminal purposes.

The following prevention and mitigation measures have been adopted:

- Explosives storage areas constructed in compliance with the Explosives Regulations (C.R.C., c. 599) of the Explosives Act (C.R.C, c. 599) and related guidelines;
- Permit from the Sûreté du Québec;
- Controls on the movement of people on site; and
- Surveillance cameras.

The level of risk associated with the theft of explosives is shown in Table 12.3.26.

Table 12.3.26 Level of risk associated with the theft of explosives

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Extremely low	Low	Moderate

This risk is on "Watch" status.

12.3.5.8 Processed kimberlite confinement

This section deals with the risks associated with the processed kimberlite confinement area. Two (2) hazards that could potentially result in major accidents have been identified:

- Seepage of leachates into Lake Lagopede; and
- Surface water runoff.

Seepage of leachates into Lake Lagopede could occur as a result of hydraulic pressure or soil permeability. Consequences could include impacts on the water quality of the lake, the fish habitat quality, and use of the lake water for the Renard mine site.

The following prevention and mitigation measures have been adopted:

- Geological/hydrogeological studies;
- Static and kinetic tests on the processed kimberlite show that leachates respect MDDEP for the protection of groundwater;
- Tests show that the processed kimberlite does not show acid mine drainage potential;
- Hydrogeological modelling of contaminant transport;

- Water management plans that provide for the collection of all runoff water from the site;
- Contact water management plan, including control structures comprised of diches and sedimentation ponds;
- Sedimentation pond in pit R-65;
- Mine wastewater treatment facilityl; and
- Instrumentation surveillance system.

The level of risk associated with the seepage of leachates from the processed kimberlite above-ground confinement area is shown in Table 12.3.27.

Table 12.3.27 Level of risk associated with the seepage of leachates into Lake Lagopede

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Low	Low	Low	Low

This risk is on "Watch" status.

➢ *SURFACE WATER RUNOFF*

A modification in the surface water runoff from the kimberlite confinement area could occur as a result of hydraulic pressure, diversion of streams or alterations to the hydrological flow pattern of streams or lakes. This could lead to changes in the water quality of Lake Lagopede, impact on the fish habitat quality, and on use of the lake for the Renard mine site, in addition to modify the current location of streams.

The following prevention and mitigation measures have been adopted:

- Geological/hydrogeological studies;
- Monitoring of water quality in Lake Lagopede;
- Peripheral ditches to capture and redirect water toward a sedimentation pond in R-65;
- Water management plan;
- Mine wastewater treatment facility; and
- Limited number of sub-watersheds affected.

The level of risk associated with modifications to the hydrological flow pattern from the processed kimberlite confinement area is shown in Table 12.3.28.

Table 12.3.28 Level of risk associated with modifications to the hydrological flow pattern from the processed kimberlite confinement area

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Low	Low	Low	Low

This risk is on "Watch" status.

12.3.5.9 Power generating sets

This section deals with the risks associated with the energy production facilities. One (1) hazard that could lead to major incidents has been identified.

- *FIRE AND EXPLOSION*

Fires and explosions occurring as a result of diesel leaks and ignition, generator set that overheat or short circuit, could potentially cause injuries or fatalities, create power shortages, impact the accommodation and service complex, and lead to a site evacuation, and economic losses.

The following prevention and mitigation measures have been adopted:

- Generator sets designed with reference to FM Global data and NFPA fire codes;
- A standby generator set usually kept in reserve but ready for use in the event of a power cut;
- A standby generator set for the mine shaft hoist;
- Generator set in separate buildings;
- Smoke and flame detectors;
- Surveillance and video circuit cameras;
- Portable extinguishers readily available at the onset of a fire;
- Fire protection water supply system, with fire hydrants and sprinklers to protect equipment;
- Trained emergency response team; and
- Emergency response plan.

The level of risk associated with energy production equipment is shown in Table 12.3.29.

Table 12.3.29 Level of risk associated with power generating sets

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Low	Low	Low	Low

This risk is on “Watch” status.

12.3.5.10 Wastewater and solid waste

This section deals with the risks associated with wastewater and solid waste. One (1) hazard that could lead to major incidents has been identified.

Domestic wastewater

The temperature of domestic wastewater and a high concentration of fecal coliforms, phosphorus and nitrogen could affect water quality and the quality of the ice and pose a risk for snowmobile traffic, with breakup of the ice cover under the weight of snowmobiles and potential related fatalities. Additionally, there is a risk of the development of localized algal blooms in the lake and localized bacterial contamination at the point of discharge.

The following prevention and mitigation measures have been adopted:

- Outfall located in a deep lake location with a 250 m long diffuser;
- Designed for a discharge volume of 458 litres per day – a small amount in relation to the volume of water in Lake Lagopede - at a temperature of 0.5^{o}C;
- Wastewater will be held initially in aerated ponds and effluent temperature will gradually adjust to the ambient temperature;
- Effluent discharge rate is relatively low in relation to the volume of water at the discharge point;
- Discharge depth is relatively large;
- Dispersion plume will not reach the surface of the lake;
- Phosphorus control system included in the treatment process;
- Modelling of the treated effluent dispersion plume has been carried out.

The level of risk associated with wastewater and solid waste is shown in Table 12.3.30.

Table 12.3.30 Level of risk associated with wastewater and solid waste

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

12.3.5.11 Accommodation and service complex

This section deals with the risks associated with the accommodation and service complex. One (1) hazard that could lead to major incidents has been identified.

➢ *FIRE*

A fire in the kitchen and cafeteria, in sleeping quarters and service areas could occur as a result of an electrical short circuit, cooking oil catching fire, the build-up of cooking oil greases under the kitchen floor or a fire in a sleeping area and could potentially result in injuries or fatalities, evacuation of the site, and economic losses.

The following prevention and mitigation measures have been adopted:

- No-smoking rule applied everywhere in the accommodation and service complex;
- Fire protection water supply system with fire hydrants;
- Sprinkler system in the accommodation complex, including the kitchen, designed with reference to NFPA fire codes and FM Global data sheets;
- Smoke detectors;
- Closed circuit surveillance cameras;
- Portable fire extinguishers;
- Emergency response team; and
- Emergency response plan.

The level of risk associated with the accommodation and service complex is shown in Table 12.3.31.

Table 12.3.31 Level of risk associated with the accommodation and service complex

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Low	Moderate

This risk is on "Watch" status.

12.3.5.12 Airstrip and terminal

This section deals with the risks associated with the airstrip and terminal. One (1) hazard that could lead to major incidents has been identified.

- *AIRCRAFT ACCIDENT*

An aircraft accident could occur as a result of mechanical failure, adverse weather conditions, poor airstrip condition, ice buildup on the aircraft lifting surfaces, pilot error, or fire in the aircraft, and could potentially result in injuries for several people or fatalities and economic losses.

The following prevention and mitigation measures have been adopted:

- Airstrip, tarmac, terminal and aircraft guidance system designed according to Transport Canada standards;
- Aircraft de-icing equipment;
- Emergency vehicle;
- Fire-fighting equipment;
- Emergency response team;
- Nurse, first responders: and
- Emergency response plan.

The level of risk associated with the airstrip and terminal is shown in Table 12.3.32.

Table 12.3.32 Level of risk associated with the airstrip and terminal

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Extremely Severe	Extremely low	Low	Moderate

This risk is on "Watch" status.

12.3.5.13 Roads

This section deals with the risks associated with roads. Three (3) hazards that could potentially result in major accidents have been identified:

- Accidents involving hazardous substances on Route 167;
- Traffic disruption on Route 167;
- Road maintenance, including Route 167 and roads on the Renard mine site.

➢ *ACCIDENTS INVOLVING HAZARDOUS SUBSTANCES ON ROUTE 167*

Accidents involving hazardous substances on Route 167 could occur as a result of spills from tankers carrying hydrocarbons (diesel, gasoline, propane), from trucks carrying containers of acids, bases or other chemicals, or from hydrocarbon fires. All such incidents could result in the contamination of surface water and groundwater and of soil by hydrocarbons, acids (hydrochloric acid), bases (sodium hydroxide) or other chemicals, and forest fires.

The following prevention and mitigation measures have been adopted:

- Road constructed to meet *Ministère des Transports du Québec* standards for heavy vehicle transport;
- Service stations along the road;
- Trucks travel in convoys, making assistance and intervention easier to provide; and
- Regular use of the road makes it possible to maintain surveillance to a certain degree.

The level of risk associated with potential spills or fires involving dangerous goods on Route 167 is shown in Table 12.3.33.

Table 12.3.33 Level of risk associated with potential spills or fires involving dangerous goods on Route 167

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Severe	Low	Moderate	Moderate

This risk is on "Watch" status.

Recommendation

It is recommended that formal agreements be established with the *Ministère des Transports*, other mining companies in the area, the closest Cree communities and road users on how emergency equipment and other resources will be shared and deployed.

➢ *DISRUPTION OF TRAFFIC ON ROUTE 167*

Weather conditions (such as blizzards), damage to road infrastructures caused by high flow in watercourses, forest fires or other natural events could prevent the safe arrival of deliveries to the Renard mining site, with resulting economic consequences and potential safety risks.

The following prevention and mitigation measures have been adopted:

- 10-day fuel reserves;
- Reserves of other items, including food for the cafeteria; and
- Air link.

The level of risk associated with traffic disruptions on Route 167 is shown in Table 12.3.34.

Table 12.3.34 Level of risk associated with traffic disruptions on Route 167

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Low	High	Low	Moderate

This risk is on "Watch" status.

➢ *MAINTENANCE OF SECONDARY ROADS AT THE MINE SITE*

Road maintenance carries with it the risk of spills of petroleum-based products that could potentially contaminate surface water and groundwater and soil, as well as the risk of injuries to workers occurring in areas far away from emergency services.

The following prevention and mitigation measures have been adopted:

- Spill cleanup kits, including absorbents are included with road maintenance equipment;
- Training and awareness sessions on the protection of the environment is provided to all employees;
- Emergency response plan with specific response procedures; and
- Radio communications systems link dispatching centres and road users.

The level of risk associated with road maintenance operations is shown in Table 12.3.35.

Table 12.3.35 Level of risk associated with road maintenance operations

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Low	Low	Low	Moderate

This risk is on "Watch" status.

12.3.5.14 Other hazards

This section deals with risks associated with hazards not previously raised. Three (3) hazards that could potentially result in major accidents have been identified:

- Risks associated with snowmobile and boat traffic;
- Forest fires;
- Food and drinking water.

➢ *RISKS ASSOCIATED WITH SNOWMOBILE AND BOAT TRAFFIC*

The casings used in both the land-based drilling process and for drilling in Lake Lagopede represent potential hazards for snowmobile and boat traffic because they are difficult to detect.

The following prevention and mitigation measures have been adopted:

- Identification of casings; and
- Cutting off of casings at or below ground level so they do not constitute obstacles to traffic.

The level of risk associated with snowmobile and boat traffic is shown in Table 12.3.36.

Table 12.3.36 Level of risk associated with snowmobile and boat traffic

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Moderate	Low	Moderate

This risk is on "Watch" status.

Recommendations

It is recommended that drill casings be identified and cut off at or below ground level.

- *RISKS ASSOCIATED WITH FOREST FIRES*

Forest fires can occur as a result of human activity or lightning and could potentially cause injuries or fatalities, economic losses and disruptions to traffic on Route 167.

The following prevention and mitigation measures have been adopted:

- Clearing of brush on the site;
- Open fire restrictions;
- Information and awareness sessions for personnel on issues relating to forest fires;
- Emergency response team;
- Fine fighting equipment
- Emergency response plan; and
- Mutual assistance agreement with Sopfeu.

The level of risk associated with forest fires is shown in Table 12.3.37.

Table 12.3.37 Level of risk associated with forest fires

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Moderate	Moderate	Moderate

This risk is on "Watch" status.

- *RISKS ASSOCIATED WITH FOOD AND DRINKING WATER*

Contamination of food or drinking water carries with it the potential to make significant numbers of people seriously ill, and consequently put tremendous pressure on medical staff and services.

The following prevention and mitigation measures have been adopted:

- Hygiene program for kitchen staff and equipment;
- Monitoring of the quality of drinking water;
- Medical staff and services available on site to provide first aid services;
- Transport by air to urban hospital centres for people needing further medical attention; and
- Emergency response plan.

The level of risk associated with the contamination of food or drinking water is shown in Table 12.3.38.

Table 12.3.38 Level of risk associated with the contamination of food or drinking water

Consequence Severity	Probability	Degree of uncertainty	Level of risk
Moderate	Low	Moderate	Moderate

This risk is on “Watch” status.

12.4 Emergency Response Plan

This section presents a summary of the emergency response plan. The detailed plan can be found in Appendix 12.3. The plan identifies emergency measures for the open pits, the underground mine, the process plant, the waste rock stockpile, the drinking water treatment and domestic and mine wastewater treatment systems, the power generating sets, the fuel storage area, the storage warehouse, the airstrip and roads under the responsibility of the Renard Project.

The emergency response plan was developed in compliance with applicable provincial and federal regulations, standards and practices, as well as those of the National Fire Protection Association (NFPA). These references include the Regulation on occupational health and safety in mines, the CSST Mine Rescue Training Manual, the National Fire Code of Canada, applicable NFPA fire codes, FM Global Loss Prevention Data Sheets, CAN/CSA standard Z731-03 (Emergency Planning for Industry), the federal *Regulations on the Transport of Dangerous Goods*, the Quebec *Environment Quality Act* (R.S.Q. Chapter Q-2), the federal *Environmental Emergency Regulations* (SOR/2003-307) of the *Canadian Environmental Protection Act (*CEPA, 1999), the *Risk Management Guide for Major Industrial Accidents, intended for municipalities and industry* (CRAIM, 2007).

Although emphasis must first be put on prevention, human and industrial activities can, by their very nature, be a factor in the advent of emergency situations, with catastrophic impacts on the operations of a company, on its employees and/or on the environment. Incidents of this kind unfortunately can happen and the fundamental purpose of an emergency response plan is to identify ways to deal with such situations.

The Renard Project site is located 360 km from the town of Chibougamau, which means it will be reached by road on Route 167 and use air links from its airstrip and terminal to access other mine sites.

Given its relative isolation, the Renard Project site must have ready access to the resources needed to appropriately respond to emergency situations.

Mutual assistance agreements also need to be agreed upon with other companies working in the area and with the closest Cree communities.

The emergency response plan also covers mine rescue operations.

The three main objectives of mine rescue operations are:

- Find victims of mine accidents and bring them above ground;

- Locate and extinguish any incipient or active fires;
- Perform certain tasks calling for the use of breathing apparatus for actions, such as restoring ventilation and verifying air quality after a fire, a extensive blasting or the release of SO_2 gas, so that normal operations can subsequently resume.

12.4.1 Management of the Plan

The Emergency Response Plan is the responsibility of the Site Director. That responsibility falls to the Assistant Site Director in Director's absence.

An Emergency Response Coordinator (EMC), appointed specifically to that position, is responsible for preparing and maintaining the emergency response plan. The coordinator will also be responsible for employee training and information on the emergency response plan and appropriate simulation or evacuation exercises. This same coordinator will act in an advisory capacity with the Directors. The Emergency Response Coordinator is vested with the authority for implementing the plan and is an ex officio member of the coordination centre team in the event of an emergency.

An emergency response planning committee will support the EMC in the preparation and updating of the plan and its implementation during emergencies.

The emergency response plan respects the management practices specified in the *Regulation respecting occupational health and safety in mines*.

12.4.1.1 Organization

The emergency response plan will be implemented using the following guidelines:

- Lines of authority remain the same during emergencies as in normal circumstances, so the Site Director on duty will take responsibility for coordination of the emergency measures to the extent required by the scale of the emergency;
- In the event of an emergency, the project supervisor or camp manager takes on the role of Director of Operations;
- The emergency response planning committee has responsibility for designing, developing and communicating the emergency response plan, structuring and organizing a major simulation exercises, reviewing results and ensuring their follow-up, developing relationships with civil authorities, other companies working in the region, and the Cree community to ensure needed responses to emergencies, in addition to updating the emergency response plan on an annual basis;
- Underground mine rescue operations are carried out by the mine rescue team;
- The Mine Rescue Service of Quebec's CSST is responsible for the training of mine rescue teams and maintenance of equipment at mine rescue stations;
- The Emergency Response Team will be responsible for responding to emergencies such as fires or spills at the process plant or other emergencies at ground level.

The main roles and responsibilities of all those taking part in the emergency response plan are outlined below.

Vice President, Operations

- Makes or ratifies important decisions.

Senior Manager, Operations

- Appoints the members of the emergency response planning committee;
- Appoints an emergency response coordinator and delegates the authority needed to that person;
- Approves the emergency response plan;
- Ensures that response teams have the resources they need;
- Direct emergency response activities;
- Ensures that a communications process is established and maintained with employees, their families, government agencies and the Cree community.

Emergency Response Coordinator

- Understands the fire and environmental risks of the project site;
- Organizes the equipment and personnel needed for responding to emergencies;
- Develops emergency response procedures and trains employees on their application;
- Maintains ongoing communications with employees and the Cree community to keep them informed about the emergency response plan. Invites feedback and ensures appropriate follow-up.

Hoist Operator

- Has a clear understanding of his or her role and corresponding procedures;
- Applies evacuation procedures when needed;
- Keeps the hoist cage available for the mine rescue team;
- Follows the orders of the Director of mine rescue operations.

Managers of Stornoway Diamond Corporation (Canada) Inc. with mine rescue responsibilities

- Hold a mine rescue training certificate and attend recurrent training;
- Inform the mine rescue team when an incident occurs;
- Inform the rescue training instructor or closest rescue trainer when an incident occurs;
- Inform the prevention and inspection service of the regional office of the CSST.

Director of Mine Rescue Operations

- Is a management employee of Stornoway Diamonds (Canada) Inc., assigned to this responsibility by the Mine Director;
- Is in charge of mine rescue operations in any emergency requiring the presence of mine rescue teams;
- Is the only person authorized to give instructions to a mine rescue team;
- Maintains ongoing contact with the mine rescue team and the rescue team leader reports on rescue operations as they are progressing and upon his or her return to the above-ground command base.

Technical Assistants to the Director of mine rescue operations

- Provide assistance to the Director of mine rescue operations;
- Carry out tasks the Director is unable or has no time to do;

- Maintain contact with miners trapped underground to gather relevant information, so they can be located and receive appropriate instructions;
- Work in close collaboration with other members of the rescue centre team and the Director of rescue operations.

Mine rescue workers

- Are members of a mine rescue team;
- Be trained in underground work;
- Have volunteered to act to help rescue workers trapped underground;
- Hold mine rescue certificates.

Witnesses to an incident

- Where possible, and without putting themselves in jeopardy, take action in response to an emergency;
- Initiate emergency procedures by communicating with their supervisor or security services and provide:
  - their names,
  - the location and description of the emergency incident;
  - any other information requested;
  - Remain available for future reference.

Employees

- Are familiar with fire and evacuation alarm signals;
- Know who they should report to in the event of an emergency;
- Know where assembly points are located;
- Can implement different emergency procedures depending on the nature of the disaster;
- Cooperate with emergency response teams;
- Remain available on site and wait for instructions from their supervisor.

Supervisors

- Inform the HSE Coordinator and the Camp Coordinator when advised of an emergency situation;
- Ensure the application of the emergency response plan;
- Move to the appropriate assembly point and ensure they can be seen by employees in their department;
- Count up how many of their employees are at the assembly point;
- Ensure that employees they are responsible for remain together;
- Participate in emergency measures, as needed;
- Keep their employees informed about the progress of emergency operations and inform them when operations return to normal.

Logistics and Supplies Coordinator

- Organizes logistics in relation to external resources to ensure that emergency responses will be adequate in the event of an accident;
- Maintains appropriate relations with external resource providers (suppliers) and negotiates service agreements with them;
- Ensures that external resources can are well prepared if called upon in an emergency;

- Keeps site coordinators informed about the progress of emergency operations;
- Reviews and breaks down emergency expenditures by category.

Human Resources Coordinator

- Ensures that all employees are aware of the content of the emergency response plan;
- Notifies families of employees, as needed;
- Ensures that the internal communications system works properly;
- Keep track of developments relating to the emergency, so as to be in a position to respond to requests for information from employees and the media;
- Acts as an advisor on communications to company management;
- Provides information to employees and the media on the overall evaluation of how emergency operations were executed.

Mine Nurse

- Collaborates in planning for an emergency response;
- Makes needs assessments, assigns tasks, and organizes simulation exercises;
- Helps first responders be ready to act appropriately in emergencies;
- Carries out triage of the injured;
- Participates in the evacuation and transport of the injured;
- Directs and coordinates first aid and emergency medical aid activities and the people involved ;
- Makes assessments of the health status of medical respondents if an emergency response continues over a long period;
- Makes assessments of emergency responses, and makes any changes needed, depending on circumstances;
- Is responsible for communications with medical services.

Camp Coordinator

- Ensures the safety of site facilities;
- Assesses the gravity of an emergency and decides if stop of operations is warranted;
- Ensures that employees are safe and that no person is missing;
- Collaborates in the planning for an emergency response;
- Ensures whether and where the emergency response plan is implemented, depending on the situation;
- Assesses needs and assigns tasks to the appropriate employees;
- Is responsible for site safety and the control of access to it;
- Organizes the repair of transport and access roads, where needed;
- Contributes to the assessment and planning for a return to normal operations;
- Informs his or her staff of the return to normal operations and provides them with information as to how emergency operations were executed.

HSE Coordinator

- Usually becomes the Emergency Response Coordinator;
- Organizes people on the basis of their area of intervention;
- Assesses the situation and fully or partially implements the emergency response plan, depending on the situation;

- Strives to ensure that people from different areas of the emergency response work in collaboration;
- Keeps company management appropriately informed about the progress of disaster operations and the implementation of the emergency response plan;
- Issues operational directives as needed;
- Takes any needed decisions on the evacuation of a sector;
- Ensures that decisions taken contribute to the safety of individuals and the protection of property;
- Assesses the effectiveness of the emergency response plan and proposes any needed improvements to company management;
- Submits a report on the emergency situation to company management.

Management team

- Inform key members of company senior management at the head office of the incident;
- Keep track of what is happening and how the emergency response plan is being implemented;
- May order the total evacuation of the project site;
- Authorize communications with employees and their families, and information to be given to the media;
- Communicate information on the progress of rescue operations to employees;
- Can decide to end the state of emergency and authorize a return to normal operations;
- Supervise the analysis of the causes and effects of the emergency incident and ensure the necessary follow-up.

12.4.1.2 Training

A training program covering the responsibilities of different groups of Stornoway Diamond Corporation (Canada) Inc. personnel in the event of emergencies has been developed.

- Management
  - Have received training on the content of the emergency response plan and have mastered its contents;
  - All workers on site/employees;
  - Stay aware of potentially hazardous situations, know how warnings are communicated, including emergency telephone numbers, are familiar with the rapid-warning radio frequencies, with fire alarm or evacuation signals, directives for evacuation and emergency assembly points.
- Emergency Response Team
  - Members of the Emergency Response Team will receive training in emergency response procedures that can be carried out in the event of a fire, explosion, spill, aircraft accident, road accident or a spill of controlled products/dangerous goods.
- Exercises
  - A program of exercises will be carried out at pre-determined time intervals to enable employees to practise procedures to be used in the event of evacuations, fires, explosions and spills, aircraft accidents, road accidents and in situations where people with injuries require attention.
- Mine Rescue Teams
  - Training on the use of self-contained breathing apparatus, and explanations on the manufacture, assembly, use and upkeep of the closed-circuit breathing apparatus that

rescue team members will need to use, together with exercises to practice its use, and training in cleaning and sterilization of the apparatus.

- Training on the goals of rescue operations in the case of a fire in a mine, the responsibilities of mine rescue teams, the basic elements and properties of normal air, the main kinds of toxic gases, the different kinds of breathing apparatus available at different rescue stations and any other topic an instructor deems to be important.
- Learning about different methods of communication.
- Carrying out endurance-building exercises.
- Training about erecting barriers and working in smoke-filled environments.
- Participation in six training sessions at regular intervals over the year.
- Learning how to use fire-retardant foam.
- Being more aware of the kind of practical problems that can be encountered in an underground mine.
- How to administer first aid to accident victims, and how victims should be moved, prepared and transported, as well as how to use inhalers and "2- in-1" cables.
- Theory courses on fire prevention and firefighting, followed by applied training on using extinguishers, and a visit to the deepest part of the mine.

- Directors of Mine Operations and Technical Assistants
  - Must hold a mine rescue training certificate and take at least one periodical refresher session every six months.
- Supervisory Staff working underground
  - Must attend a special information session offered by a mine rescue instructor.

12.4.1.3 Audit and compliance

An annual audit of the emergency response plan will be conducted by a third party. The audit will be carried out with reference to the Mine Rescue Manual, Can/CSA Standard Z-781, and the CRAIM Risk Management Guide for major industrial accidents.

12.4.1.4 Management review

An annual management review will be conducted to ensure that the emergency response plan is fully operational and appropriately backed up by trained personnel and emergency equipment and that relations with external collaborators, including the Cree community, are adequately maintained and supported.

12.4.2 Accidents and malfunctions

The emergency response plan includes specific procedures to follow in emergencies involving accidents and malfunctions.

12.4.3 Specific emergency response procedures

The following specific emergency response procedures are identified in the detailed emergency response plan which includes a listing of roles and responsibilities, equipment and emergency response techniques.

12.4.3.1 Fire

Fires can occur in the following places:

- Underground mine;
- Propane storage areas;
- Fuel storage area;
- Power generating sets;
- Explosives storage area;
- Accommodation and service complex;
- Airstrip and terminal;
- Forests; and
- Roads.

Specific emergency response procedures for each different situation are described in the emergency response plan.

12.4.3.2 Explosions

Areas where explosions could potentially occur include:

- Explosives storage area;
- Propane storage areas;
- Fuel storage area; and
- Power generating sets.

Specific emergency response procedures for each different situation are described in the emergency response plan.

12.4.3.3 Aircraft accidents

A specific emergency response procedure to be followed in the event of an aircraft accident is described in the emergency response plan.

12.4.3.4 Medical emergencies

Potential medical emergencies include:

- Heart attacks;
- Serious traumas;
- Severe (third-degree) burns;
- Food poisoning;
- Etc.

Specific emergency response procedures for evacuating ill or injured persons are described in the emergency response plan.

12.4.3.5 Spills of chemical products

Specific emergency response procedures to be followed in the event of a spill of chemical products are described in the emergency response plan.

12.4.4 Emergency response equipment

The emergency response equipment listed below is needed for the operations of Stornoway Diamond Corporation (Canada) Inc. The list is not exhaustive and will be updated where necessary:

Underground mine

- BG 4 oxygen respiratory protection devices;
- Self-rescue masks;
- Direct-reading devices that show the presence of combustible gases, oxygen, nitrogen dioxide and carbon monoxide;
- Positive pressure oxygen unit;
- Haskel oxygen pump;
- Gas sensors chosen to match the risk profile of the mine;
- First aid kits;
- Basket stretchers and victim strap systems;
- Radios and telephones;
- Ethanethiol (more commonly known as ethyl mercaptan) “stink” alarm for injection into the mine ventilation system;
- Rescue route marking supplies;
- Digital imaging camera;
- Inflatable fire barriers;
- Foam generators and foam cannons;
- Shelters with the equipment required under the Regulation respecting occupational health and safety in mines;
- Brattice line;
- Portable fire extinguishers;
- Fire protection water supply system and fire hoses.

Open pits, process plant, power generating sets and fuel, propane, and explosives storage areas.

The emergency response equipment listed below is already available:

- Reserve fire protection water supply;
- Fire pump;
- Fire protection water supply system with fire hydrants and fire hoses with a minimum capacity of 60 L/sec;
- Special purpose sprinklers to protect the accommodation and service complex, energy-generating equipment, conveyors;
- Emergency vehicle with pump;
- Fire-retardant foam for petroleum-based fires;
- Different classes of portable fire extinguishers for fighting wood and paper-based fires, petroleum-based fires and electrical fires;
- Gas sensors chosen to match the risk profile of the mine;
- Self-contained breathing apparatus;
- First aid kits;
- Stretcher;

- Emergency vehicle;
- Radios and telephones;
- Alarms;
- Surveillance camera;
- Smoke and fire detectors; and
- Other equipment for specific purposes.

12.4.5 Alarms and evacuations

The Emergency Response plan provides details on the different alarm signals and thresholds and evacuation procedures.

12.4.6 Overview of the risk assessment and emergency response plan

The risk assessment demonstrates how Stornoway Diamond Corporation (Canada) Inc. has engaged in implementing a continuous improvement policy based on the ALARP principle (where risk is kept as low as reasonably practicable).

The Corporation will establish a prevention program whose main features have been described above. Responsibility for application of the prevention program guidelines includes all levels of decision-making, right down to the workers themselves. All workers on the site have an obligation to perform their duties without endangering their own safety or that of any other person. Tools such as Job Safety Analyses (JSAs) and Hazard and Operability Studies (HAZOPs) will be used to identify potential workplace hazards. Procedures, together with corresponding training, will be established to prescribe safe ways to use equipment and execute tasks. The prevention program deals specifically with what is meant by accountability, with knowledge and information about the mining process, hazards in different facilities, Job Safety Analyses, change management, the management of sub-contractors, pre-startup reviews, mechanical reliability of equipment, critical safety procedures, training, information, investigation of incidents, inspections and audits, performance indicators, fire protection, first aid, emergency respondents and first aid kits, transportation of sick or injured persons to hospital centres, and human error.

An emergency response plan will be implemented to ensure that the personnel, equipment and procedures are in place to intervene effectively and safely in the event of any incident that that could potentially cause harm to the site or to employees working there.

A Health and Safety Committee will be established and a Safety Representative appointed. A Mine Rescue Team will be trained and provided with all needed equipment.

In anticipation of mining activities, geological and hydrogeological studies were conducted to identify ground-level and underground features of the site and a decision made to operate both open pit and underground mining facilities. The mining plan was governed by the results of those studies. No obviously dangerous features were identified at the site in relation to these proposed operations.

In addition, the company will construct a process plant, install power generating sets and build maintenance facilities, as well as treatment facilities for process water, drinking water, and process and domestic wastewater. A fuel storage area will be created, in addition to storage areas for the propane used for heating the air of the mine ventilation system, the kitchens and the dry room. Propane storage tanks have been installed far enough away from the mine ventilation intake to avoid any risk to the system in the event of an accidental leak.

An accommodation and service complex will be built on the site and an airstrip and terminal constructed as well. None of the facilities have been identified as constituting potential hazards for personnel on site.

A final point to be made is the fact that mutual assistance arrangements will need to be agreed upon with other companies working in the region, the Cree community and users of Route 167, so as to ensure that, if necessary, there can be shared access to emergency response resources in the area.

Chapter 13

References

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Chapter 14

Glossary

Term	*français (ajouté temporairement)*	Definition	Source
Dust control agent	Abat-poussières, agent de contrôle de poussières	Agent (e.g., calcium chloride) used to prevent the raising of dust from unpaved roads.	Termium Plus & 1
Shrinkage OR Blasting	Abattage	Technique used to extract mineral ore from an underground or open pit mine.	Termium Plus
Shelter	Abri	Place providing protection against the elements (predators, the sun, strong currents, etc.) and where individuals can rest.	
Acculturation	Acculturation	Cultural modification or transformation of distinct groups of individuals resulting from prolonged, close contact among culturally different groups.	Termium Plus
Traditional Activity	Activité traditionnelle	Activity such as fishing, hunting or trapping in which Aboriginal peoples engage every year.	
Aerator	Aérateur	Device used to treat wastewater in ponds by infusing it with oxygen.	Termium Plus
Confinement area	Aire d'accumulation	Land on which ore, top soil, concentrates, waste rocks and mine tailings have been, are, or are planned to be confined. Mining water basins, sedimentation and polishing ponds are also considered confinement areas.	Roche
Fish nursery	Aire d'alevinage	Area where fry (young fish) still live off the food reserves in their yolk sacs.	Termium Plus
Feeding area OR Ground	Aire d'alimentation	Area where individuals of a given species feed or can find food.	Termium Plus
Processed kimberlite confinement area	Aire de confinement de la kimberlite usinée	Site where kimberlite is stored after being processed.	Roche
Migration route	Aire de migration	Area serving as a corridor between breeding and feeding grounds.	
Rest area	Aire de repos	Area where individuals gather to rest (e.g., deep ditch, area providing sufficient shelter).	1
Breeding area OR Ground	Aire de reproduction	Area where the males and females of a given species gather to breed, including known and potential spawning grounds.	1 & 2
Alkalinity	Alcalinité	The measure of the capacity of water to neutralize acids and indicate the presence of carbonates, bicarbonates and hydroxides and, on a second level, borates, silicates, phosphates and organic matter.	T
Alun	Alun	Salt used as coagulant in water treatment.	Termium Plus
Ambiance	Ambiance	Feeling reflecting the physical aspect of a landscape and an observer's impression of the area; ambiance is the overall result of individual perception.	
Habitat development	Aménagement (habitats)	The creation of fish habitats, and the development and enhancement (flow control, addition of nutrients, access to spawning and rearing grounds, etc.) of any kinds of habitat to help maintain and improve the productivity of fishery resources.	1
Anatidae	Anatidés	Family of birds including ducks, geese and swans.	Termium Plus
Anuran	Anoures	Order of amphibians including salamanders, mudpuppies (necturus) and newts.	Termium Plus
Aquifer	Aquifère	Permeable soil or land containing groundwater.	Termium Plus
Temporary shutdown	Arrêt temporaire	Complete interruption of mining operations, with one of the operations planned to resume at a pre-determined time, generally within 6 months.	
Mitigation measures	Atténuation (mesure d')	Actions taken during the planning, designing, implementation and operation of works or undertakings to alleviate potential adverse effects on the productivity of fish habitats.	1
No net loss	Aucune perte nette	Working principle by which the Ministry strives to balance unavoidable habitat losses with offset actions so that further reductions in fishery resources due to habitat damage may be prevented.	1
Total Kjeldahl nitrogen	Azote total Kjeldahl	Overall amount of ammonia nitrogen and organic nitrogen, two forms of nitrogen that can be converted into nutrients through biological processes.	Termium Plus
Mining lease	Bail minier	Mining right giving its holder the exclusive right to explore and mine minerals on a given piece of land.	Termium Plus
Borrow pit	Banc d'emprunt	Site from which raw materials are extracted for construction purposes. The terms *sandpit* , *quarry* and *borrow pit* are sometimes used as near synonyms.	Termium Plus

Term	*français (ajouté temporairement)*	Definition	Source
Riparian OR Riverfront strip	Bande riveraine	Vegetated area adjacent to a watercourse or body of water that directly contributes to fish habitats by providing shade, cover and food production areas.	Termium Plus
Sediment barrier	Barrière à sédiment	Sediment control structure set up on the perimeter of a construction site and near a watercourse or lake to filter sediment particles resulting from soil erosion.	Roche
Pond	Bassin	Deep waters usually located at the foot of an obstacle and at the swelling of a watercourse, where slow currents allow sedimentation. However, at the head of the pond located downstream of a major break of a slope, the current is turbulent and speeds up at the outlet. Sediments are mainly sand, but often include coarse materials that settle on the banks. Ponds in between sections of waterfalls or cascades are not included in this definition, because of their smaller size and because their beds are mainly formed by boulders or coarse materials.	Termium Plus
Sedimentation pond	Bassin de sédimentation	Water treatment structure placed downstream of a work site or disturbed area in which part of suspended particles settle at the bottom as sediments; basin or pond in which suspended solids and water treatment sludge deposit at the bottom.	Roche
Watershed	Bassin versant	Area in which all the surface waters flow towards a single point of the watershed called an *outlet* ; the physical boundaries of the area are defined by the line created together by the crests of mountains, hills and heights of the area called *crestline* or a *drainage divide* .	Termium Plus
Berm	Berme	Bench or level platform formed into the sidewall of a slope to allow easier access, and to slow down and collect runoff water.	Termium Plus
Berm	Berme	Horizontal platform: in an open pit, the horizontal distance between two benches (vertical floors) measured perpendicular to the pit's perimeter.	Termium Plus
Bioaccumulation	Bioaccumulation	Process by which chemical elements are accumulated by organisms from exposure to water, sediments or contaminated soil directly or through consumption of food containing the chemical elements.	Termium Plus
Biological magnification OR amplification	Bioamplification	Increase in tissue concentrations of accumulated chemical elements in organisms from one trophic level to the next (i.e., organisms contain higher concentrations of a given substance than the organisms on which they feed).	Termium Plus
Erratic	Blocs erratiques	Isolated fragment of rock resting on the ground where it was carried by a glacier that has since disappeared. Rounded, subrounded, or subangular fragment of any rock more than 256 mm (about 10 in) in diameter.	Termium Plus
Sludge	Boues	Waste from water treatment in the form of slurry or mud with high water content, settled at the bottom of ponds.	
Brunisol	Brunisols	Any of the soils that have developed B horizons but do not meet the criteria of the other orders. Covering close to 790,000 km^2 (8.6 p. 100) of the Canadian landscape, brunisol soils are associated with other soils found in all the regions south of the permafrost area. There are 4 major groups based on the richness in organic matter of horizon A and the level of acidity, including melanic, eutric, sombric and dystric brunisols.	Termium Plus
Residual cap, ice cap	Calotte, calotte glaciaire résiduelle	Layer of ice resulting from the final splitting of a much wider glacier that remains at the end of a glacial period.	Termium Plus
Quarry	Carrière	Site from which raw materials are extracted.	Termium Plus
Cascade	Cascades	Staircase-like break of a slope in the bed of a watercourse; an intermediate between a waterfall and a rapid, with a bed mainly formed by boulders and large rocks.	Termium Plus

Term	*français (ajouté temporairement)*	Definition	Source
CFC (chlorofluorocarbon)	CFC (hydrocarbure chlorofluoré)	Hydrocarbon in which hydrogen atoms are replaced, in part or in whole, with chlorine and fluorine atoms (freon).	Termium Plus
Channel	Chenal	Segment of a waterway whose depth of water, usually more than 1 m, is constant. The current is moderate to slow and the surface of the water is sleek. The sizes of particles range from sand to pebble stone based on the type of substrates intersected by the bed of the waterway.	Termium Plus
Headframe	Chevalement	Framework of steel, rarely concrete, set up above a mine shaft to support thumbwheels on which the hoisting cable moves.	GDT
Waterfall	Chute	Segment of a waterway where there is a sharp drop in the bed formed of stationary rocks and, sometimes, very large boulders.	
Claim	Claim	Land whose boundaries are defined in accordance with a prospection licence.	Termium Plus
Substrate gran size distribution	Classe granulométrique du substrat	Gradation of the substrate of a watercourse or a body of water based on the size of particles in the substrate.	Termium Plus
Coagulant	Coagulant	Chemical product used to prompt adsorption or attraction by agglomeration (flocculation, coagulation) of fine or particles in suspension or colloidal dispersion in a liquid.	Termium Plus
Storage coefficient	Coefficient d'emmagasinement	Product of the specific storage coefficient of an aquifer material per its thickness.	Termium Plus
Fecal coliform	Coliformes fécaux	Thermoresistant coliform: sub-group of total coliform count that ferments lactose at a temperature of 44.5 ^{o}C. The species most frequently associated with this bacterial group is *Escherichia coli* (*E. coli*).	Termium Plus
Community	Collectivité	Group of people naturally grouped together and living in particular buildings.	
Fuel	Combustible	Any material that burns in contact with oxygen while producing a quantity of usable heat.	
Compensation (fish habitat)	Compensation (habitat du poisson)	Replacement of natural habitats, increase in the productivity of existing habitats or maintenance of fish production through artificial means under circumstances dictated by socio-economic conditions and when mitigation techniques are unsuccessful in maintaining sufficient habitats for the fishery resources in Canada.	1
Visual complexity	Complexité visuelle	Complexity influences the ability to absorb and reflects the volume and number of elements involved in land use (vegetation and buildings) based on the residential, recreational, institutional or commercial function for which they are intended. The more land use is complex, the more the landscape is absorbing and visual accessibility is poor.	
Crushing	Concassage	Reduction of large rocks extracted from quarries or mines into fragments of smaller sizes to be used for subsequent treatment.	Termium Plus
Mining concession/claim	Concession minière	Title on a mineral bedrock issued by the government giving the grantee the right to exploit the substance granted and to dispose of the products of the operations.	Termium Plus
Balance	Concordance	Harmony resulting from the convergence of all the elements of a landscape towards the same effect.	
Hydraulic conductivity	Conductivité hydraulique	Ability of a material to allow water to flow through it.	Termium Plus
Contaminant	Contaminant	Solid, liquid or gaseous matter, micro-organism, sound, vibration, radiance, heat, odour, radiation or the combination of any of those likely to alter the quality of water or the environment in any way whatsoever.	Termium Plus
Gaseous contaminant	Contaminants gazeux	The main emissions of gaseous contaminants include nitrogen oxide (NOx), sulphur dioxide (SO_2) and carbon monoxide (CO).	Termium Plus
Continuity	Continuité	The continuity of a landscape is the quality allowing it to be perceived as a whole comprised of non-separate parts.	
True colour	Couleur vraie	Measurement of dissolved colouring compounds (organic and inorganic matter) in water.	Termium Plus

Term	*français (ajouté temporairement)*	Definition	Source
Stream or watercourse	Cours d'eau	Generic term referring to flowing water, including creeks, brooks, rivers, etc.	
CPC (WO) Contamination prevention criterion	CPC(EO)	Criterion aimed at protecting water (W) and aquatic organisms (O) from contamination likely to affect actual and future human consumption.	3
Screen	Crépine	Filter or wire grid placed at the end of a liquid suction pipe to prevent solid matter from obstructing the pump.	Termium Plus
Screening	Criblage	Sorting granular materials with a screen based on their sizes.	Termium Plus
Cree	Cris	North American Indians of Algonquian culture and language living in the James Bay area in Northern Quebec and Ontario.	
High waters OR Flood	Crue	A watercourse overflowing from its minor bed following heavy rains, snowmelt or any other geomorphological phenomenon.	
Acute aquatic life criterion (AALC)	CVAA	Surface water quality criterion aimed at protecting aquatic life against acute impacts; maximum concentration of a substance to which aquatic organisms may be exposed for a short period time without affecting them seriously.	4
Chronic aquatic life criterion (CALC)	CVAC	Surface water quality criterion aimed at protecting aquatic life against chronic impacts; highest concentration of a substance to which aquatic organisms (and their offspring) are exposed daily throughout their life cycle without any adverse effect.	4
Centrifugal separator	Cyclone	Device without any mobile parts in the shape of a cylinder in which a mixture is injected tangentially to be submitted to centrifugal force to separate or grade substances.	Termium Plus
dBA	dBA	Sound level of acoustic power or pressure to which the A scale is applied.	Termium Plus
BOD_5	DBO_5	Biochemical oxygen demand over 5 days of incubation; measure of the amount of dissolved oxygen required for the decomposition of organic matter in a water sample.	Termium Plus
Discharge OR Flow rate	Débit	Volume of liquid (e.g., water, treated effluent) flowing through a cross-section of a waterway or a pipe during a given period of time (e.g., litre per second).	
Specific discharge OR Flow rate	Débit spécifique	Flow rate per surface unit of a watershed.	Termium Plus
Deforestation OR Land clearing	Déboisement	Permanent removal of the forest cover from a landscape.	Termium Plus
Scouring	Débourbage	Operation consisting of placing into suspension fine mineral particles when they are aggregated or stuck to coarser fragments.	
Scourer	Débourbeur	Device in which coarse ore containing a binder like clay is washed and the size of its particles is sometimes reduced.	
Progressive discovery	Découverte progressive	Gradual, continuous process facilitating the regular and ongoing discovery of a landscape.	
Extent of passability – passable	Degré de franchissabilité - Franchissable	Passable at all times by target species.	1
Extent of passability – passable with reservations	Degré de franchissabilité - Franchissable avec réserve	Passable most of the time by target species, except during extreme hydrological events (e.g., too strong or too low flows).	1
Extent of passability – impassable	Degré de franchissabilité - Infranchissable	Impassable at all times by target species.	1

Term	*français (ajouté temporairement)*	Definition	Source
Extent of passability – impassable with reservations	Degré de franchissabilité - Infranchissable avec réserve	Impassable most of the time by target species, except during particular hydrological events depending on the configuration of each obstacle (e.g., very low flow combined with the presence of a gap in a waterfall).	1
Simultaneous maximum demand	Demande maximale simultanée	Maximum energy requirements (power, kW) for the operation of mine infrastructures, most often during peak period.	5
Surface deposit or surficial deposits	Dépôt de surface	All soft materials (clay, sand, gravel, blocks, etc.) overlying bedrock. The mining industry sometimes uses the term *overburden* to refer to the unconsolidated material above bedrock.	Termium Plus
Destruction (fish habitat)	Destruction (habitat du poisson)	Any permanent change of fish habitat that makes it completely unsuitable for future production of fish, regardless of the means employed in causing the change (e.g. by removal, infilling, blockage etc).	
Diamicton	Diamicton	Any non-sorted or poorly sorted unconsolidated soft sediment that contains a wide range of particle sizes.	Termium Plus
Diatreme	Diatrème	Breccia-filled volcanic pipe that was formed by gaseous explosions. It may be linked for instance to the violent vaporisation of phreatic waters that come in contact with ascending lava.	Termium Plus
Aerobic digestion	Digestion aérobie	Digestion of suspended organic matter in an aerated environment.	Termium Plus
(sludge) Anaerobic digestion	Digestion anaérobie (des boues)	Digestion of sludge by microorganisms that develop in the absence of dissolved oxygen.	Termium Plus
Bioclimatic domain	Domaine bioclimatique	An area characterized by a particular type of vegetation that, at the final stage of succession, grows on sites with average soil conditions, drainage and exposure (mesic sites). The balance between vegetation and climate is the main criterion used to distinguish domains.	Termium Plus
Acid mine drainage	Drainage minier acide	Acid water runoff that contains dissolved metals resulting from natural oxidation of sulphide-bearing minerals contained in tailings, ore and mine waste exposed to air and water.	Termium Plus
Hardness	Dureté	A property of water mainly due to its overall content in calcium and magnesium salts, and sometimes to the presence of other compounds such as iron, manganese or aluminium compounds.	1
Changing	Dynamisme	Quality of a visual sequence giving an impression of power and movement in action.	
Raw water	Eau brute	Untreated water collected from a lake or watercourse that can supply a drinking water treatment plant.	Termium Plus
Dewatering water (surface)	Eau d'assèchement	Water from watercourses or lakes in the process of being dewatered.	6
Drinking water	Eau potable	Water suitable for human consumption whose quality is subject to legislation and regulations.	
Mine-drainage water OR Pit water, Mine water	Eaux d'exhaure, eau de mine	Water pumped from a mining excavation to maintain it dry for exploration and operations.	Termium Plus
Greywater	Eaux usées domestiques	Wastewater from domestic use, mainly from the bathroom (toilets, showers), the kitchen and clothes washing machine.	Termium Plus
Mine wastewater	Eaux usées minières	Includes mine drainage water, water from the waste rock pile confinement area, the processed kimberlite stockpile confinement area, the ore storage area, and runoff water from the mine site.	
Mine wastewater	Eaux usées minières	Water potentially influenced by construction and mining operations and through contact with mining facilities and infrastructure.	
Ion exchange	Échange ionique	The process by which certain anions or cations in natural or synthetic resin are replaced by those of water to be treated to change its ionic composition.	Termium Plus
Ecocentre	Écocentre	Public facilities for disposing of selective collection waste, cumbersome, toxic or hazardous domestic waste, building or renovation materials or organic waste to encourage and reuse and recycle.	
Ecosystem	Écosystème	Natural unit of living and non-living components that interact to form a functional base unit of ecology.	

Term	*français (ajouté temporairement)*	Definition	Source
Eeyou IsTchee	Eeyou IsTchee	The land of the people.	
Effluent	Effluent	Liquid flowing out from physical structures or water treatment plants.	Termium Plus
Final effluent	Effluent final	Wastewater no longer treated before being discharged at the outlet into the receiving body of water.	Termium Plus
Treated effluent, Treated water	Effluent traitée, eau traitée	Treated wastewater discharged into a watercourse or lake and whose quality meets legislation and regulatory requirements.	Roche
Reference point	Élément d'orientation	Object or location easily recognized and chosen by users to find their way.	Termium Plus
Outfall	Émissaire	Piping system designed to admit treated wastewater from a wastewater treatment plant and carry it to the discharge outlet.	
Source emission	Émissions des sources	The emission rate of each contaminant released by the sources was obtained by the project development team or estimated using emission factors.	
Rock embankment	Enrochement	Rocks piled up along the edge of a waterway to support culverts, piers or other structures.	GDT
Hydro-seeding	Ensemencement hydraulique	High-pressure broadcast application of seeds, fertilizers or pesticides on land out of reach of conventional seeders.	Termium Plus
Impacts and Benefit Agreement (IBA)	Entente sur les répercussions et les avantages (ERA)	Contractual agreement between an Aboriginal community or entity and a mining company. Parties indicate the terms on which they have agreed regarding job and business opportunities, training, respective obligations in those areas, and the actions to be taken regarding project-specific funding. The content of such an agreement on repercussions and benefits varies based on the stakes involved.	7
EnviroBag	EnviroSac	Highly-resistant bag in which liquids or solids can be confined.	
Epilimnion	Épilimnion	Layer of water located above the thermocline in a stratified body of water such as a lake.	Termium Plus
Even-aged	Équienne	Said of a forest crop or stand in which there are relatively small age differences between individual trees.	Termium Plus
Wind erosion	Érosion éolienne	Soil degradation by the displacement of particles of different sizes due to the action of the wind.	1
Esker	Esker	A very long, narrow, steep-sided ridge of unconsolidated material and fluvioglacial origin, often stretching over hundreds of kilometres.	1
Special status species	Espèce à statut particulier	Group of threatened species according to the *Act respecting threatened or vulnerable species* (MRNF, 2007) and species at risk according to the *Species at Risk Act* (Environment Canada, 2006; COSEPAC, 2007).	1
Lithophilous species	Espèces lithophiles	Species laying their eggs at the bottom of waterways formed by blocks, rocks, gravel or sand with a current over 30 cm/s.	Termium Plus
Acute toxicity testing	Essais de toxicité aiguë	Biological testing conducted on a sample of effluent to see if the standard mortality threshold of the species used for testing has been exceeded; measurement of the inherent capacity or potential of a toxic substance to provoke adverse effects (mortality).	Termium Plus & 8

Term	*français (ajouté temporairement)*	Definition	Source
Sublethal toxicity testing	Essais de toxicité sublétale	Biological testing conducted as part of an environmental effects monitoring (EEM) program on a sample of effluent to verify its level of toxicity; measurement of the element harmful to organisms, but at a lower level than the element likely to cause death.	Termium Plus & 8
Facultative aerated pond	Étangs aérés facultatifs	Oxygenated pond using an air diffuser set up on the bottom of the pond or a surface air diffuser; one part of solids is maintained in suspension, while the other settles at the bottom of the pond to form mud that enters into anaerobic digestion.	GDT
Minimum low flow OR Lowest flow	Étiage	Time of the year when the flow of a watercourse reaches its lowest level (low waters).	Termium Plus
Feasibility study	Étude de faisabilité	Study to highlight the technical or economic aspects of a project to identify the potential of implementation.	
Longitudinal study	Étude longitudinale	Scientific study of individual or collective conduct in their development to highlight the characteristics of each stage of development with regard to previous stages.	
Extraction	Extraction	A part of mining operations consisting of extracting ore, mine waste or mine tailings from an underground or open-pit mine.	Termium Plus
Flow facies	Faciès d'écoulement	Aspects of a watercourse defined by the height of water, the velocity of flow and type of substrate. Also see the definitions of *waterfall* , *cascade* , *meander* , *threshold* , *pond* , *channel* and *rapid* .	1
Family unit	Famille nucléaire	Family composed of the parent couple and their single children.	Termium Plus
Fluvial	Fluvial	Relating to running waters such as rivers, creeks and brooks.	
Fluvioglacial	Fluvioglaciaire	Relating to unconsolidated material composed of loose debris rolled by the action of glacial melt-water.	Termium Plus
Drilling	Forage	Mining operation consisting of boring holes into the ground with drill or cutting tool. Operation can be blasting, exploration, prospection, or extraction of natural resources such as gold, oil, gas, or water. Also refers to boring through mine shafts, drifts and mining sites.	Termium Plus
Open pit mine	Fosses d'extraction à ciel ouvert	Area excavated in the shape of a funnel during open-pit mining operations.	
Catchment ditch	Fossé de captage	Ditch used to capture contaminated water and transfer it towards a treatment facility.	
Diversion ditch	Fossé de dérivation	Ditch used to harness water to prevent contamination.	Termium Plus
Frazil	Frasil	Ice crystals floating in suspension in lake or river waters.	Termium Plus
Confirmed spawning ground	Frayère confirmée	Spawning grounds where specific work has allowed highlighting the spawn of a particular species (observation of the behaviour of spawn or eggs).	1
Potential spawning ground	Frayère potentielle	Sites identified based on the preferred spawning habitats of species and the characteristics of watercourses.	1
Gaviids	Gaviidés	Family of birds including diving birds.	9
Financial guarantee	Garantie financière	Legal and financial obligation imposed upon the applicant ensuring the government that monies will be available to conduct restoration work in the event of non-compliance of commitment.	Termium Plus
Combustion gas	Gaz de combustion	Gas resulting from combustion, usually composed of CO_2, O_2, and H_2.	GDT
Wisconsin glaciation	Glaciation wisconsinnienne	A glaciation period covering most of the northern half of North America from about 85,000 years ago until about	Termium Plus
Aggregate, Agglomerate	Granulat, agrégat	Inert materials part of the composition of layers of pavement or used for construction. Aggregates are usually composed of sand, gravel, crushed rock, pebbles or stones.	

Term	*français (ajouté temporairement)*	Definition	Source
Diesel power generating sets	Groupes électrogènes au diesel	Unit of several diesel generators producing electricity by converting thermal energy resulting from diesel combustion.	Linguee
Fish habitat	Habitat du poisson	Spawning grounds, fish nurseries, rearing grounds, feeding grounds and migratory routes on which fish depend directly or indirectly to survive.	
Habitat du poisson	Habitat du poisson		
Waste rock stock pile	Halde à de stériles	Site for storing rocks that do not contain minerals in sufficient quantities to mine for profit.	
Harmony	Harmonie	Overall effect resulting from the relationships existing among the elements of a landscape. There is balance when these elements focus on the same effect. The harmony of an infrastructure is in relation with the harmony of the surrounding landscape, which depends on the number and significance of viewpoints, and the intensity and balance of the ambiance. A harmonious landscape is necessarily balanced, and discordance reflects a lack of harmony.	
Aquatic vegetation bed	Herbier aquatique	Aquatic environment characterized by the dominance of floating, algae or submerged vegetation, or by a combination of all three.	1
History	Histoire	The architectural value of particular buildings or the quality of events they witnessed.	
Hydrocarbon	Hydrocarbure	Organic compound containing only carbon and hydrogen.	
Hypolimnion	Hypolimnion	The lowermost layer of water in a stratified lake, located under the thermocline.	Termium Plus
Image	Image	Evocation of the actual aspect of a landscape whose representation is collective, due to similarity or analogy. The image of the landscape is recognized and typical.	
Bray-Curtis index	Indice de Bray-Curtis	Index used to measure the level of difference in community structure (more particularly, the composition of communities) among sites. This measure helps to assess the dissimilarities among communities of benthic invertebrates of different sites.	10
Simpson's diversity index	Indice de régularité de Simpson	Measurement of the regularity of individual distribution among taxa. This measure allows assessing change in the relative abundance of taxa.	
Uneven-aged	Inéquienne	Said of a forest, a forest cover or a stand with trees of very distinct age classes.	Termium Plus
Laurentide ice sheet	Inlandsis laurentidien	Name given to the last glacier to cover the Quebec territory.	Termium Plus
Mining facilities	Installations minières	All the structures and equipment required to operate a mine.	
Benthic invertebrate	Invertébrés benthiques	Small animals (excluding fish and other vertebrates) living on the bottom or close to the bottom of a water body that can serve as food to fish.	1
Juvenile (fish)	Juvénile (poissons)	Generally used to define immature individuals of fish or invertebrates, including eggs and fry.	
Kimberlite	Kimberlite	Ultramafic magnatic rock in the form of an explosion breccia filling vertical volcanic chimneys a few hundred metres to 2 km wide, which tends to be smaller in deeper waters. Name given to eruptive rocks which contain diamond.	Termium Plus
Processed kimberlite	Kimberlite usinée	Kimberlite obtained following diamond extraction.	

Term	*français (ajouté temporairement)*	Definition	Source
Lacustrine	Lacustre	Pertaining to anything related to lakes.	Termium Plus
Lamination OR Buffering effect	Laminage	Mitigation of flood flows by containing water stored in lakes, low lands, flood plains, etc.	Termium Plus
Laridae	Laridés	Family of birds comprising of gulls and terns.	Termium Plus
Solid waste trench landfill site	LEET, lieu d'enfouissement en tranchées	Waste landfill site where disposed materials are covered periodically with natural materials (soil, overburden, etc.)	
Lentic	Lentique	Stagnant or slow circulating freshwater.	GDT
Laboratory detection limit	Limite de détection de la méthode d'analyse (LDM)	The smallest quantity of a given compound to titrate detectable with a certain degree of confidence (usually 1%), but not necessarily precisely quantified.	15
Limit of quantification	Limite de quantification	The smallest quantity of a given compound used to observe a difference between two values; in the present study, this quantity is identified as being three times the detection limit of the method of analysis.	
Sludge drying bed	Lit de séchage	Surface, covered or not, used to dry out sewage sludge spread over dried out lakes.	Termium Plus
Leaching	Lixiviation	Process through which soluble soil matter is gradually eliminated through percolating water.	Termium Plus
Hight water mark	LNHE, ligne naturelle des hautes eaux	Limit where land plants are more abundant than aquatic plants or area where there is no more shrub vegetation near the body of water.	12
Lotic	Lotique	Fast-circulating freshwater.	Termium Plus
Tallyman	Maître de trappage	Individual whose primary responsibility is to manage animal populations and harvesting activities within the limits of the territory under his charge. A symbolic figure of Native traditional lifestyle and know-how.	1
Layering	Marcottage	Ability for a plant to propagate in a vegetative manner through stem rooting.	1
Setback	Marge de recul	Distance between a projected infrastructure and the boundary of a riverfront property.	Termium Plus
Organic matter	Matière organique	Any material of biological origin such as vegetation debris, dejections and animal carcasses.	
Hazardous material	Matières dangereuses	Any material posing risks to human health or the environment due to its properties and that, within the meaning of the regulations imposed under this act, is explosive, gaseous, flammable, toxic, radioactive, corrosive, oxidizing or leachable, including any material or object assimilated into a hazardous material subject to the regulations.	Termium Plus
Solid waste	Matières résiduelles	Any waste resulting from a production, treatment or utilization process, or any substance, material or product, or, more generally, any moveable goods that are discarded or meant to be discarded.	
Mature (fish)	Mature (poissons)	In general terms, individuals whose gonads are developed and who are able to reproduce (adults).	
Meander	Méandre	Section of a watercourse running in multiple loops. The bed alternates between sills and wetlands, where particles range from sand to stone.	1
Total suspended solids (TSS)	MES	Substance in suspension, non-dissolved in a liquid.	1

Term	*français (ajouté temporairement)*	Definition	Source
Mesotrophic	Mésotrophe	The trophic level of a lake in which water transparency ranges between 2.5 and 5 m, total phosphorus concentration, between 0.01 and 0.03 mg/L, and chlorophyll a concentration, between 0.003 and 0.008 mg/L.	Termium Plus
Metalimnion	Métalimnion	Layer of transition between the epilimnion and hypolimnion, featuring a thermocline.	Termium Plus
Heavy metal	Métaux lourds	High atomic weight metal, toxic in water even at concentrations slightly above normal.	Termium Plus
MG-112	MG-112	Grade of granular materials particularly defined by its size range; for the MG-112 grade, 100% particles are required to go through a 112-mm sieve.	Termium Plus
MG-20	MG-20	Grade of granular materials particularly defined by its size characteristics; for the MG-20 grade, 100% particles are required to go through a 31.5-mm sieve.	Termium Plus
Migration (fish)	Migration (poisson)	Spatial and temporal movement of animal species between spawning, feeding and refuge habitats in response to genetic or environmental stimuli.	
Mine	Mine	A mine is an open pit or underground, where one can extracts ore (iron, gold, copper, uranium…) or others solid natural compounds (coal, diamond, salt…).	
Ore	Minerai	Rock mass containing valuable minerals in sufficient quantities and volumes to justify mining.	
Staging	Mise en scène	Organization of the elements of a landscape. It refers to the laying out and arrangement of the exterior and visible parts of the relief, vegetation and land use.	
Atmospheric emission dispersion modeling	Modélisation atmosphérique	Modeling of the concentration of air pollutants.	Termium Plus
Overburden	Mort-terrain	In mining operations, waste rock land covering the minable rock formation or bedrock.	1
Equivalent level	Niveau équivalent	Sound level representing the average quantity of acoustic energy released during a given time period.	
Observer	Observateur	Individual who, as the user of a waterway (mobile observer) or riverside resident (motionless observer) observes a landscape likely to be changed by the construction of an infrastructure.	
Land use	Occupation du sol	Generic term referring to the inventory of landscape characteristics, including hydrography, vegetation and the elements of land use.	Termium Plus
Effluent discharge objectives	OER, objectifs environnementaux de rejet	Concentrations and maximum demands of contaminants likely to be discharged in a receiving body of water while ensuring the maintenance of uses, even their recovery.	17
Oligotrophic	Oligotrophe	The trophic level of a lake in which water transparency ranges between 5 and 12 m, total phosphorus concentration, between 0.004 and 0.010 mg/L, and chlorophyll a concentration, between 0.0010 and 0.0030 mg/L.	Termium Plus
Oligo-mesotrophic	Oligo-mésotrophe	The trophic level of a lake in which water transparency ranges between 4 and 6 m, total phosphorus concentration, between 0.007 and 0.013 mg/L, and chlorophyll a concentration, between 0.0025 and 0.0035 mg/L.	17
Organochlorinated	Organochloré	Said of a synthesized organic product derived from chlorine.	19
Ortstein, Ferruginous (hard) pan	Ortstein, carapace ferrugineuse	Humic Podzol B horizon, cemented, of reddish colour, with very low permeability, that can reach over a metre thick.	Termium Plus
Open air access	Ouverture au jour	Shafts, chimneys, drifts on hillsides, underground sites open at the surface, and any other access to underground sites.	

Term	*français (ajouté temporairement)*	Definition	Source
Paludification	Paludification	Expansion of a bog (ombrotrophic peatland) due to the gradual rise of the water table as accumulated peat prevents drainage.	Termium Plus
Dispersion plume	Panache de dispersion	Space including all the actual trajectories of water particles moving in a porous environment from a given point, under the effect of convection and kinematic dispersion.	Termium Plus
Fuel storage area	Parc à carburant	Area reserved for the fuel storage.	Linguee
Fish passage	Passage du poisson	The free transit of fish, upstream and downstream, associated with migration or localized movements that are necessary to complete their life cycle. Depending on the context, fish passage is also a route for fish to move from one habitat to the other.	
Peneplain	Pénéplaine	Weakly undulating plain, resulting from the erosion of ancient formations by glaciers, water and wind.	Termium Plus
Permafrost	Pergélisol	Layers of soil or rock at variable depths beneath the earth's surface, in which temperatures are continuously below 0°C for at least several years. Permafrost exists where summer warm-up does not reach the base of the layer of frozen soil.	GDT
Restriction period (fish)	Périodes de restriction (poisson)	Indicates when it is appropriate to proceed with proposed development in bodies of water or watercourses. This time constraint typically coincides with critical periods in the life cycle of fish (reproduction, incubation and nursery stages).	
Periphyton	Périphyton	A community of small or microscopic aquatic organisms (plants, animals, and bacteria) that live attached to submerged surfaces in watercourses or lakes.	Termium Plus
Person-year	Personne-année	Number of hours typically worked during a year by workers in a particular industry; corresponds to the regular workload related to the measured activities.	GDT
Disruption (fish)	Perturbation (poisson)	Any change to fish habitat occurring for a limited period that reduces the capacity of fish to support one or more of their life processes.	
Stand	Peuplement	A community of trees with sufficient uniformity in species composition, age, spatial arrangement, etc., to be distinguishable from forests or other growth on adjoining areas.	Termium Plus
Piezometer	Piézomètre	Instrument for measuring the level of a water table or fluid pressure in soil, rock or concrete.	Termium Plus
Piezometric (level)	Piézométrique (niveau)	Elevation to which water will rise in a test drill or bored shaft at a given point in an aquifer.	
Surface pillar	Pilier de surface	Rock mass of variable geometry, mineralized or not, located above the excavations of an underground mine	Termium Plus
Impact control plan	Plan contrôle-impact	Study plan including at least one reference area, typically located upstream of the exposed area or in another watershed, and in one or more exposed areas located downstream.	
Body of water or waterbody	Plan d'eau	General term referring to ponds, bays, lakes, estuaries, marine areas, etc.	Termium Plus
Podzol	Podzol	Soil typically developing under cold and wet conditions, especially where acidic, coarse parent material (unconsolidated bedrock or materials) is found.	Termium Plus
Humo-ferric podzol	Podzols humo-ferriques	Acidic soils with a B horizon containing amorphous substances composed of humidified organic matter combined with aluminium and iron. They develop most often in areas of sandy materials and under cold and humid climates, in forest or shrub vegetation.	Termium Plus
Viewpoint	Points de vue	Main areas from which particularly picturesque and spectacular vistas can be enjoyed. One of the parameters of harmony.	
Fish	Poissons	Includes (a) fish and all their parts, (b) shellfish, crustaceans, marine animals and their parts, (c) eggs, sperm, milt, spawn, larvae, spat and juvenile stages of fish.	

Term	*français (ajouté temporairement)*	Definition	Source
Atmospheric pollution	Pollution atmosphérique	Contaminants present in the atmosphere, such as dust, fumes, gas, emanations, fog, smoke, odours or vapours in such quantities and of such a nature and duration as to be injurious to plant, animal and human life or private property.	
Polymer	Polymère	Substance composed of a great number of identical or different molecules of low mass that link to each other in chains or networks to create molecules with a high molecular mass.	Termium Plus
Culvert	Ponceau	Small bridge allowing the free traffic of vehicles above streams, brooks and rivulets.	Termium Plus
A-scale	Pondération A	Scale of sound applied to each band of octaves or third-octaves closest to human hearing.	Termium Plus
Postglacial	Postglaciaire	Any phenomenon that occurred after a glacial period.	Termium Plus
Dust	Poussières	General term referring to solid particles of various sizes and origins that can remain for a certain amount of time suspended in a gas.	
Fine dust	Poussières fines	Particles smaller than 2.5 microns.	Termium Plus
Anthropogenic pressure	Pression anthropique	Having its origin in the human activities.	
Hydrostatic pressure	Pression hydrostatique	Pressure exerted by a motionless liquid against the walls of the interstices of its solid container, particularly on the walls of the interstices of the porous medium or the discontinuity surfaces of a cracked medium.	
Yield (fish)	Productivité (poisson)	Sum of production rates for all co-occurring fish stocks within a defined area or ecosystem (Minns, 1997). As such, the productivity integrates the value of primary production, food, cover and other habitat variables needed to produce healthy fish.	
Proglacial	Proglaciaire	Any observable phenomenon ahead of a glacial front and whose existence is controlled by the glacier itself.	Termium Plus
Psychosocial	Psychosocial	Refers to human psychology as it occurs in social life.	
Mine shaft	Puits de mine	The entry to a mine to access below. Typically, a mine shaft starts at the surface. If it is bored starting from an underground site, it is called *slope,* although it can also be called *winze shaft* if equipped with a winch. A mine shaft can be vertical or inclined.	GDT
Quartenary	Quaternaire	Last and current geological period in the history of the earth that began, according to the U.S. Geological Survey (USGS), about 2.6 million years ago, characterized by a series of glacial periods.	Termium Plus
Access ramp	Rampe d'accès	Sloping tunnel allowing access to underground ore deposits and mining sites.	
Rapid	Rapide	Slight break of a slope in the bed of a watercourse where the current is fast and the surface of the water is broken by the presence of coarse materials that jut out above the surface. Particle sizes range from pebbles to rocks with, sometimes, large rocks jutting out.	
Recurrence	Récurrence	Potential period of return of a given event.	
Water OR Hydrological regime	Régime hydrologique	Variations in the conditions and characteristics of an aquatic formation that repeat regularly over time and in space, by going through cyclic variations; for instance, seasonal changes.	Termium Plus
Backfilling	Remblayage	Action of returning mine tailings underground to ensure the stability of work sites.	Termium Plus
Waterway or hydrographical network	Réseau hydrographique	Includes all the permanent and temporary waterways (rivers, creeks, brooks, etc.) that drain a more or less extended region.	Termium Plus

Term	*français (ajouté temporairement)*	Definition	Source
Probable mineral reserve	Réserves minérales probables	Portion of indicated mineral resources and, in some cases, measured mineral resources that can be mined for profit as demonstrated by at least one preliminary feasibility study. The study must include adequate information on the mining operations, processing, metallurgy, economic considerations and other relevant factors showing that the cost-effectiveness of mining that portion can be justified, at the time the report is written.	12
Proven mineral reserve	Réserves minérales prouvées	Portion of measured mineral resources that can be mined for profit as demonstrated by at least one preliminary feasibility study. The study must include adequate information on the mining operations, processing, metallurgy, economic considerations and other relevant factors justifying the cost-effectiveness of mining the portion, at the time the report is written.	12
Mine tailings	Résidus miniers	Any solid or fluid material discarded during the extraction, preparation, beneficiation and separation of ore, excluding the final effluent but including sludge and dust resulting from the treatment or purification of mine wastewater or atmospheric emissions.	Termium Plus
Fishery resources	Ressources halieutiques	Fish stocks or populations that sustain commercial, recreational or subsistence fishing activities of benefit to Canadians.	Termium Plus
Indicated mineral resources	Ressources minérales indiquées	Portion of the mineral resources whose quantity and concentration or quality, density, shape and physical characteristics can be estimated with a sufficient level of confidence to allow the appropriate establishment of technical and economic parameters in order to justify planning mining operations and assessing the economic viability of the deposit. The estimate is based on detailed, reliable information on exploration and testing collected using appropriate techniques at locations such as outcroppings, trenches, shafts, work sites and exploratory borings during a relatively short timeline to issue a reasonable hypothesis on the continuation of the geology and concentrations.	12
Restoration	Restauration	Operation consisting of putting a mining site back into satisfactory conditions.	
Direct spin-off	Retombées directes	Income (wages and profits) generated by the direct expenditures of a project into the economy concerned.	1
Indirect spin-off	Retombées indirectes	Income from which the owners and employees of businesses located along the chain of intermediate suppliers benefit.	1
Induced spin-off	Retombées induites	Income generated by the consumer expenses of households who benefit from the direct and indirect spin-off of a given project.	1
Taxonomic richness	Richesse taxonomique	Total number of taxonomic categories to which organisms collected at a sample station belong.	14
River	Rivière	Moderately important waterway in continuous flow, following a defined course, receiving water from other tributary watercourses (affluents) and flowing into another waterway.	
Creek, Brook	Ruisseau	Small waterway in continuous or intermittent flow, neither very wide nor long, and into which natural water sources drain.	
Drainage gully OR Ditch OR Trench	Saignées	Shallow trench dug into moist soil to drain it.	Termium Plus
Salmonid	Salmonidés, salmonidae	Anadromous species including fish living in salt water and breeding in fresh water and freshwater species living in lakes and watercourses; dominant species living in cold northern waters and divided into three sub-families: salmonids (salmon, trout, char), coregonids (whitefish, cisco, round whitefish) and Thymallinae (Arctic grayling).	Termium Plus
Blasting	Sautages	Breaking up rock or matter by detonating explosives.	Termium Plus
Scarify	Scarifier	To loosen soil before harrowing it.	Termium Plus

Term	*français (ajouté temporairement)*	Definition	Source
Oil-water separator	Séparateur huile-eau	Device used to separate hydrocarbons contained in collected water before disposal.	Termium Plus
Sill	Seuil	Shoal formed by shallow waters, a succession of shoals alternating with trenches, or a slight break of a slope in the bed of a watercourse. The water flows relatively fast and particles usually range from gravel to pebbles, with occasional sandy parts.	
Mining OR Mine site	Site minier	Any land that has been, is or could be used for exploration or mining.	
Sociosanitary OR Health region	Sociosanitaire ou région sanitaire	Concerning both social and health aspects.	GDT & 14
Basement rock	Socle rocheux	The underlying or older rock mass. Solid rock mass on which loose or relatively unconsolidated sediments rest.	Termium Plus
Organic soil	Sol organique	Soil with a high content of organic matter.	Termium Plus
Area source emission	Sources étendues (émission des régions sources)	Source likely to produce emissions when filled with materials or due to wind erosion.	Termium Plus
Stationary source	Sources fixes	Source with a fixed emission rate that does not change locations during the course of a project.	
Mobile source	Sources mobiles	Any type of movable equipment.	
Waste rock	Stériles	Rock containing an insufficient amount of minerals to be mined for profit.	
Sublimation	Sublimation	The transition of a substance from the solid phase directly to the vapour phase without passing through the liquid phase; e.g., the sublimation of snow.	Termium Plus
Substrate	Substrat	The bed of a body of water or a watercourse, which may be rocks, blocks, cobblestones, pebbles, gravel, sand, silt, clay, mud, or plant matter.	
Monitoring	Suivi	Regular observation and recording of specific parameters and/or indices to determine the level of compliance with statutory requirements and associated mitigation, and/or offset measures.	
Switching system	Système de commutation	System where the switches of a network are operated to establish end-to-end links needed to transmit signals.	Termium Plus
Blasting mat	Tapis de dynamitage	Heavy mat made of recycled tires serving to confine flying debris on the ground during rock blasting.	19
Exfiltration rate	Taux d'exfiltration	Water leaking through capillary action and percolation into a piping system having reached a state of stability.	Termium Plus
Taxum	Taxon	Organisms are divided into categories based on their similarities and evolutionary relations. Each category (e.g., species, genus, family, phylum) is called a taxum.	
Background content or Geochemical bakground	Teneur de fond	Concentration of a chemical substance corresponding to the ambient presence of the substance.	Termium Plus
Trapline	Terrain de trappage	Subdivision of Cree territory, typically divided based on the water system for animal population management purposes by tallymen.	E
Terrigenous	Terrigène	Any elementary component (rock fragment, mineral) torn away from the ground that emerged through erosion and the sediments constituting those components.	Termium Plus
Tetraonidae	Tétraoninés	Bird sub-family of the Phasianidae family, including grouse, ptarmigan and tetra.	20
Thermistor	Thermistor	Instrument used to measure radiant energy comprised of a small quantity of semi-conducting substances placed between two current adduction wires.	Termium Plus
Thermocline	Thermocline	Range of water characterized by a high vertical thermal gradient.	GDT

Abbreviations and Symbols

Abbreviation	*Meaning*
General	
EBS	Environmental baseline study
ESIA	Environmental and social impact assessment
HDPE	High density polyethylene
TLS	Trench landfill site
CCT	Closed circuit television system
Organizations	
CÉAA	Canadian Environmental Assessment Agency
CFIA	Canadian Food Inspection Agency
CISA	Canadian Ice Service Archives
MPMO	Major Projects Management Office
JBNQA	James Bay and Northern Quebec Agreement
CCME	Canadian Council of Ministers of the Environment
CEAEQ	Centre d'expertise en analyse environnementale du Québec
CEHQ	Centre d'Expertise Hydrique du Québec
ASCOM	Assessment Committee
RECOM	Review Committee
MIARC	Major Industrial Accidents Reduction Council
CSST	Commission de la santé et de la sécurité au travail
FOC	Fisheries and Oceans Canada
GCC(EI)	The Grand Council of the Crees (Eeyou Itschee)
MDDEP	Ministère du Développement durable, de l'Environnement et des Parcs
MPO	Ministère des Pêches et Océans
MRNF	Ministère des Ressources naturelles et de la Faune
MTQ	Ministère des Transports du Québec
CNM	Cree Nation of Mistissini
NWPP	Navigable Waters Protection Program
RBQ	Régie du bâtiment du Québec
NRCan	Natural Resources Canada
TC	Transport Canada

Abbreviation	*Meaning*
Regulations and Legislation	
LFA	Lease-free Authorization
EXL	Exclusive Lease
NEL	Non-exclusive Lease
CA	Certificate of Authorization
SOR/2003-307	*Environmental Emergency Regulations* of the *Canadian Environmental Protection Act* (CEPA) 1999
SOR/2008-34	*Transportation of Dangerous Goods Regulations Goods*
SOR/88-66	*Controlled Products Regulations*
EEM	Environmental Effects Monitoring
R. S. Q., c. S-2.1, r.15	*Regulation respecting the quality of the work environment*
R.S.Q., c. Q-2	*Environment Quality Act*
R.S.Q., c. S-2.1	*An Act respecting occupational health and safety*
R.S.Q., c. S-2.2 r.19.1	
R.S.Q., c. M-13.1, r.2	*Mine Health and Safety Regulations*
CÉAA	*Mining Act*
CEPA	*Canadian Environmental Assessment Act* (R.S., c. 37)
NWPA	*Canadian Environmental Protection Act*
EQA	*Navigable Waters Protection Act*
EDO	*Environment Quality Act*
RSFM	*Regulation respecting standards of forest management for forests in the public domain*
Methods, Compounds and Units	
BPUE	Biomass per effort unit
CPC(WO)	Contamination prevention criterion (CPC) aimed at protecting water (W) and (O) aquatic organisms
CPUE	Catch per unit effort
AALC	Acute aquatic life criterion
CALC	Chronic aquatic life criterion
dBA	A-weighted decibel
LRC	Limited range count
PAI	Punctual abundance index
DLMA	Detection limit of the method of analysis
NHWL	Natural high-water line
MSL	Mean sea level
$Q_{10,7}$	Dry-weather flow (average minimum flow) observed during 7 consecutive days, with a 10-year recurrence
Q_2, Q_{10}, Q_{25}, Q_{50}, Q_{100} & $Q_{1,000}$	Flood flow with a 2-year, 10-year, 25-year, 50-year, 100-year and 1,000-year recurrence
$Q_{2,7}$	Dry-weather flow (average minimum flow) observed during 7 consecutive days, with a 2-year recurrence

Abbreviation	*Meaning*
$Q_{5,30}$	Dry-weather flow (average minimum flow) observed during 30 consecutive days, with a 5-year recurrence
UV	Ultraviolet rays (disinfection of raw water)
CFC	Chlorofluorocarbon
DIC	Dissolved inorganic carbon
DOC	Dissolved organic carbon
BOD	Biochemical oxygen demand
BOD_5	Biological oxygen demand over 5 days
$Fe_2(SO_4)_3$	Iron sulphate
GHG	Greenhouse gas
SM	Suspended matter
NH_4	Ammonia nitrogen
N-NH_4	Ammonia nitrogen based on its nitrogen content
TKN	Total Kjeldahl nitrogen
O_2	Dissolved oxygen
P	Phosphorous
ha	Hectare
kg	Kilogram
l	Litre
l/s/ha	Litre per second per hectare
m^3/s	Cube metre per second
mg/l	Milligram per litre
CFU	Colony-forming unit
NTU	Nephelometric turbidity unit
TSS	Total suspended solids

Term	***français (ajouté temporairement)***	**Definition**	**Source**
THM (Trihalomethane)	THM (trihalométhane)	Compound mainly formed by chlorine reacting with organic matter during water treatment.	Termium Plus
Till	Till	Glacial deposit left directly by ice and composed of clay, sand, gravel and boulders combined in any proportion. Till can only be glacial.	1
Fen	Tourbière minérotrophe	Type of peatland receiving a variable quantity of water from both atmospheric precipitation and the drainage water of a pond loaded with minerals that fertilize the moist soil. Fens contain a wide variety of vegetation, mainly grass cover such as Cyperaceae and Bryophytes (particularly brown moss of the Amblystegiaceae family), shrubs and trees.	1
Bog	Tourbière ombrotrophe, bog	Type of peatland watered only by atmospheric precipitation, which is also the single source of nutrients except for nutrients produced by the decomposition of plants forming the substrate of the peatland.	1
Patterned fen	Tourbière structurée	Peatland whose surface is rippled due to alternating small ridges and narrow depressions laid out perpendicularly against the slope. In patterned fens, ridges and strips are usually small, barely a few (ten) or so centimetres high above depressions. Whereas in bogs, ridges are called folds or mounds because of their particular morphology and size at times larger than that of strips.	Termium Plus
Water treatment	Traitement des eaux	Application of appropriate techniques allowing raw water or wastewater to be used for particular purposes.	
Ore processing	Traitement du minerai	Operation consisting of extracting minerals, concentrates, or mine tailings and the economic substance(s) they contain.	Termium Plus
Power transformer	Transformateur de puissance	Industrial transformer, generally three-phased, used for converting electrical power on constant frequency and relatively constant voltage grids.	Termium Plus
Transition	Transition	Swift or gradual passage between two landscapes, depending on whether passage is between two areas of homogeneous or mixed land use.	
Transmissivity	Transmissivité	Product of the hydraulic conductivity of an aquifer material per its thickness.	T
Turbidity	Turbidité	Measure of content in particles like loam and clay particles, organic matter, plankton and microscopic organisms generally held in suspension due to turbulent flow or Brownian movement.	T
Forest type	Type forestier	Unit defined by the dominant arborescent and companion species, along with indicator species associated with the conditions of the physical milieu or particular disturbances. Each forest type has its own physical features and is found on sites whose range of tolerance varies within known limits. The forest type serves as the base for classifying forest vegetation in Quebec.	T
Urodeles	Urodèles	Order of amphibians including frogs, tree frogs and toads.	R & C
Water use	Usage de l'eau	Any utilization of water required for the development, growth and breeding of wildlife and flora, and human consumption for practical and recreational purposes.	
Added value, Gross domestic product	Valeur ajoutée, produit intérieur brut	Measure of the value of the domestic production of a given economy (for instance, the economy in Quebec) obtained by adding production factor earnings: wages, the individual net income of businesses, other gross income (profits and amortization of capital), taxes and production subsidies.	
Mixing zone	Zone de mélange	Restricted area where water quality criteria may be exceeded as long as there are no adverse effects to the overall body of water.	1
Reference area	Zone de référence	As part of environmental effects monitoring, a sampling site that includes waters where benthic invertebrates, fish and fish habitats are not exposed to an effluent and whose characteristics are as close as possible similar to those in the exposure area.	21
Exposure area *(as part of environmental effects monitoring)*	Zone exposée *(dans le cadre des ESEE)*	As part of environmental effects monitoring, a sampling site that includes waters where benthic invertebrates, fish and fish habitats are exposed to mine effluents.	21
Buffer area	Zone tampon	Portion of land not to be altered by human activities.	1