Northern Village of Salluit

VULNERABILITY ANALYSIS OF THE DRINKING WATER SOURCE

WATER INTAKE N˚ X2114282 OF SALLUIT

March 15th 2021

Project 21-0056

PROJECT TEAM

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ADVICE TO THE READER

This document has been realized using data collected from Kativik Regional Government (KRG), the Northern Village and the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC), as well as from other stakeholders involved in the protection of water resources in Northern Québec. No data has been collected on the field by our professionals due to the SRAS-CoV-2 pandemic. All the analysis presented in this document are based on the interpretation of various provincial regulations.

The analysis presented in this report are given for general guidance and benefit of the client only. Any final decision regarding an eventual intervention on site should be made along with the consultation of the MELCC.

Consequently, Nuna Resources cannot be held responsible for interventions undertaken in the environment before obtaining the necessary environmental and government authorizations.

REFERENCE FOR CITATION

Nuna Ressources. 2021. Vulnerability Analysis of the drinking water source – Water intake n° x2114282 of Salluit. Rapport du projet 21-0056. 30 pages + appendices.

ABSTRACT

The environmental firm Nuna Ressources was mandated by the northern village of Salluit to carry out the vulnerability analysis of its drinking water source in compliance with article 75 of the Water Withdrawal and Protection Regulation (WWPR) and following the guidelines of the *guide de réalisation des analyses de vulnérabilité des sources destinées à l'alimentation en eau potable du Québec* (MELCC, 2018).

The northern village of Salluit is located at the end of Nord-du-Québec, in the Kativik regional government and on the edge of the Hudson Strait. Subject to an arctic climate and located in an area of continuous permafrost, the challenges of protecting the source of drinking water are particularly important. The presence of permafrost and the varying climatic conditions indeed imply development challenges specific to these latitudes.

The drinking water source for the northern village of Salluit is located in the Kuuguluk River, along Immirtavik Street. It consists of a well which descends under the bed of the river, in an area of the ground called "sub fluvial talik", an unfrozen portion of the permafrost which is located under the bed of a major water system.

Water from the well is sent to the water treatment plant via the pumping station. It undergoes disinfection by UV light and then two disinfections with chlorine before its storage and distribution by water trucks.

The drinking water source protection areas, determined by mapping method, are as follows: the inner protection area rises 500 m upstream from the water intake and 50 m downstream, including riparian strips of 10 m. The intermediate protection zone rises 10 km upstream from the water intake and 50 m downstream, encompassing riparian strips of 120 m. Finally, the outer protection area corresponds to the entire watershed of the water intake, as well as the portion of the intermediate zone located downstream of the intake.

Following the assessment of the vulnerability of the water source, two of the six indicators, the physical integrity of the sampling site and the vulnerability to turbidity, were set at a "high" level. The level of physical vulnerability was judged to be high following repeated episodes of water scarcity during the winter, one of the probable causes of which would be the exceptional freezing of the bed of the Kuuguluk River. This phenomenon occurs chronically in winter and is likely to place severe strain on drinking water intake installations. The level of vulnerability to turbidity was classified as "high" following an assessment of the natural characteristics of the watershed.

Since the village of Salluit is located downstream from the drinking water intake, very few activities are located in the source protection areas. The anthropogenic activities that have been identified are the exploitation of the borrow pit in the inner/intermediate protection areas and the passage of

a portion of the road in the intermediate protection area. However, after evaluating the contaminants and potential events associated with these activities, it was determined that these activities do not significantly threaten the quality, or the quantity of water exploited.

Finally, within the limits of the northern village of Salluit, the water source protection areas are all included in the “Nuna” land use, which is mainly dedicated to traditional and recreational activities and where no development or activity likely to pollute the municipal water source is allowed; this contributes to the protection of the water source.

It emerges from this study that the source of drinking water in Salluit therefore provides the northern village with quality water, so far with very little impact from human activities. However, it also emerges from this assessment that the drinking water intake does not seem to provide a sufficient volume of water for the needs of the community. It is therefore urgent to carry out a complete evaluation of the installations in connection with the drinking water system and a hydrodynamic study at the location of the water intake in the riverbed, to determine the exact origin of the water problems encountered and to propose solutions to guarantee safe and permanent access to drinking water for the inhabitants of the community.

To improve the monitoring and protection of the drinking water source for the future, the following recommendations have been made :

- A complete assessment of the drinking water intake and treatment infrastructures should be done by a professional, as well as a hydrodynamic study at the water intake;
- Following the results of this evaluation: upgrade the drinking water withdrawal and treatment facilities where necessary;
- Train more personal capable of operating the drinking water installations;
- Create a register in which to record the values of the turbidity of the raw water, particularly during periods of flood (spring melt, heavy rains) when the turbidity is likely to increase sharply;
- Keep a written record of events, even minor ones, which have affected the drinking water production chain and keep this information for inter-annual monitoring. An example of such a register is provided in Annex 6;
- During Colilert tests performed every week, test raw water samples at least once a month in winter, and weekly in summer.

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1 INTRODUCTION

1.1 MANDATE ET OBJECTIVE

The firm Nuna Resources was mandated to carry out a vulnerability study of the drinking water source in the northern village of Salluit, which, as responsible for a category 1 surface water withdrawal (supply of more than 500 people) is obliged to provide a vulnerability report before April 1, 2021, under article 75 of the regulation on water withdrawal and protection (WWPR). This report is to be renewed every five years.

In accordance with the guidelines of Article 75, this report combines the following information:

- The location of the drinking water sampling site, a description of the water treatment facilities;
- The location plan for inner, intermediate and outer protection areas;
- Water vulnerability levels according to the six indicators presented in Article 69, Annex IV of the WWPR;
- Human activities, potential events and land uses likely to affect the quantity or quality of water within the protection areas;
- An assessment of the threats that the elements listed could represent for the quality and quantity of water exploited;
- An identification of the probable causes that may explain the medium or high levels of vulnerability concerning the six indicators mentioned in Article 69 Annex IV of the WWPR;

This report presents a summary of all the information required by the Ministère de l'Environnement et de la Lutte contre les changements (MELCC), when available, for the Northern Village of Salluit in accordance with the guidelines provided by the *guide de réalisation des analyses de vulnérabilité des sources destinées à l'alimentation en eau potable du Québec* (MELCC, 2018). Section 5.2 presents information that is missing or could not be obtained in the context of this study. If essential elements prove to be missing, this report proposes recommendations, ranked in order of priority, that the municipality could adopt to address the lack of data by 2026, the date of the next vulnerability report.

1.2 GENERAL DESCRIPTION OF THE STUDY AREA

The northern village of Salluit (62˚12'5"N, 75˚38'30"W) is located in a deep valley 500 m wide and 2 000 m long on the edge of Hudson Strait (Lemieux et al. 2016). This village, the second northernmost village in Québec (Allard et al. 2020) borders the south shore of Sugluk Fjord, which empties into the Hudson Strait, north of Ungava Bay. It has a population of 1,640 inhabitants over an area of 14.34 km^2 (Affaires municipales et Habitation Québec, 2020) and is part of the Kativik regional government in Nunavik, in the administrative region of Nord-du-Québec (10).

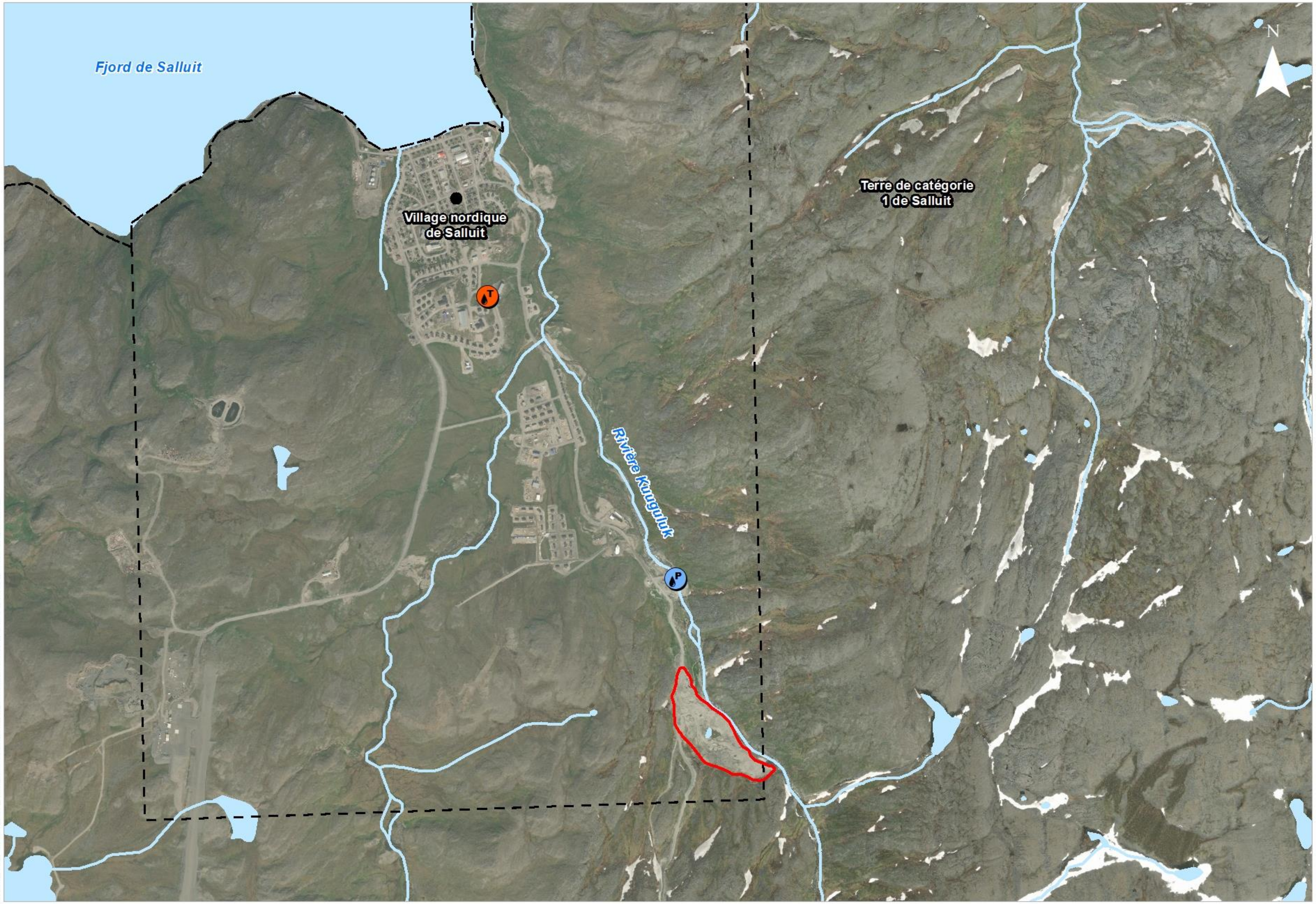
Salluit is located in a continuous permafrost zone, characterized by an arctic climate and herbaceous tundra-type vegetation. Annual precipitation is between 250 and 500 mm. The mean annual temperature hovers around -6.29˚C while between 2002 and 2008, the frost season extended for an average of 222 days (Allard et al. 2020).

The village of Salluit is mainly built on an ice-rich permafrost (Annex 1), which is sensitive to the significant increase in temperatures observed in the arctic regions since the 1970s (+ 2.7˚C in the global arctic region between 1971 and 2017; Box et al. 2019). The dominant geological units present are rock outcrops, glacial deposits, and marine deposits (Allard et al. 2020). These deposits are ice-rich tills and marine clays. The village is therefore exposed to detachments of the active layer of permafrost whose melting increases with warming, which can cause the appearance of large crevices and destabilize / damage existing infrastructures (Allard et al., 2020; Gauthier et al. 2019).

Outside the northern village of Salluit are :

- To the southwest, the proposed Kovik River Aquatic Reserve, protected area no. 165875 of 465,120;
- To the West, Illuliq National Park, protected area 4844 of 77,749 ha;
- To the East, halfway between Salluit and Kangiqsujuaq, the Raglan nickel mine;
- In the South-East, the Pingualuit National Park.

CARTE 1
Localisation de l'aire d'étude



Prise d'eau

Traitement des eaux

Banc d'emprunt

Limite des municipalités

Hydrographie

Cours d'eau

1:20 000

0 500 1 000 2 000 m

Système de projection cartographique: NAD83 (CSRS) MTM 9

Source des données:
Fond de carte, ESRI
Géobase du réseau hydrographique du Québec (GRHQ) (MERN, 2019);

Salluit
Projet 21-0056-01

5 février 2021
Réalisé par: Sophie Savard
Approuvé par: Rachel Hussherr

Analyse de la vulnérabilité de la source destinée à l'alimentation en eau potable - Village Nordique de Salluit

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2 CHARACTERIZATION OF WATER WITHDRAWAL

The determination of the water source protection areas, as well as the determination of the vulnerability levels of the water quality indicators presented in sections 2.3 and 2.4 (article 69, annex IV of the WWPR), were carried out by consulting the various data transmitted by the Kativik regional administration as well as the data available for the study areas in the open databases mentioned below :

- Geobase of the hydrographic network of Québec (MERN, 2019);
- Database of hydrographic basins (MELCC, 2019);
- Topographic Data of Canada – CanVec Series (Natural Resources Canada, 2020)
- Imagery of northern villages (https://mern.gouv.qc.ca/repertoire-geographique/imagerie-villages-autroits-nord/);
- Mapping of northern villages on a scale of 1/2000 (https://www.donneesquebec.ca/recherche/dataset/cartes-topographique-des-villages-autroits-du-nord-al-echelle-de-1-2 -000);
- Historical and recent satellite images available on Google Earth Pro ©.

2.1 RAW WATER WITHDRAWAL SITE

2.1.1 Contextualisation : before 2012

Salluit is located in an area of continuous permafrost, which complicates the sustainable supply of drinking water, due to the sensitivity of surface water to freezing and potential contamination (Lemieux et al. 2016). Prior to 2012, the village was supplied with surface water through an infiltration gallery-type intake in the Kuuguluk River. The shallow depth at which the perforated pipe was placed in the river (strainer), as well as the low water level of the river outside the flood period (exact data not available), made the water intake particularly exposed to freezing during the winter period; and water shortages, which were chronic in winter. Exploratory drilling carried out by the consulting engineering firm CIMA + in 2011 and then in 2012 detected an underground water reservoir and made it the main water intake for the village. This sheet of water is located under the riverbed, in a zone of permafrost called “talik”, an area of the ground permanently thawed within the permafrost (Fortier et al, 2011 and 2012). In the case of Salluit, the sub-fluvial talik is a type III supra-permafrost aquifer, that is, it does not freeze in winter and is located above the permafrost and under the bed of a major water system such as a lake or a river (Annex 2; Lemieux et al. 2016).

2.1.2 Current water intake: since 2012

Since the exploratory drilling carried out in 2012, the main source of drinking water for the village of Salluit has come from the talik located under the bed of the Kuuguluk River. Exploratory drilling has shown that this groundwater table is in contact with the surface water of the river through a fracture in the rock located at a depth of 8.23m. The water pumped through the vertical well installed in 2013 therefore comes mainly from the surface. Indeed, the collection of water in this groundwater varies the level of the artificial basin at the edge of which the well is installed (CIMA +, 2012; see also photos 1 and 2). This artificial basin in the river had been set up for the previous surface water intake (in 1996), to meet the village's water needs. The current well is located on the edge of the artificial basin, at the GPS coordinates shown in Table 1. The water intake borders Immirtavik Street about 150m from the intersection with the road (location map 1).

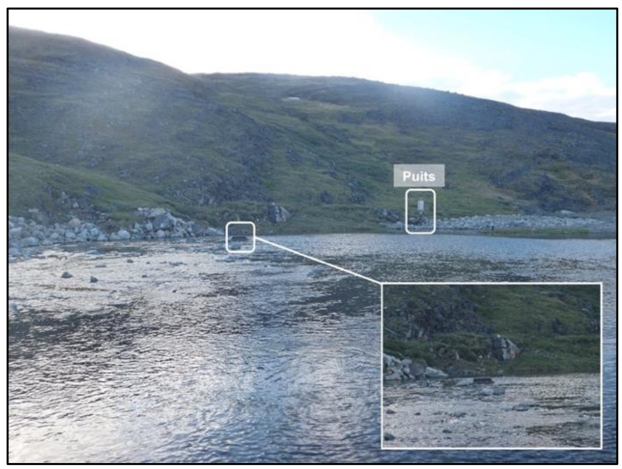

Photo 1. Dated July 26, 2013. Vertical well in the Kuuguluk river, at the level of the artificial basin (Source: KRG)
Photo 2. Dated July 26, 2013. Closed piezometer well in the water retention basin (adapted from KRG's photos)

The plans presented in Annex 3 describe in detail the installations at the water intake.

The installations at the water intake are as follows: a vertical well with a total length of 24 m and a diameter of 15 cm allows water to be taken from under the riverbed, at a depth of 6.84 m using a submersible turbine pump (Berkeley SL70G4). In the well, the pump is located just before the fracture in the rock that connects the groundwater table to the river retention basin. A second closed well is located nearby in the retention basin of the river and serves as a piezometer (photo 2) to monitor the level of drawdown of the exploited water table. The end of the well ends with a rectangular box to accommodate the electrical connections, then with a waterproof cover and a swan neck vent itself covered by an anti-vermin screen (photo 1 and annex 3).

Table 1. Summary of the characteristics of the drinking water intake in the northern village of Salluit

Sample site element	Description and details
Name of water intake	Salluit – Approvisionnement
Reference number for water intake	X2114282
Geographical coordinates	62˚ 11’18.52’’N; 75˚ 37’20.79’’W
Type of use	Permanent
Type of sampling method	In the water using a pump installed in a vertical well
Depth of sample	6.84 m
Population served	1640 habitants
Direct debit per day	Around 200 m^3
Critical water level	3 meters
Width of the stream at low water	Unknown
Number of the most recent authorization issued by the Ministère	Unknown

A 50 mm diameter pre-insulated HDPE pipe fitted with two heating cables connects the well to the pumping station, located in a shed about 235 m from the well, on the other side of Immirtavik Street (Annex 3). The pipe is buried at least 1m below the ground. The pumping station is then connected to the water treatment station by two pipes, one 150 mm in diameter, the other 75 mm in diameter (supply pipe and recirculation pipe), located about 2km more far into the village (location map 1).

2.2 DRINKING WATER TREATMENT INFRASTRUCTURES

The Salluit water pumping and treatment station is located on Aqutikutak Street (map 1 and photo 3), 2.2 km from the intake in the Kuuguluk River, at the following geographic coordinates :

62° 12' 3.08"N 75° 38' 23.42"W

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Photo 3. Dated July 26, 2013. Salluit drinking water treatment and distribution station (Source: KRG)

The frequent negative temperatures in Salluit, as well as its geographical location in an area of continuous permafrost, make it difficult or even impossible to install an aqueduct system (Vincent et al. 2012). Thus, once the water is treated, it is distributed by tanker truck to the various infrastructures and to the residents of the village, each with a specific water tank.

At the drinking water treatment and distribution plant, the raw water treatment steps are as follows :

- UV light disinfection (4 UV reactors of the Trojan brand);
- Addition of a sodium hypochlorite solution (1.2 %) using two pumps with a capacity of 1.3 L/h at 125 psi each;
- Storage of water in the tank (volume of 6000 m^3);
- New residual addition of sodium hypochlorite (12 %) when the water is transferred to the tanker for distribution.

2.3 WATER SOURCE PROTECTION AREAS

Under articles 70, 72 and 74 of the WWPR, category 1 surface water withdrawals are surrounded by 3 protection areas, nested one in the other and which may overlap: the inner protection area, the intermediate protection area and the outer protection area. In the case of a surface water intake installed in a river, the boundaries of these protection areas follow the following criteria:

Table 2. Characteristics of protection areas when the surface water source is located in a river

Type of environment	Protection areas		
	Inner	Intermediate	Outer
River	500m upstream and 50m downstream of the sampling site and riparian strips of 10m	10km upstream and 50 m downstream from the sampling site and 120m riparian strips	The watershed of the withdrawal site and the portion of the intermediate protection area located downstream of the withdrawal site

General methodology :

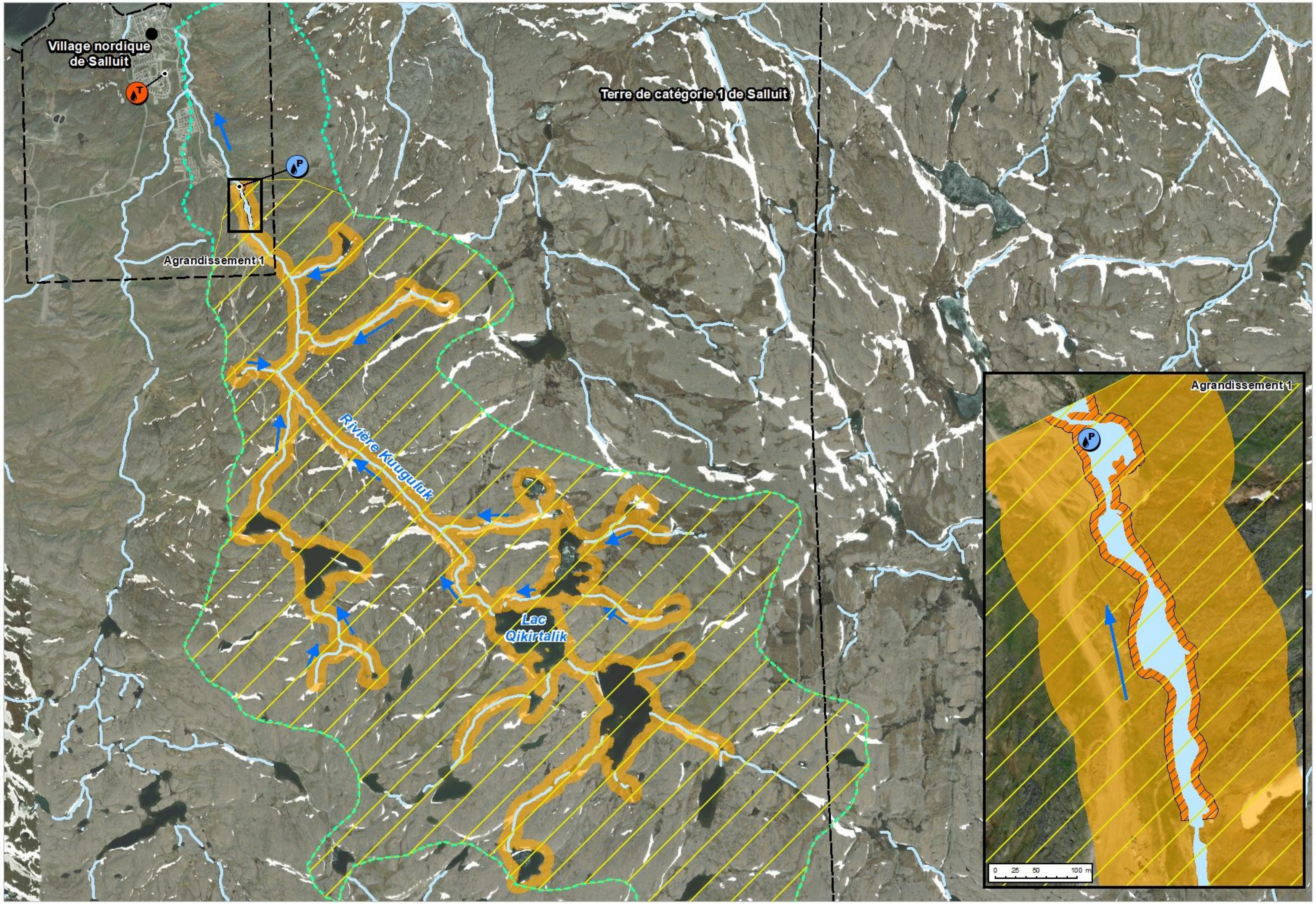
Watershed delimitations were determined using the hydrographic cutting units (HCU) as well as the linear (rivers) and polygon (lakes) geometric networks available from the Geobase of the Quebec Hydrographic System (GQHS or GRHQ in French, 2019). For reference, HCU represent a portion of a bigger watershed or a group of small watersheds delimited by the “Centre d’expertise hydrique du Québec” (CEHQ; now incorporated into the MELCC).

On the one hand, the maximum extension for the water source watershed was determined using the linear (rivers) and polygon (lakes) geometric networks, in particular by the validation of the direction of the water flow and the classification of the linear features according to the Strahler stream order. This operation allows to validate the interconnectivity of the hydrographic system at the HCU limits.

On the other hand, the watershed portion that was downstream the water withdrawal location had to be removed from the lake/ river global watershed when relevant i.e., the portion of the global watershed that has no influence on the exploited waters. The portion upstream the water withdrawal location (watershed delineation) was delimited using level curves at a 1: 50 000 scale available from the topographic data of Canada (CanVec Series, 2020) as well as the linear (rivers) and polygon (lakes) geometric networks available from GQHS. Finally, this whole operation permitted us to properly delimit the water source watershed.

Maps 2 and 3 show the protection areas for the drinking water source in the northern village of Salluit. As high-water mark data was not available, stream boundaries were determined from existing hydrographic layers for the study site.

CARTE 2
Aires de protection de la prise d'eau



Prise d'eau
Usine de traitement des eaux
Bassin versant
Limite des municipalités

Zone de protection

Zone de protection immédiate
Zone de protection intermédiaire
Zone de protection éloignée

Hydrographie

Cours d'eau
Plan d'eau
Sens d'écoulement

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1:50 000
0 500 1 000 2 000 m

Système de projection cartographique: NAD83 (CSRS) MTM 9

Source des données:
Fond de carte, ESRI
Géobase du réseau hydrographique du Québec (GRHQ) (MERN, 2019);

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Analyse de la vulnérabilité de la source destinée à l'alimentation en eau potable - Village Nordique de Salluit

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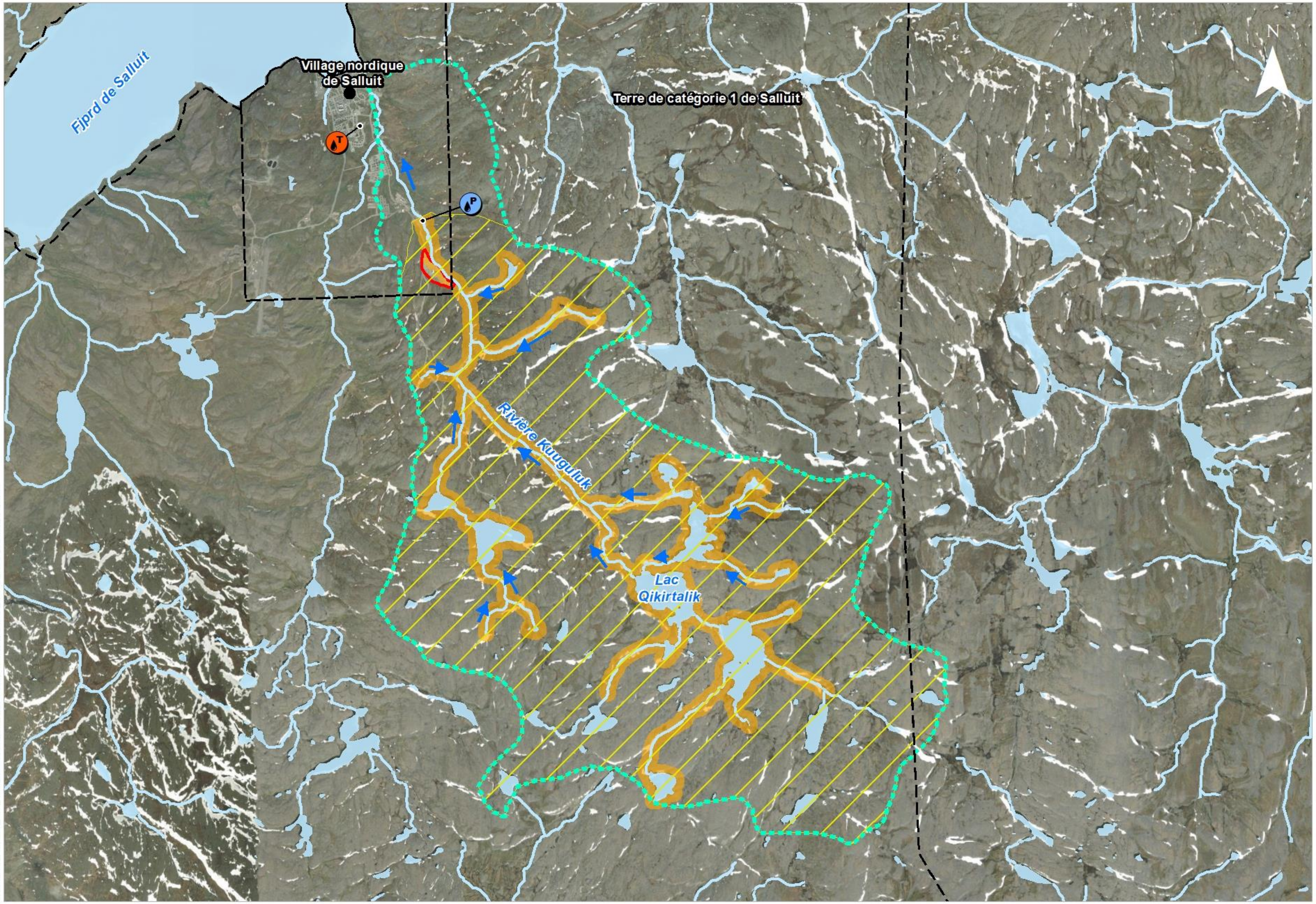
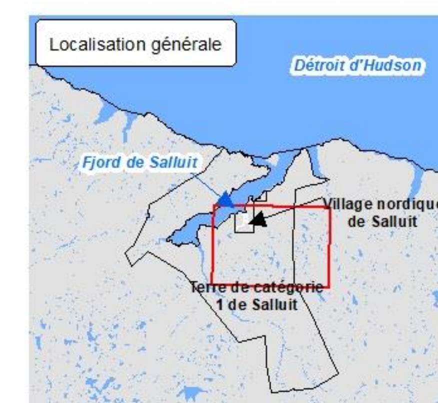
CARTE 3
Vue d'ensemble du bassin versant de la rivière Kuuguluk



- Prise d'eau
- Usine de traitement des eaux
- Banc d'emprunt
- Bassin versant
- Limite des municipalités
- Zone de protection intermédiaire
- Zone de protection éloignée

Hydrographie

- Cours d'eau
- Plan d'eau
- Sens d'écoulement



1:60 000
0 500 1 000 2 000 m

Système de projection cartographique: NAD83 (CSRS) MTM 9

Source des données:
Fond de carte, ESRI
Géobase du réseau hydrographique du Québec (GRHQ) (MERN, 2019);

Salluit
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Réalisé par: Sophie Savard
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Analyse de la vulnérabilité de la source destinée à l'alimentation en eau potable - Village Nordique de Salluit

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2.4 INDICATORS OF VULNERABILITY

As required by Article 69, Annex IV of the WWPR, the vulnerability of the surface drinking water source is assessed using six indicators which are assigned a low, medium or high level of vulnerability. These vulnerability levels are determined by following the analysis methods presented in the *guide de réalisation des analyses de vulnérabilité des sources destinées à l'alimentation en eau potable du Québec* (MELCC, 2018) and prescribed in Annex IV of the WWPR. The following sections present the results of these analyzes for each of the six indicators, as well as the methods employed based on the data available for this assessment.

2.4.1 Physical vulnerability of the site

Method 1 : Consultation of the register of events. Since August 14, 2014, all those responsible for a category 1 surface water withdrawal are required to keep an up-to-date register of events that have affected, among other things, a water shortage, an obstruction, or a breakage of the water. sampling site (article 22.0.4 of the WWPR). Such a register does not seem to be available for the drinking water system of the Northern Village of Salluit. However, it was reported by the community that a freezing event in 2019 severely damaged the water intake facilities and the drinking water treatment plant. In addition, this frost problem would unfortunately be common in winter, despite the installation of the new water intake in 2012/2013.

Method 2 : Professional opinion on the condition of the infrastructure.

Unfortunately, the context of the pandemic due to COVID-19 since the start of 2020 has not allowed our professionals to visit Salluit to meet the local stakeholders, to visit the infrastructures and to assess their condition since their upgrade in 2012/2013. Having received the mandate to assess the vulnerability of the water source in November 2020, we are therefore relying on the data made available by university research teams (Centre for northern studies, Université Laval) and exchanges of information with members of the Salluit community and the Kativik regional administration to issue an opinion on the state of infrastructure and the risk of damage caused by the hazards of the weather. We strongly recommend that this advice soon be validated by a professional visit to the site.

According to the information we were able to gather, the drinking water intake is in a section of the Kuuguluk River that is prone to flash flooding or flooding. However, a risk analysis carried out by a research team from the Centre for northern studies (CEN, Université Laval) indicates that the probability of such an event occurring is low (Allard et al. 2020).

As for the water treatment and storage facilities, these are located on a zone of thick till (= sand, gravel, and thick cover block <2 m on bedrock) classified as being subject to differential settlement during the melting of the permafrost. The active layer of permafrost reaches a thickness of between

1.5 and 2.5 m and the volume content of ice is between 15 and 70 %. However, the land on which the drinking water treatment and storage facility is built has a slope of less than 4˚. The land is therefore considered to be thaw stable (Allard et al. 2020; Annex 1). In addition, still according to the report of Allard and co-authors, the area of the village that hosts the water reservoir is not subject to natural and apprehended hazards that were listed by the team of scientists in the framework of their research (more details are available in Annex 1). However, it was reported to us by the northern village that the volume of the water tank (6000 m^3) and the drinking water treatment equipment would no longer be sufficient to meet the needs of the community and that the age and number (4) of tanker trucks available would also be worrying issues. Also, it was brought to our attention by the municipal council that only 2 persons are fully trained to operate the drinking water installations. More professionals should be trained in order to prevent personal shortage.

In addition, despite the drilling of a new well allowing the village access to a new drinking water resource, it seems that the chronic problems linked to frost have unfortunately not been resolved following the installation of the sampling well in 2012/2013. Without having obtained specific dates, it was reported to us by the community of Salluit that the northern village is still subject to frequent water shortages in winter due to frost or malfunctions at the water treatment and distribution plant. These periods of water scarcity force operators to pump water directly from the river using tankers. Furthermore, these freezing episodes damaged several components of the drinking water system, especially the pumps.

In winter, major freezing forms along the bed of the Kuuguluk River, for reasons that are still poorly understood by the scientific teams studying it (R. Fortier[1], personal communications, and scientific publication in preparation). In light of the information provided by the northern village of Salluit, it is clear that the movements of ice in the riverbed play a significant role in the water scarcity events that frequently occur during winter periods. In addition, the movement of the ice could also be likely to cause the displacement of the well casing and possibly damage the plugging of the installations in the bed of the river. It is therefore advisable to undertake a hydrodynamic study of the river at the location of the water intake and to study the movement of the particles constituting the bed of the river there. If the latter move a lot, this could indicate strong stress exerted by the ice on the installations and it would then become important to check their integrity, particularly at the level of clogging (J. Targosz[2], personal communication). The study should also help determine the exact causes of water shortages related to the water withdrawal.

Faced with this information, the physical vulnerability of the facilities at the water intake site is considered **high**.

[1] Richard Fortier, ing., Ph. D., Centre for northern studies director, Professor at département de géologie et de génie géologique, Université Laval
[2] Jérémy Targosz, Chargé de projet at LNA Hydrogéologie Environnement

A full assessment of the facilities conditions and a hydrodynamic study would be essential to determine the exact origin of the problems encountered and to propose solutions to ensure safe and permanent access to drinking water for the inhabitants of the community. An assessment of the water needs of the northern village, the flows available at the current water intake and the search for alternative water intakes should also be considered.

2.4.1 Vulnerability to microorganisms

The northern villages, because located north of the 55th parallel (article 22.0.3 of the WWPR), are not subject to the requirements of article 22.0.1 of the WWPR, i.e. the obligation to test a raw water sample per month when the distribution system serves between 1,001 and 5,000 people. This sampling aims to detect the possible presence of pathogenic microorganisms, particularly the bacteria *E. Coli*, which can cause gastroenteritis, the main symptoms of which are as follows: diarrhea, abdominal cramps, nausea, and vomiting (https://www.quebec.ca/agriculture-environnement-et-ressources-naturelles/eau-potable/contamination-de-l-eau-reseau-de-distribution/e-coli-coliformes-fecaux-ou-enterocoques/). Surface water sources, compared to groundwater sources, are particularly sensitive to the risks of contamination by coliform bacteria (total, fecal) related to the activities of the surrounding fauna and the impacts of human activities located nearby.

There is no continuous 5-year dataset for the presence of fecal coliforms in raw water for the northern village of Salluit. Remember that being north of the 55th parallel, this municipality is not obligated to monitor this parameter on a regular basis. In addition, when data relative to microorganisms are available for raw water, the analysis results only specify the “absence” or “presence” of coliforms (Colilert fluorescence test under UV light), which does not allow us to apply method 1, which requires concentrations (CFU / 100mL) to apply it.

To determine the vulnerability of the water source to microorganisms, we therefore applied **method 2**. The latter consists in determining whether, over the entire watershed of the water intake, there is no agglomeration served by a combined or pseudo-domestic sewer system or any industry or activity likely to release pathogenic microorganisms into the river.

After examining the land uses and satellite imagery (MERN, Google Earth), it appears that no element likely to reject pathogenic microorganisms is present in the watershed of the water intake (maps 2 and 3; see also in Annex 4 concerning the map of land uses).

Analyzes carried out in the summer of 2019 by a team of scientists from Université Laval (Guilherme and Rodriguez, 2020) indicate that out of a total of 6 raw water samples, two of them were contaminated with the bacterium *E. Coli* at concentrations of 1 and 4.2 CFU/100 mL. In addition, although the raw water data from the Colilert tests are disparate (they are mainly concentrated in 2017 and to a lesser extent, in 2020), these seem to indicate that the presence of fecal coliforms in the source of raw water is anecdotal. Of course, surface water sources remain particularly sensitive to contamination by surrounding fauna. For this reason, it would be prudent to institute more regular monitoring of the raw water coming from the water source.

All these elements lead us to set the level of vulnerability of the water intake to microorganisms at "**low**".

2.4.2 Vulnerability to fertilizers

Villages located north of the 55th parallel (article 22.0.3 of the WWPR) are not subject to the requirements of article 22.0.2 of the WWPR, i.e. the obligation, for a municipal distribution system serving more than 500 people and at least one residence, to sample and quantify the total phosphorus in raw surface water once a month between May and October.

Methods 2 and 3 will therefore be used for this indicator and the highest level of vulnerability will be kept as the final rating.

Method 2 : it consists of listing all the events associated with blooms of algae or cyanobacteria in the water as well as a suspected increase in ammoniacal nitrogen. No event of this nature has been reported by the Northern Village of Salluit. The application of this method therefore makes it possible to attribute a **low level** of vulnerability to fertilizers.

Method 3 : a professional assesses all the activities that represent a potential source of phosphorus or ammoniacal nitrogen in all the protection areas and judges whether they represent a risk.

No risky activity has been identified in the entire protection zones away from the water source. In addition, a measurement of total phosphorus taken in the waters of the river in August 2019 by a team of scientists from Laval University indicates that its concentration measured in the water is low (1.5 µg / L) (Guilherme and Rodriguez, 2020). The criterion for the quality of aquatic life is set at 30µg / L of total phosphorus in surface water bodies. It aims to limit the excessive and harmful proliferation of aquatic algae (MELCC, surface water quality criteria).

The level of vulnerability of the water source to fertilizers is therefore set at **low**.

2.4.3 Vulnerability to turbidity

Villages located north of the 55th parallel (article 22.0.3 of the WWPR) are not subject to the requirements of article 22.0.2 of the WWPR, i.e. the obligation to continuously monitor variations in the turbidity of the raw water sampled at the surface once every 4 hours at least and record the values in a register.

As there is no recorded dataset concerning the turbidity of the water exploited for the northern village of Salluit, **method 2** is applied to determine the vulnerability index of the water source. This method consists of issuing a professional opinion following the assessment of the potential impacts of the characteristics of the watershed and the anthropogenic activities taking place there. Questions were also sent to the municipality regarding the turbidity of the exploited water, and it appears that the drinking water has a darker appearance and an earthy taste at certain times of the year. Moreover, the measured turbidity in the raw water well often reaches a value of 1.5 NTU.

Eight turbidity measurements analyzed by a team from Laval University (Guilherme and Rodriguez, 2020) between August 19 and 27, 2019 indicate that this parameter was between 0.13 and 0.25 NTU for the period concerned. However, these data points represent only a frozen moment in time, and it is difficult to extrapolate a conclusion about changes in turbidity over a long period of time.

In addition, an in-depth analysis of the characteristics of the watershed carried out by the hydrogeology firm LNA[3] highlights the steep slopes bordering the river (excessive slopes greater than 40 %), which promote runoff and the setting in motion of particles, especially during spring melt and after episodes of heavy rains. The analysis also made it possible to establish that only 8% of the outer protection area is occupied by vegetation which contributes to the protection of the water exploited in relation to turbidity and a high proportion of this surface (91 %) is occupied by rocky outcrops which also increase the vulnerability of the water exploited. Full details of the analysis produced by LNA are presented in Annex 5.

According to the land use map of the northern village of Salluit, the edges of the river upstream of the water intake belong to the “Nuna” zone, which is mainly dedicated to traditional and recreational activities (see also section 3 for more details on land use assignments). Given these elements, anthropogenic activities in the watershed of the water intake are not likely to influence the turbidity of the water exploited.

Based on the information gathered in this section and as a precautionary measure, the level of vulnerability of the water source to turbidity is therefore considered to be **high**. For the future, the best way to validate this level of vulnerability would be to record the values of the turbidimeter installed at the drinking water treatment plant, in order to be able to examine a complete dataset when producing the update of this report, in 5 years.

Consistently high turbidity readings can lead to technical failures in water treatment facilities.

[3] Considering the lack of available data and in order to valdidate the water intake’s vulnerability rating to turbidity, an external advice was requested to LNA

2.4.4 Vulnerability to inorganic substances

The 11 inorganic substances whose concentrations are to be monitored on an annual basis in drinking water under article 14 of the RRQDW are as follows: antimony, arsenic, barium, boron, cadmium, chromium, cyanides, fluorides, mercury, selenium, uranium. Nitrates and nitrites should be monitored on a quarterly basis.

As the data set available does not include 5 consecutive years and in accordance with the recommendations of the guide, we favored **method 2**. The available analysis data were used as a complement to the main method.

Method 2 aims to determine whether sectors of industrial, commercial, or agricultural activity are located within the 120 m strip of land of the intermediate protection zone and what percentage of this land area they occupy. The level of vulnerability is low if the percentage is less than or equal to 20 %.

In the case of Salluit, only the borrow pit is located on a portion of the 120m riparian strips of the intermediate protection area. It covers an area of 66,216 m^2, which represents 1.071% of the 120m strips of land in the intermediate area (with a total area of 6,181,320 m^2). In addition, the concentrations of the 11 inorganic substances, available for the years 2015, 2016 and 2020; as well as the nitrate-nitrite concentrations, available in part for 2015, 2016, 2017, 2018 and 2020, are all well below the applicable standards.

In light of this information, the vulnerability level of the drinking water source to inorganic materials is set at **low**.

2.4.5 Vulnerability to organic substances

As the Salluit drinking water system does not serve more than 5,000 people, it is not mandatory for this municipality to monitor the 16 pesticides and 16 other organic substances under section 19 of the RRQDW. Method 2 was therefore applied to determine the level of vulnerability of this indicator. It is identical to method 2 used in section 2.4.5 for inorganic substances.

The level of vulnerability of the drinking water source to organic substances is therefore set at **low**.

2.4.6 Summary of vulnerabilities

Table 3. Summary of the methods used to determine the vulnerability index of each of the six indicators and the results obtained

Indicator	Principal methodology	Vulnerability level
A (physical integrity)	Method 1 and 2	**High**
B (microorganisms)	Method 2	**Low**
C (fertilizers)	Method 2 et 3	**Low**
D (turbidity)	Method 2	**High**
E (inorganic substances)	Method 2	**Low**
F (organic substances)	Method 2	**Low**

3 INVENTORY OF ELEMENTS LIKELY TO AFFECT THE EXPLOITED WATER

3.1 ANTHROPIC ACTIVITIES

Given the context linked to the Covid-19 pandemic, our professionals were unable to go to the northern village of Salluit to take an inventory of human activities in the field. The following sections were therefore carried out thanks to the consultation of the land use map, the Salluit development plan and the consultation of the members of the municipal council and of the Kativik regional government when clarifications were necessary. Google Earth satellite images and imagery from northern indigenous villages (MERN) were also consulted.

Since the village of Salluit is located downstream from the drinking water intake, very few activities are located in its watershed.

3.1.1 Inventory of human activities

The anthropogenic activities to be listed are those which, in their usual functioning, are likely to release contaminants that may affect the quantity or quality of surface water exploited.

Table 4. Usual activities likely to have an impact on the quality of the water in the water source watershed

Activity Type	Protection area	CUBF Name and Code	Potential contaminants
Operation of the borrow pit	Intermediate	89 – exploitation and extraction of other natural resources	Turbidity, inorganic substances
Road network	Intermediate	42 – motor vehicle transportation	Turbidity, inorganic substances

3.1.2 Threats linked to human activities

The assessment of threats from anthropogenic activities involves first determining the frequency with which the activity is likely to release contaminants and then the severity associated with this activity and the contaminants released. The combination of the frequency level with the severity level makes it possible to determine the final risk potential, in accordance with the method presented in the drafting guide and under Article 75 of the WWPR.

Table 5. Risk potential of the listed usual activities

Activity type	Protection area	Considered contaminants	Risk potential
Operation of the borrow pit	Intermediate	Particles suspended in water that can affect taste or smell	Low
Operation of the borrow pit	Intermediate	Inorganic materials such as trace metals	Low
Road network	Intermediate	Particles suspended in water that can affect taste or smell	Low
Road network	Intermediate	Inorganic materials such as trace metals	Low

The usual activities of the exploitation of the borrow pit could produce dust, hence influencing the turbidity and inorganic substances in the drinking water drawn from the neighboring river (such as trace metals, for example). The vibrations of the machinery could cause the sediment to resuspend in the water and therefore also influence the turbidity and inorganic content. However, none of the water tests reviewed in this study suggest a detectable impact on regulated inorganic materials. The seriousness of the consequences of the activities of the borrow pit on the concentrations of inorganic substances is **minor**. Turbidity data is not available. The severity of the consequences of these activities on turbidity remains unknown but is considered minor since no activity in the borrow pit is allowed near the banks of the river and berms have been erected between the borrow pits and the river.

In addition, it should be noted that these activities only represent a risk during the summer (June to October) since the borrow pit is not exploited during the winter season or during the melting period. The risk potential is then set to **low** (consequence to minor severity, occurring frequently).

The portion of the Immiqtavik road that crosses the intermediate water intake protection area (Map 2) leads, among other things, to the borrow pit, located downstream of the intake. The road then becomes a track that continues for about 5 km before ending up in a dead end at the edge of a lake. This road is used by off-road vehicles, snowmobiles, cars and trucks for traditional activities such as hunting and fishing, and as an access to the borrow pit' site. As this road does not connect essential village infrastructures with each other, it is assumed that it is less traveled than the rest of the road network, especially in winter when borrow pit operations are on hold. Dust generated by traffic, which can fall back into the river near the water intake and change the inorganic content and turbidity of surface water, is only a problem during the summer season. By following the guide's criteria, we estimate that the consequences of this activity are **minor** and that it occurs at a **frequent** rate (more than once a year but less than once a week when reduced to the year). Road traffic therefore has a **medium** risk potential for the quality of the water used.

It would therefore be relevant to monitor the turbidity of the water exploited, particularly during the thaw season, to validate that neither road traffic, nor the operation of the borrow pit, significantly influence this parameter in the water exploited.

3.2 POTENTIAL EVENTS

Potential events linked to human activities correspond to exceptional events caused by accidents or extreme climatic events and which are likely to release contaminants into the surface water exploited or affect the quantity of drinking water available.

3.2.1 Potential events inventory

Table 6. Potential events related to the anthropogenic activities inventoried in the watershed of the water intake

Potential event	Associated activity	Code and name CUBF	Concerned protection area	Potential contaminants
Machinery spill	Operation of the borrow pit	89 – exploitation and extraction of natural resources	Intermediate	Organic and inorganic substances (oil products)
Spill at the pumping station	Heating system at the raw water pumping station	483 – Aqueduct and irrigation	Intermediate	Organic and inorganic substances (oil products)
Machinery / vehicle spill	Road traffic	42 – motor vehicle transportation	Intermediate	Organic and inorganic substances (oil products)
River freezing over	Water intake in the river	483 – Aqueduct and irrigation	Inner	Water shortage

3.2.2 Threats related to potential events

The threat assessment of potential events involves first determining the level of likelihood of the event occurring and then the severity of this event. The combination of the level of probability with the level of severity makes it possible to determine the final risk potential, in accordance with the method presented in the reaction guide and under Article 75 of the WWPR.

Table 7. Risk potential of the listed events

Potential event	Protection area	Considered contaminants	Risk potential
Spill / accident of machinery at the borrow pit	Intermediate	Oil products	**Very low**
Spill at the pumping station	Intermediate	Oil products	**Low**
Machinery / vehicle accident on the road network	Intermediate	Oil products	**Very low**
River freezing	Inner	Water shortage	**Very high**

A machinery failure or an accident at the borrow pit operation site represents a potential event during which petroleum-derived substances could be spilled and possibly drained into the river. However, in view of the protocols to be applied during such spills, the presence of berms between the borrow pit and the river and the regulations governing the operation of such sites (Regulation respecting quarries and sand pits Q-2, r. 7), the seriousness of the consequences of such a discharge on the exploited waters is considered **minor**. Moreover, it is possible that such an event will occur in the next 5 years. The risk potential associated with such an event is therefore **very low**.

Likewise, an accident or a breakdown of a transport vehicle on the portion of the road that crosses the intermediate protection area represents a potential event during which substances derived from petroleum would be liable to be spilled and possibly drained towards the stream. Once again, the small amount of potentially released contaminants, the dilution effect and the supposed decontamination of the soiled surface make the consequences of such an event **minor**. Moreover, it is possible that such an event will occur in the next 5 years. The risk potential associated with such an event is therefore **very low**.

An oil spill related to the heating system at the raw water pumping station located across from the water withdrawal site on the other side of the Immiqtavik road is a potential event that could contaminate the exploited waters. A potential spill following either the maintenance of the oil tank coupled with the heating system or some instruments malfunctions (due to a freezing event, defective/ old parts, ...) could have **serious** consequences on water quality (aesthetic or organoleptic water quality problem that is not acceptable for the consumer; MELCC 2018). Moreover, it is possible that such an event will occur in the next 5 years. Following the guide's criteria, the associated risk potential is therefore **low**.

Frequent freezing of the river in winter has the potential to put great pressure on the intake facilities in the river. A water shortage associated with this event would have serious consequences for the population. Since a water shortage would affect the inner protection area and following the criteria of the guide, the severity of the consequences must be readjusted upwards from "serious" to "catastrophic". As such events have occurred several times in the past, it seems almost certain that a similar event will occur again in the next 5 years if nothing is done with the infrastructures of the drinking water system. The risk potential associated with such an event is therefore **very high**.

Although permafrost melting is a pervasive challenge in all intake protection areas, it is difficult, with current data, to assess the extent to which this threat represents a potential risk, since it is difficult to predict where and when a subsidence or a melt pool will appear and what consequence (s) these will have on the quality of the water exploited. For this reason, potential events related to permafrost melting have not been identified and assessed using the methods applied to the other events above. However, we still consider it essential to mention it here since this type of event could gain in frequency and amplitude with the ongoing global warming in this region and would benefit from being better characterized.

3.3 LAND USES

3.3.1 Land use inventory in the protection zones

As can be seen in Annex 4, the “Nuna” land use designation is the only allocation that entirely overlaps the protection areas of the Salluit drinking water source, up to the municipal limits. The development plan for the Northern village of Salluit specifies that the designation "Nuna" applies to lands that have not received other land affections within the village limits. These lands are mainly used for traditional and recreational purposes and <u>no development or activity likely to pollute the municipal water source is permitted.</u> The development plan was adopted by the municipal council in 2016 until 2035 (BY-LAW No. 2016-06, Village Nordique de Salluit).

The portion of the outer protection area that extends beyond the municipal boundaries represents Category I lands (Map 3), i.e. owned by the Qaqqalik landholding company in Salluit, which manages them in benefit of its members.

3.3.2 Risks related to land use assignments for the drinking water sources

The "Nuna" lands include, among other things, the borrow pit exploited downstream from the water source, in the intermediate protection area. However, the development plan of the northern village stipulates that the borrow pit must comply with the regulations governing the operation of such natural resource exploitation sites (Regulation respecting quarries and sand pits Q-2, r. 7) and must hold a certificate of authorization from the Ministry to which it reports (currently the MELCC). Its use should therefore not represent a risk for the water source.

Some of the activities permitted on "Nuna" lands would likely affect the water source such as mineral exploration, solid waste landfills and sewage ponds. However, it should be noted that the waste treatment infrastructure is currently located opposite the water source and its watershed, on the other side of the village. They therefore pose no risk to the drinking water source in the present. If new waste treatment infrastructures were to emerge by 2035, the regulations incorporated into the development plan concerning the "Nuna" allocation prohibit the establishment of such activities in places where they are likely to affect the source. of water. The same goes for exploratory mining activities.

Although minimal, Table 9 in Annex 4 summarizes the risks associated with permitted activities in "Nuna" territories. It should be noted that the use of these territories by the local population for their traditional and recreational activities (hunting and fishing, berries picking, camping, etc.) contributes to the protection of the water source.

4 IDENTIFICATION OF PROBLEMS AND PROBABLE CAUSES

Under section 75 of the WWPR, this stage of the analysis seeks to identify the natural or anthropogenic causes behind the medium or high level of vulnerability identified in section 2.4 of this report.

Due to the isolated nature of the northern villages, and the pristine nature of the surrounding areas, drinking water sources are not exposed to the risks of chemical / biological contamination from human activities (Vincent et al. 2012).

Table 8. Identification of the problems related to the vulnerability indicators of the drinking water sampling site, the level of which is medium or high

Identification of problem	Associated vulnerability indicator	Identification of causes	Type of cause	Description of cause	Protection area concerned
Water shortage	Physical vulnerability indicator	Freezing of the water, faulty installations	Natural	The stresses exerted by the ice in the riverbed could damage the facilities and cause some of the water shortages observed.	Inner
Risk of occasional increases in turbidity	Turbidity vulnerability indicator	Watershed characteristics	Natural	The slopes bordering the river, the dominance of rock outcrops and the type of vegetation make the water source vulnerable to turbidity	All protection areas

Freezing-related water shortages

As presented in section 2.4.1, the level of physical vulnerability of the water withdrawal site was considered **high**.

The major freeze-up of the river in winter is most likely linked to at least part of the winter episodes of water scarcity and could lead / have led to damage to the water intake facilities, in the riverbed. In fact, the ice that gradually forms there in successive layers throughout the winter is likely to exert strong stresses on the well casing and its clogging.

We therefore recommend to conduct a complete assessment of the installations at the water intake, as well as a hydrodynamic study at the location of the water intake in the riverbed to determine the exact origin of the encountered problems and to find solutions in order to guarantee safe and permanent access to drinking water for the inhabitants of the community. The study should make it possible to determine the exact causes of water shortages related to the water intake (for example: blockage of installations due to freezing as such, or lack of water at the location of the water intake due to excessive pressure from the ice cover in the riverbed which makes water unavailable for the withdrawal well, or lack of water due to excessively low winter low flows, etc).

An assessment of the northern village's water needs, the flow rates available at the current intake and the search for alternative intakes should also be considered.

It should be noted that some of the water shortages reported by village officials appear to be linked to malfunctioning installations at the drinking water treatment and distribution plant. A number of these malfunctions could be related to freezing damages. Professional assessment of facilities should address these issues as well and offer solutions to the problems identified.

Risks of occasional increases in turbidity

Due to the lack of available data concerning the turbidity values of raw water and considering the natural characteristics of the watershed, the level of vulnerability of the water intake to turbidity was set at **high**, and this by precaution. No anthropogenic activity in the source water protection areas is likely to significantly affect this parameter in the present (see also sections 3.2.1 and 3.2.2. for details on the pit activities and road traffic lane in the intermediate protection zone).

Thus, it is above all the natural characteristics of the watershed that are likely to influence the turbidity of the water exploited. Indeed, a detailed analysis of the available data carried out by the hydrogeology firm LNA (Annex 5) made it possible to determine that steep slopes border the river (excessive slopes greater than 40 %), which favor runoff and the setting in motion of the particulate matter, especially during spring melt and after heavy rains. The analysis also made it possible to establish that only 8 % of the water intake watershed is occupied by vegetation which contributes to the protection of the water exploited in relation to turbidity and the high proportion of this surface (91 %) is occupied by rocky outcrops which also increase the vulnerability of the water exploited.

It is strongly recommended that the turbidity values be recorded in a register on a regular basis, to validate whether the characteristics of the watershed have a significant impact on the turbidity values of the raw water, and this on the update of this vulnerability study in 2026. If this is the case, it will be essential to take measures to remedy this possible problem.

If it is determined that the abnormal taste and color of the water (opaque and earthy) at certain times of the year is indeed related to a problem of increased turbidity, a filtration system to neutralize the particulate matter and thus controlling the turbidity level of the raw water should also be installed in the treatment plant. This issue should be discussed with the professional who will oversee assessing the drinking water infrastructures.

5 CONCLUSION

5.1 GENERAL CONCLUSIONS

The village of Salluit, like the other northern villages in Nunavik, is located in an isolated environment and very little exploited by commercial or industrial activities. For this reason, the drinking water source provides particularly good quality water. The main threat to water installations is of natural origin, namely the characteristics of the watershed of the water intake and the vagaries of the arctic climate, linked to the risk of freezing during the winter period (more particularly, the significant freezing of the riverbed) and movements of permafrost, which is undergoing profound changes with global warming.

Following the vulnerability assessment of the water source, two of the six indicators (physical integrity of the sampling site and vulnerability to turbidity) were set as "**high**". The level of physical vulnerability was considered high following repeated episodes of water scarcity during the winter, a probable cause of which would be the exceptional freezing of the bed of the Kuuguluk River. This phenomenon occurs chronically in winter and is likely to place severe strain on drinking water intake installations. The level of vulnerability to turbidity was classified as "**high**" following an assessment of the natural characteristics of the watershed.

The anthropogenic activities that have been identified in the inner and intermediate protection areas are the operation of the borrow pit and the passage of a portion of the Immiqtavik road. However, after evaluating the contaminants and potential events associated with these activities, it was determined that these activities do not significantly threaten the quality, or the quantity of water exploited.

Finally, within the limits of the northern village of Salluit, the water source protection areas are all included in the “Nuna” land use, which is mainly dedicated to traditional and recreational activities and where no development or activity. likely to pollute the municipal water source is not allowed; this contributes to the protection of the water source.

It emerges from this study that the source of drinking water in Salluit therefore provides the northern village with quality water, so far very little influenced by human activities. However, it also emerges from this assessment that the drinking water intake does not seem to provide a sufficient volume of water for the needs of the community. It is therefore urgent to carry out a complete evaluation of the installations at the water intake, as well as a hydrodynamic study at the location of the water intake in the riverbed, to determine the exact origin of the encountered problems and to propose solutions to guarantee safe and permanent access to drinking water for the inhabitants of the community.

Recommendations are made in section 5.3 to compensate for the lack of certain data and to strengthen the monitoring and protection of the drinking water source.

5.2 MISSING DATA

There are no data on low water levels and high-water mark. Riparian strips were determined from the cartographic boundaries of the studied watercourses, available on the databases used for mapping. The best available resolution was used.

There is no event log.

The number of the most recent authorization granted by the Ministry is also missing information.

A request for access to water quality data had been made to the regional office of the MELCC for Nord-du-Québec on January 6, 2021 concerning drinking water quality for the northern village of Salluit. However, no data had been provided to us at the time of writing this report.

Some data on analyzes of inorganic substances are missing.

5.3 RECOMMENDATIONS

Following the analysis of the vulnerability of the drinking water source in the northern village of Salluit, here is a list of recommendations, ranked in order of priority to validate certain data discussed in the report and to guarantee the best possible protection of the water. source of drinking water.

- A complete assessment of the drinking water intake and treatment infrastructures should be done by a professional, as well as a hydrodynamic study at the water intake;
- Following the results of this evaluation: upgrade the drinking water withdrawal and treatment facilities where necessary;
- Train more personal capable of operating the drinking water installations;
- Create a register in which to record the values of the turbidity of the raw water, particularly during periods of flood (spring melt, heavy rains) when the turbidity is likely to increase sharply;
- Keep a written record of events, even minor ones, which have affected the drinking water production chain and keep this information for inter-annual monitoring. An example of such a register is provided in Annex 6;

During Colilert tests performed every week, test raw water samples at least once a month in winter, and weekly in summer.

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Vincent, W.F., Martin, D., Pienitz, R., Laurion, I.,Muir, D. Young, K., and Bégin, Y. 2012. Freshwater resources in a changing environment. Dans: Allard, M. and Lemay, M. (eds) Integrated Regional Impact Studies. p. 137-155.

ANNEX 1. GEOLOGY AND PERMAFROST

- A1.1 Geological map of Québec
- A1.2 Permafrost conditions map (Source : Allard et al. 2020)
- A1.3 Natural hazard map (Source: Allard et al. 2020)

Géologie du Québec

DV 2012-06

Métadonnées

Surface de référence géodésique :	Ellipsoïde GRS 80
Système de référence géodésique :	NAD 83 compatible avec le système mondial WGS 84
Projection cartographique :	Conique de Lambert
Méridien central :	68° 30' ouest

0 50 100 150 km

1/2 000 000

Sources

Données	Organisme	Année
Géologie :	Ministère des Ressources naturelles Direction de l'information géologique du Québec	2012
Topographie :	Ministère des Ressources naturelles Direction générale de l'information géographique	2010

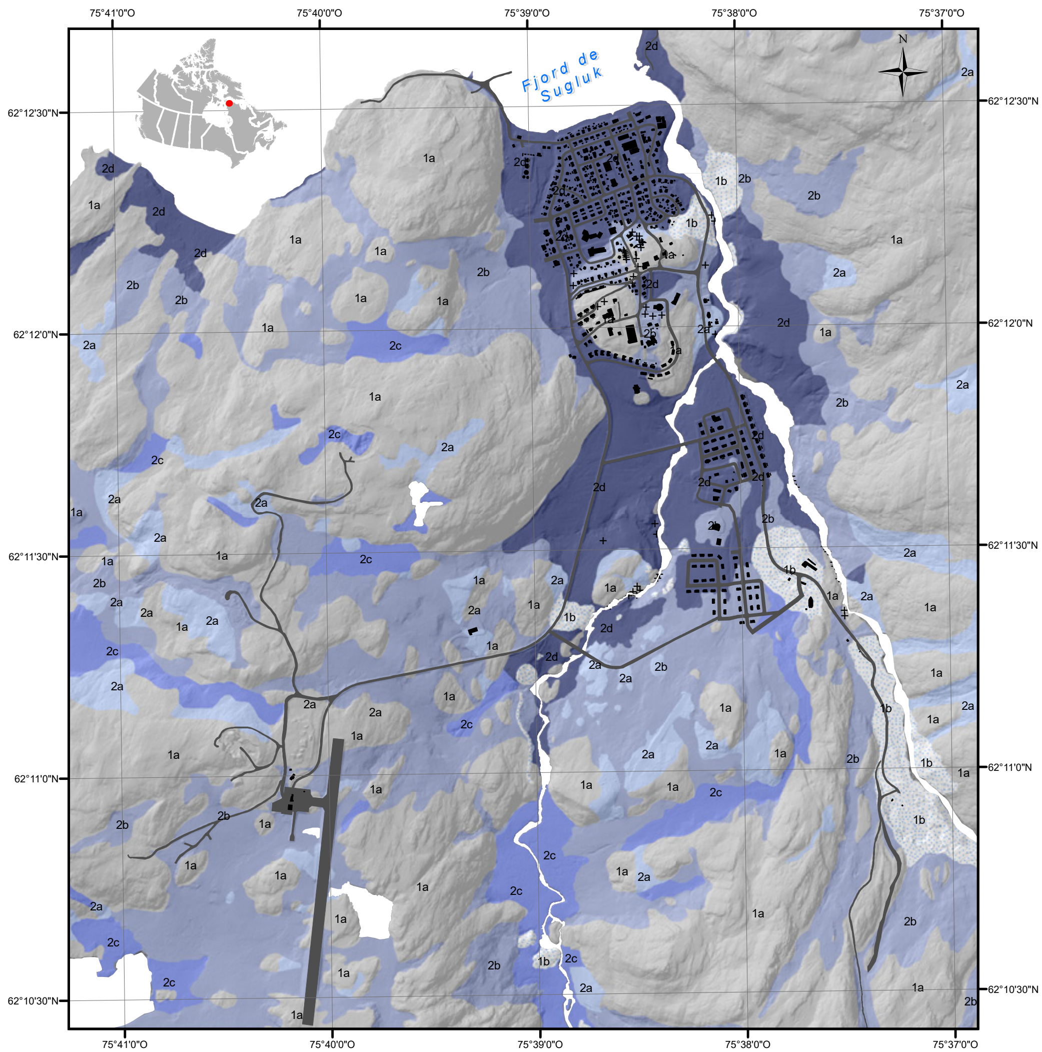
Réalisation

Compilation géologique :	Robert Thériault
Assistance technique :	Stéphane Beauséjour, André Tremblay
Production :	Ministère des Ressources naturelles Direction générale de Géologie Québec
Diffusion :	Ministère des Ressources naturelles Direction de l'information géologique du Québec

Localisation

Canada
États-Unis

Ressources naturelles Québec



Conditions de pergélisol

Roc et dépôts contenant très peu ou pas de glace

\+ Affleurements rocheux ponctuels

1a Socle rocheux massif d'âge précambrien. Surface parsemée de blocs et parfois recouverte d'une mince couche de sable et gravier avec cailloux (till). L'épaisseur de la couche active varie sur le terrain entre 2,5 et 3,5 m.

1b Dépôts de sable et gravier stratifiés. Contient de la glace interstitielle et possiblement de la glace sous forme de lentilles dans les couches de matériau à granulométrie fine.

Dépôts contenant beaucoup de glace

2a Sable, gravier et blocs en couverture mince sur socle rocheux. L'épaisseur du dépôt est généralement inférieure à 2 m et sa topographie est contrôlée par le roc. Présence d'affleurements rocheux dispersés. La couche active atteint une épaisseur comprise entre 1,5 et 2,5 m. Tassement différentiel lors de la fonte du pergélisol limité à la couche de couverture. Le contenu volumique en glace varie entre 15 et 70 %.

2b Sable, gravier et blocs (till) en couverture épaisse sur socle rocheux. L'épaisseur du dépôt est généralement supérieure à 2 m avec possibilités d'affleurements rocheux ponctuels. La profondeur maximale au roc est estimée à environ 8 m. Présence d'ostioles et de coulées de gélifluxion sur les versants. Sujet au tassement différentiel lors de la fonte du pergélisol. La couche active atteint une épaisseur comprise entre 1,5 et 2,5 m. Le contenu volumique en glace varie entre 15 et 70 %.

2c Dépôts quaternaires épais mal drainés à couverture tourbeuse. Épaisseur supérieure à 2 m et pouvant atteindre plus de 6 m. Dépôts riches en glace avec réseaux de polygones à coins de glace bien développés. L'épaisseur de la couche active varie de 0,5 m à 2,5 m.

2d Dépôts à granulométrie fine d'origine marine (silt et argile) très riches en glace. Parfois recouverts d'une couche mince de sable ou gravier. Sujet aux tassements différentiels et aux ruptures de mollisol sur les pentes. Surface fréquemment recouverte d'ostioles. La couche active atteint une épaisseur comprise entre 0,5 m et 1,2 m. La teneur volumétrique en glace du pergélisol dépasse régulièrement 30 % et peut attendre près de 100 %.

Routes Bâtiments Aéroport Plans d'eau

0 0,25 0,5 1 Km

Projection : MTM NAD 1983 zone 9 1: 20 000

Mise à jour : Gauthier, S., Allard M. et L'Hérault E. (2019)

Résumé

Cette carte présente les risques naturels actuels et appréhendés de la région de Salluit. Ce village se situe au Nunavik, sur la la rive sud du détroit d'Hudson, à 600 km au nord-ouest de Kuujjuaq (62°12' N ; 75°39' O).

Abstract

This map shows the actual and potential natural hazards of the Salluit region. This Nunavik village is located on south shore of the Hudson Strait, at 600 km to the North-West of Kuujjuaq (62°12' N ; 75°39' W).

Note

Cette carte a été compilée principalement par photo-interprétation et validée avec un nombre limité d'observations de terrain, de sondages et de forages dans le pergélisol. Toute information pouvant en améliorer la précision et éventuellement conduire à la production d'une mise à jour sera appréciée.

Les risques naturels sont représentés par un symbole ponctuel, linéaire ou zonale, en fonction de leur échelle et de leur géométrie.

Note

This map was compiled mainly by air photo interpretation and validated by a limited number of terrain observations, probing and drill holes in the permafrost. Any information leading to an improvement of precision and, eventually, an update of the map will be received with thanks.

Natural hazards are presented according to their scale and geometry: polygons, lines or points.

Système national de référence cartographique
The National Topographic System of Canada

RNCan, gouvernement du Canada, centre d'information topographique (2008). Index vectoriels du système national de référence cartographique du Canada.

Vector Indexes of the National Topographic System of Canada. Government of Canada, Natural Resources Canada, Earth Sciences Sector, Mapping Information Branch, Centre for Topographic Information (2008).

Illustration de couverture / Cover illustration:
Salluit, Nunavik, Québec.
Photographie par Antoine Boisson / Photocredits: Antoine Boisson

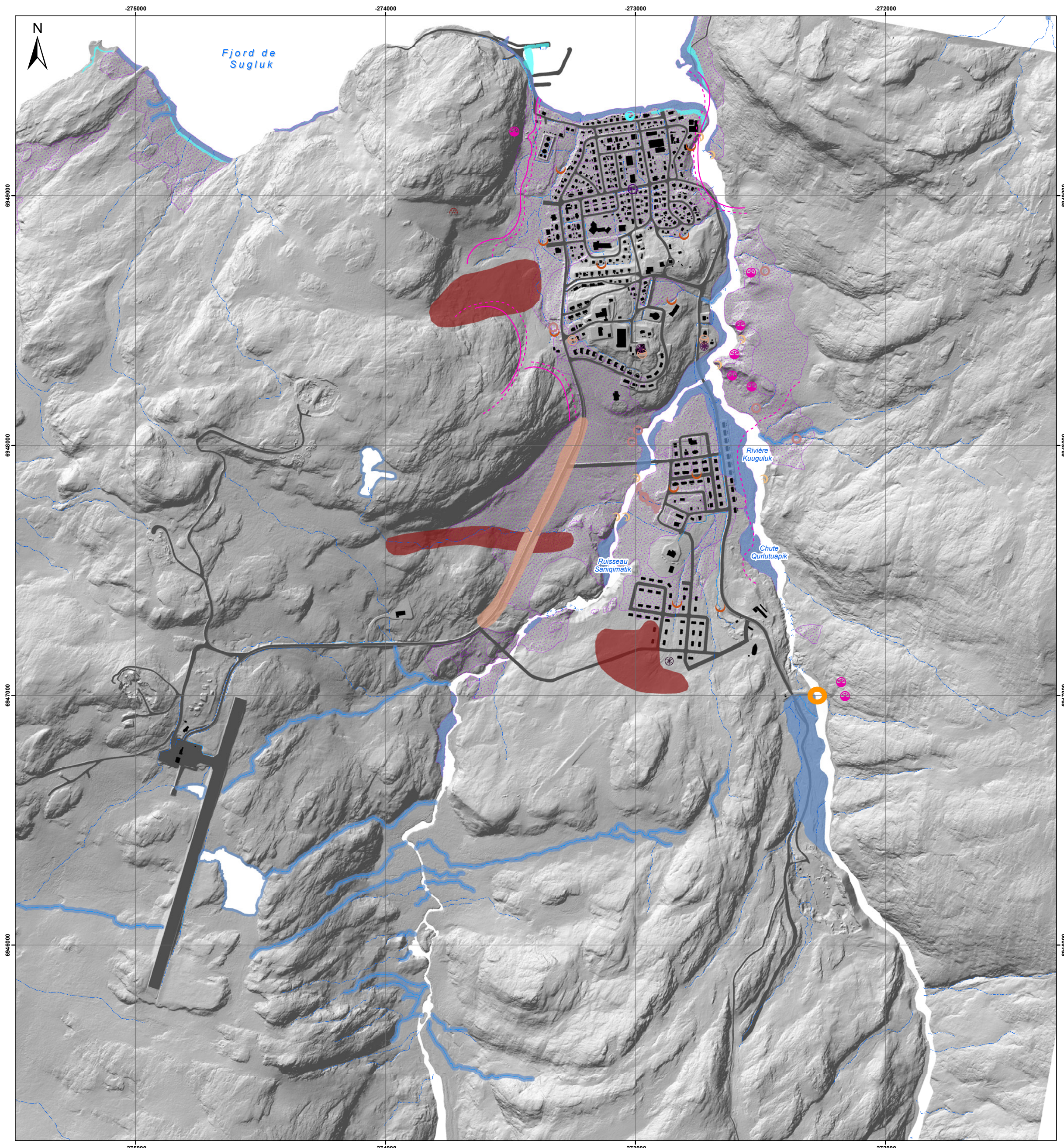
Centre d'études nordiques, Québec, 2017

ALÉAS NATURELS ACTUELS ET APPRÉHENDÉS
ACTUAL AND POTENTIAL NATURAL HAZARDS

SALLUIT

Québec, Nunavik

1 : 8 000



MOUVEMENT DE MASSE / MASS WASTING

AVALANCHE DE NEIGE / SNOW AVALANCHE — 1/100 — 1/1000
GLISSEMENT DE TERRAIN / LANDSLIDE
GÉLIFLUXION / GELIFLUCTION
COULÉE / FLOW
ÉBOULIS / FALLS

ÉROSION / EROSION

ÉROSION CÔTIÈRE ET FLUVIALE / COASTAL AND FLUVIAL EROSION
ÉROSION PAR LE VENT / WIND EROSION

CLIMATIQUE / CLIMATIC

FEU / WILDFIRE
TEMPÊTE DE VENT / WIND STORM
BLIZZARD / BLIZZARD
VERGLAS / ICE STORM

PROCESSUS PÉRIGLACIAIRES / PERIGLACIAL PROCESSES

PERGÉLISOL RICHE EN GLACE / ICE-RICH PERMAFROST
GLAÇAGE / ICING
BUTTE SAISONNIÈRE À NOYAU DE GLACE / FROST BLISTER

PROCESSUS LIÉS AU DÉGEL / THAW-RELATED PROCESS

AFFAISSEMENT THERMOKARSTIQUE / THERMOKARST SUBSIDENCE
ÉROSION THERMIQUE / THERMAL EROSION

PROCESSUS HYDROLOGIQUES / HYDROLOGICAL PROCESSES

DRAINAGE D'UN LAC / LAKE DRAINAGE
SURCOTE / STORM SURGE
CRUE SOUDAINE ET INONDATION / FLASH FLOOD AND FLOOD
EMBÂCLE ET DÉBÂCLE GLACIELS / ICE-JAM AND BREAK-UP
POUSSÉE GLACIELLE / ICE-PUSH

TREMBLEMENT DE TERRE / EARTHQUAKE

TREMBLEMENT DE TERRE / EARTHQUAKE

HYDROLOGIE / HYDROLOGY

RÉSEAU DE DRAINAGE - ruisseaux permanents
RILLS AND WATERTRACKS - running throughout all arctic summer

RÉSEAU DE DRAINAGE - ruisseaux intermittents
RILLS AND WATERTRACKS - running occasionally during spring melt

INFRASTRUCTURES / INFRASTRUCTURE

BÂTIMENTS / BUILDING
INFRASTRUCTURES DE TRANSPORT / TRANSPORT INFRASTRUCTURE

Centre d'études nordiques
UNIVERSITÉ LAVAL

Image en relief ombragé dérivée des données LIDAR 2010 (MRNF 2010, gouvernement du Québec) préparée par L'Hérault,E.
Illumination : azimuth 315°, altitude 45°, exagération verticale 1x

Hillshade created by L'Hérault, E. from LIDAR data (MRNF 2010, gouvernement du Québec). Illumination: azimuth 315°, altitude 45°, vertical exaggeration 1x

Projection : MTM zone 5, NAD83

ALÉAS NATURELS ACTUELS ET APPRÉHENDÉS
ACTUAL AND POTENTIAL NATURAL HAZARDS
SALLUIT
Québec, Nunavik
1 : 8 000

0 125 250 500 750 1 000 1 250 1 500 Mètres

Auteurs : S. Aubé-Michaud., M. Allard et E. L'Hérault, Centre d'études nordiques, Université Laval, décembre 2017.

Authors: S. Aubé-Michaud., M. Allard and E. L'Hérault, Centre d'études nordiques, Université Laval, December 2017.

Citation recommandée :
Aubé-Michaud, S., Allard, M. et L'Hérault, E., 2017. Aléas naturels actuels et appréhendés, Salluit, Québec, Nunavik, Centre d'études nordiques, échelle 1: 8 000.

Recommended citation:
Aubé-Michaud, S., Allard, M. and L'Hérault, E., 2017. Actual and potential natural hazards, Salluit, Québec, Nunavik, Centre d'études nordiques, scale 1: 8 000.

ANNEX 2. DETAILS ON THE HYDROLOGY OF THE WATER INTAKE

- A2.1 Sectional representation of the sub-fluvial talik of the Kuuguluk River (Source: Lemieux et al. 2016)

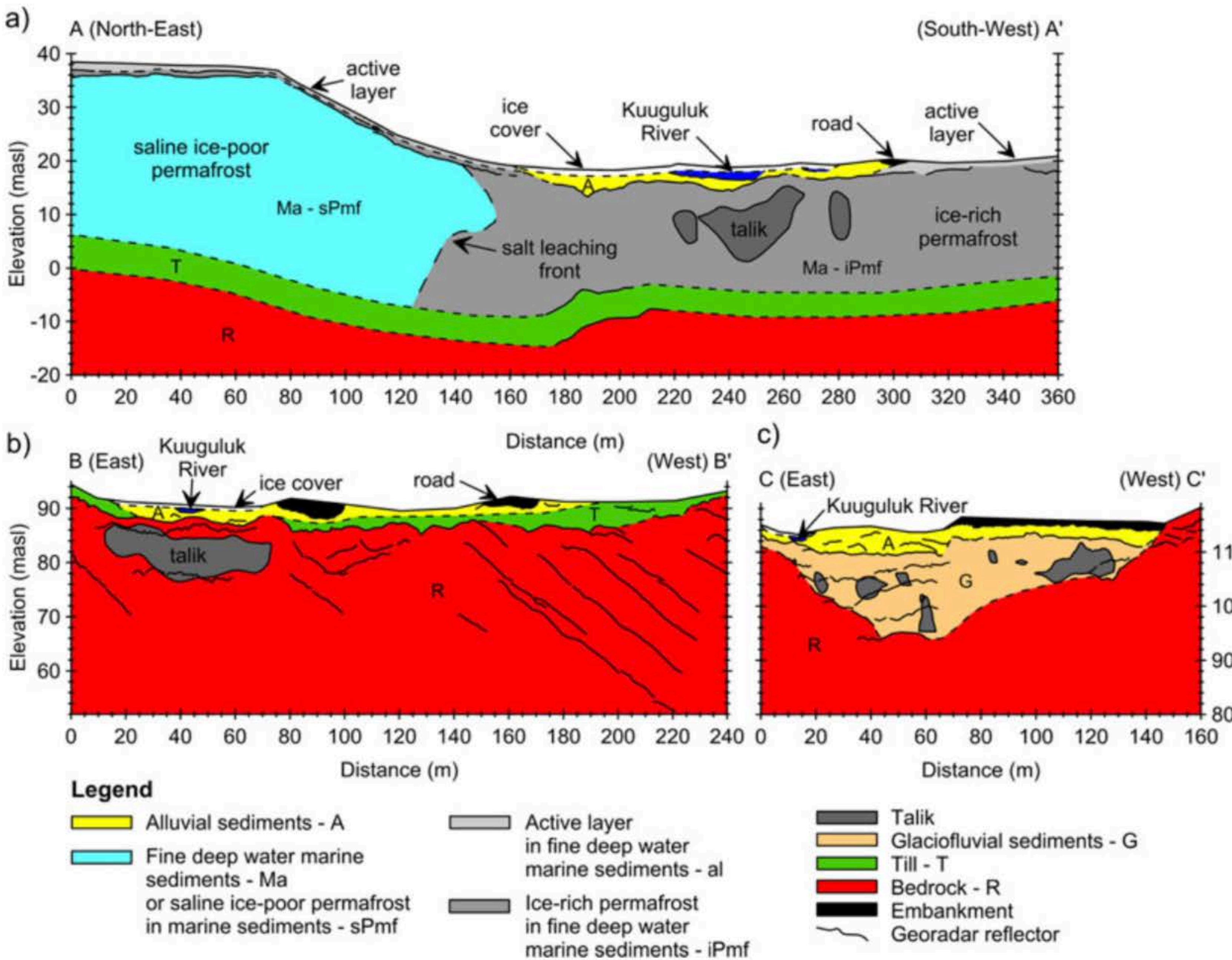
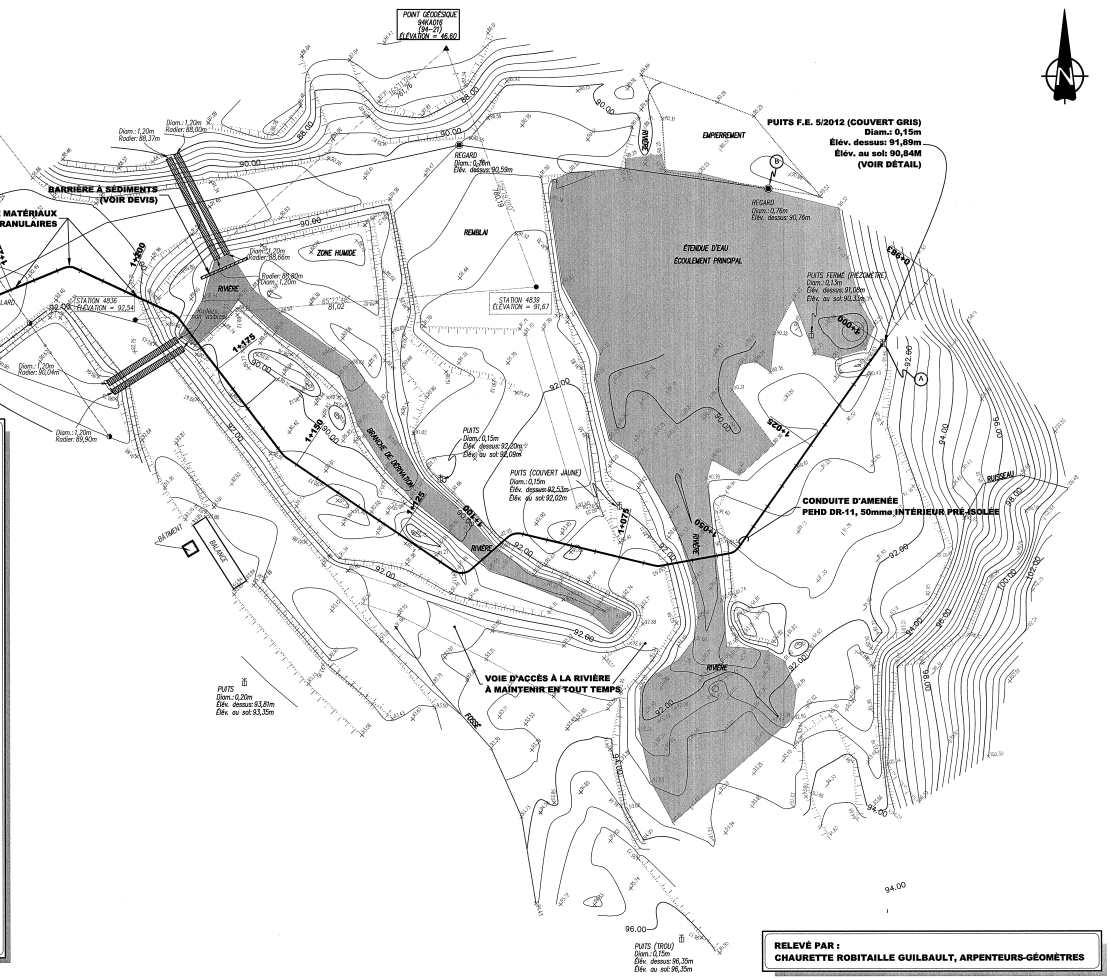
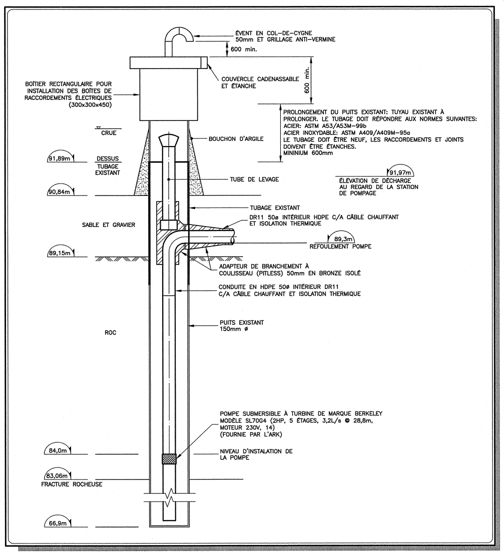


Fig. 8 Cross-sections showing the cryohydrogeological settings of the closed river talik in Salluit along the survey lines **a** A–A′, **b** B−B′ and **c** C–C′. See Fig. 7 for the location of the cross-sections. Note the vertical exaggeration of 1:2

ANNEX 3. WATER INTAKE CONSTRUCTION DIAGRAMS

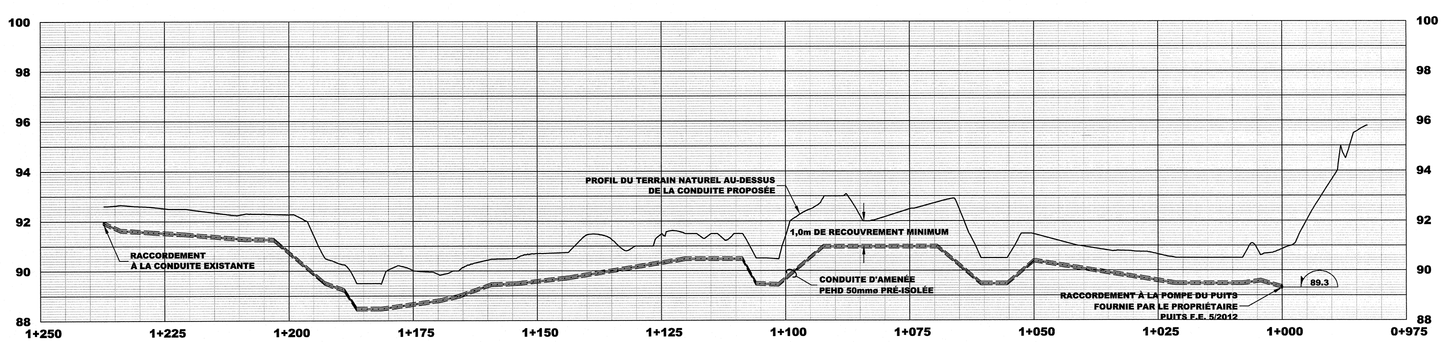
- A3.1, A3.2 Diagrams of the installations for the collection and treatment of drinking water in the northern village of Salluit





DÉTAIL - PUITS FE 5/2012

ÉCHELLE: AUCUNE



N. B. : L'ENTREPRENEUR DEVRA, AVANT DE COMMENCER TOUT TRAVAIL :
A) VÉRIFIER TOUTES LES DIMENSIONS DES DESSINS ET LES CONDITIONS EXISTANTES SUR LE CHANTIER;
B) AVERTIR AUSSITÔT L'INGÉNIEUR DE TOUTE ERREUR ET/OU OMISSION;

no	date	émissions et révisions	par
00	12-09-08	ÉMIS POUR SOUMISSION	F.B.

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Administration régionale KATIVIK Regional Government
P.O. Box 9 KUUJJUAQ (QUÉBEC) CANADA J0M 1C0

Architecture:
GILBERT SAUVÉ Architecte
370, rue Le Moyne, Bureau 101
Montréal, Qc. H2Y 1Y3
Tél.: 514-253-0007

Électricité et contrôle:
ELECTROSULT INC.
EXPERTS CONSEILS CONSULTANTS

Civil, Mécanique de procédé, Mécanique de bâtiment, Structure:
CIMA+
740, rue Notre-Dame Ouest, bureau 900
Montréal (Québec) H3C 3X6
Téléphone : (514) 337-2462
Télécopieur : (514) 281-1632
www.cima.ca
ISO 9001

sceau | sceau

projet
MISE À NIVEAU DES INFRASTRUCTURES D'ALIMENTATION EN EAU POTABLE DU VILLAGE NORDIQUE DE SALLUIT

titre
CIVIL

RACCORDEMENT DU PUITS D'EAU POTABLE

dessiné: Stéphane Boucher	échelle: 1:500
projeté: Estelle Lagacé, ing.jr.	date: Octobre 2012
vérifié: Francis Bourdua, ing.	dessin vérifié: Stéphane Boucher
approuvé: Francis Bourdua, ing.	no. d'appel d'offre: KRG 20 (1493)

M02125A SU 02 001 00
no. projet | département | série | feuille | rév.

Date : 9 octobre 2012
Dernier enregistrement : Alain Dorval
Chemin et fichier : Q:\PROJETS\M02125A_KATIVIK\DAO.SU.0100.PLANS\M02125A-SU-00-001.DWG

A1 841 x 594 mm

M02125A SU 02 001 00
no. projet département série feuille rév.

Rév. No	Description	Date
4	TEL QUE CONSTRUIT / AS BUILT	96-11-26
3	POUR / FOR CONSTRUCTION	93-07-14
2	ÉMIS POUR SOUMISSION / FOR TENDER CALL	93-05-21
1	POUR APPROBATION / FOR APPROBATION	93-05-17

Administration régionale KATIVIK
kATIVIK Regional Government
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SALLUIT

Consultant :

SVB GROUPE STAVIBEL INC.

ST-Amant, Vézina, Vinet, Brassard
Ingénieurs-Conseils
1271, 7ième rue Val d'Or, Qué. J9P 3S1
Téléphone: 825-2233 , Fax: 825-1322

Titre du plan :

Plan d'ensemble des travaux
Master plan

Gilles Marcotte ing.	Préparé par	1 : 5000	Échelle
Yves Boisvert T.Sc.A.	Dessiné par	Avril 1993	Date
			Lot No
Gilles Brisson ing.	Approuvé par	V-064	Dossier No
		V-064-001	Plan No

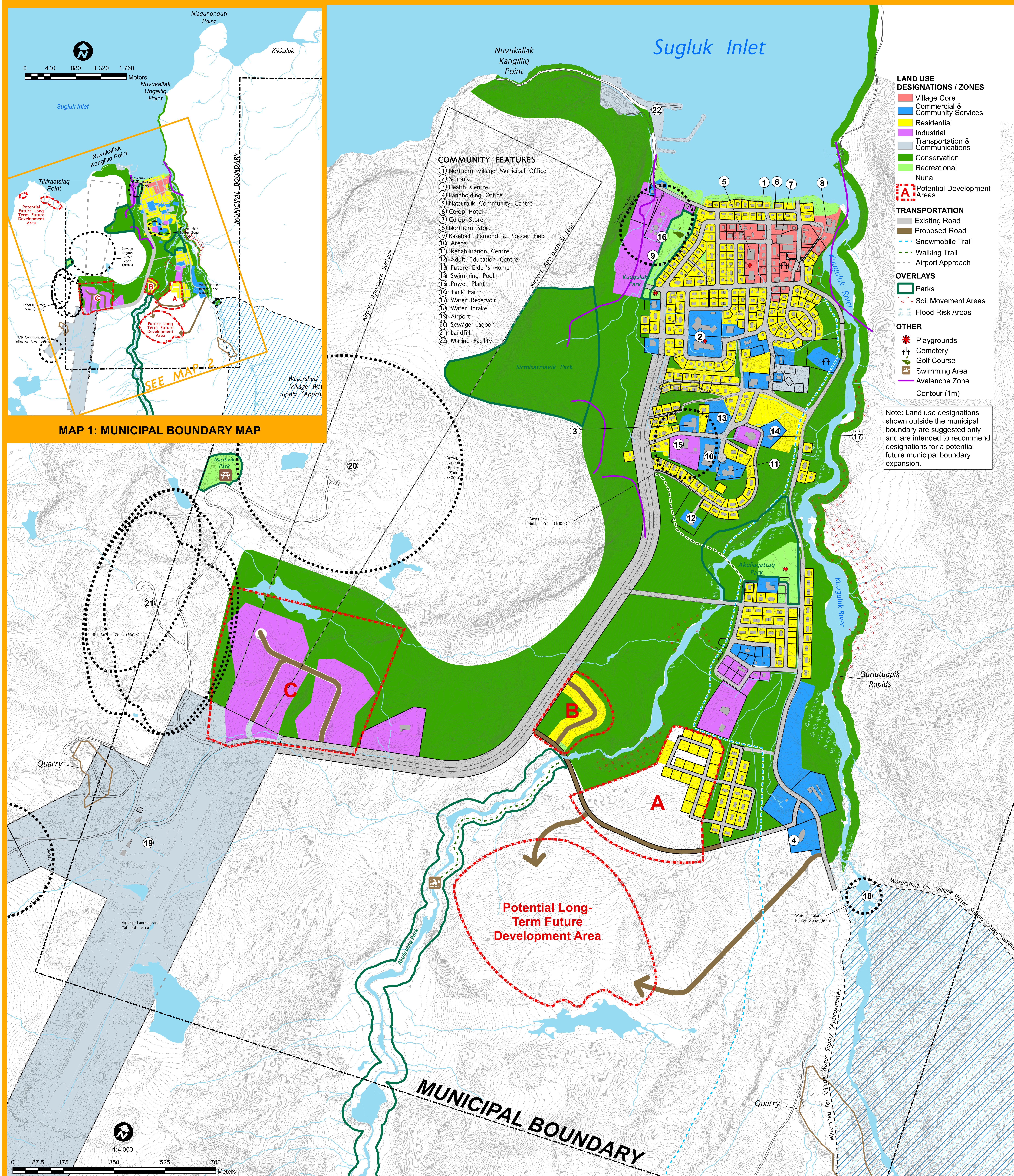
ANNEX 4. TERRITORY ALLOCATIONS

Table 9. Inventory of activities in the land use area "Nuna" likely to have a positive or negative impact on the exploited waters

Name of condition	Protection areas concerned	Condition representing risk / protection	Activity representing a risk / protection	Potential contaminants and associated risk
Nuna	All areas	Risk	Mining exploration	Inorganic matter and sediments **Negligible risk**
Nuna	All areas	Risk	Cimetary	Organic matter, micro-organisms, **Negligible risk**
Nuna	All areas	Risk	Sewage ponds	Organic matter, micro-organisms, **Negligible risk**
Nuna	All areas	Risk	Landfill site	Organic and inorganic materials, microorganisms **Negligible risk**
Nuna	All areas	Protection	Hunting and fishing	-
Nuna	All areas	Protection	Berry picking	-
Nuna	All areas	Protection	Camping and outdoor activities	-

- A4.1 Land use plan for the northern village of Salluit (Source: KRG)
- A4.2 Map of Category I lands in the northern village of Salluit (Source: Nunavik Landholding Corporations Association)

Salluit Master Plan Amendments By-Law 2017- 2015-2035



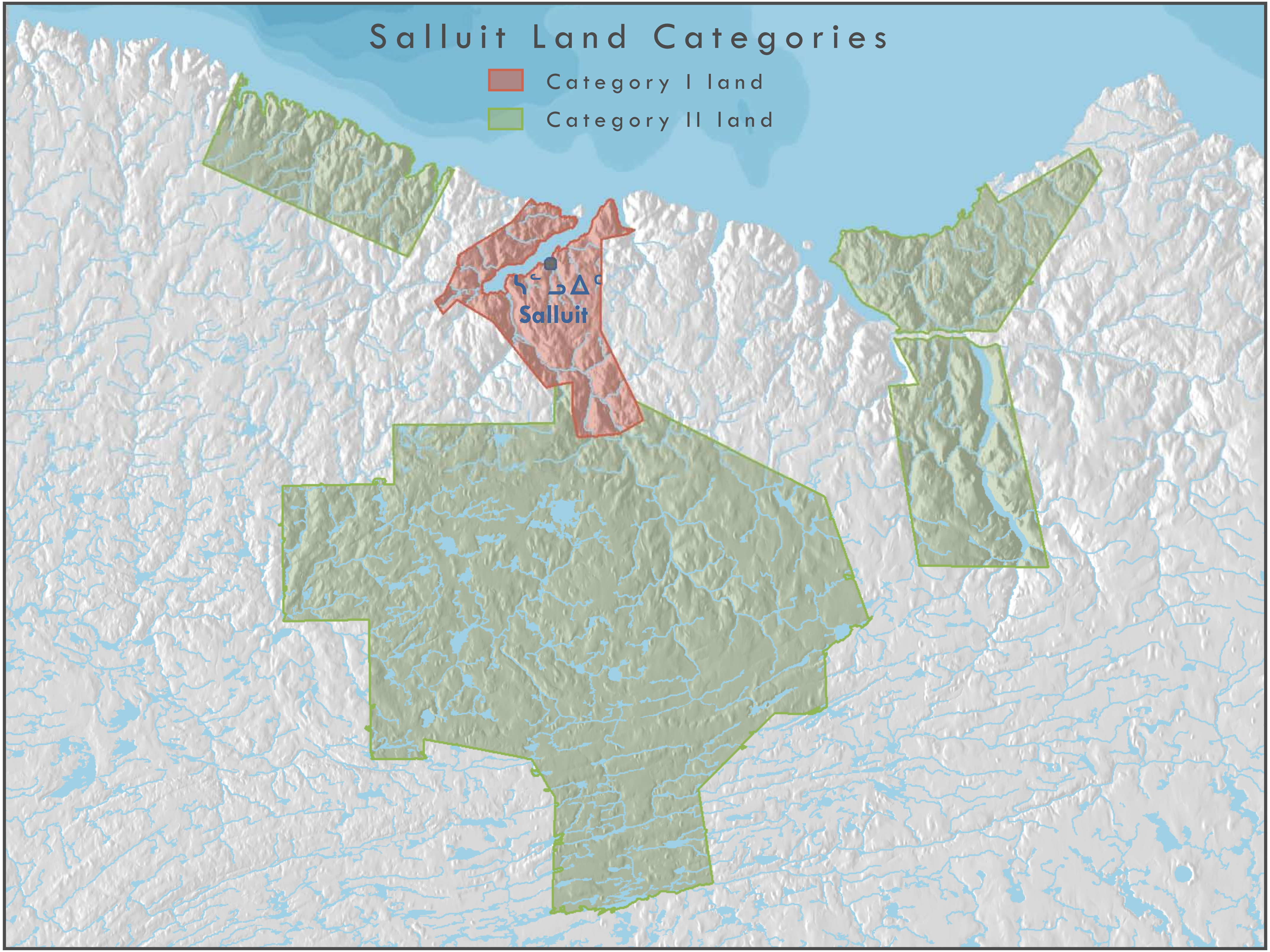
MAP 1: MUNICIPAL BOUNDARY MAP

MAP 2: LAND USE DESIGNATION AND ZONE MAP

PERMITTED USES

(REFER TO PART 5 - ZONE REGULATIONS - ZONING BY-LAW)

Residential	• Bed and breakfast • Craft studio • Day care centre • Dwelling, detached • Dwelling, semi-detached • Dwelling, duplex • Dwelling, multi-unit • Mobile home • Elders' facility • Group home • Home occupation • Park or playground • Place of worship • Secondary suite • A use similar to the uses permitted in this zone
Village Core	• Bank • Cemetery • Community Centre • Convenience Store • Craft Studio • Day care centre • Dwelling, multi unit • Dwelling row-house • Dwelling unit(s) in a non-residential building, provided they are either at the back of the building or above the ground floor • Educational Facility • Elder's facility • Fire hall • Gas Station • Group home • Health care facility • Home occupation • Hotel • Municipal/ government office • Office • Park or playground • Parking lot • Personal or business service • Place of Worship • Police Station Post office • Radio and television station • Recreation Facility • Restaurant • Retail Store • Youth Centre • A use similar to uses permitted in this zone
Commercial & Community Services	• Bank • Cemetery • Community Centre • Convenience Store • Communications facility • Community Hall or Centre • Craft Studio • Day care centre • Dwelling unit(s) in a non-residential building, provided they are either at the back of the building or above the ground floor • Educational Facility • Elder's facility • Fire hall • Gas Station • Group home • Health Care facility • Home occupation • Hotel • Municipal/ government office • Office • Park or playground • Parking Lot • Personal or Business Service • Place of Worship • Police Station • Post office • Radio and television station • Recreation Facility • Restaurant • Retail Store • Youth Centre • A use similar to uses permitted in this zone
Industrial	• Agricultural use • Automotive repair, sales or rental shop • Building supply or contractors' shop • Caretaker unit • Communications facility • Dog team • Gas station • Hazardous goods storage • Outdoor storage • Manufacturing and industrial plant • Petroleum tanks • Power plant • Pit • Quarry • Rental shop • Tank farm • Warehouse • Water intake • Water treatment plant • Workers' camp (temporary) • A use similar to the uses permitted in this zone
Recreational	• Beach shack • Boat storage • Breakwater • Communications facility • Dock • Monument, cairn, or statue • Park or playground • Shed to store equipment for traditional, cultural, and recreational activities • Sports field • Temporary outdoor storage during sealift • Washroom facility • A use similar to the uses permitted in this zone
Conservation	• Snow fence • A use similar to uses permitted in this zone
Transportation & Communications	• Airport and related uses • Communications facility • Floatplane base • Pit • Quarry • Sealift facility and other marine infrastructure • A use similar to the uses permitted in this zone
Nuna	• Cabin • Cemetery • Dog team • Commercial harvesting • Communications facility • Permanent hunting and fishing cabins or camps • Pit • Quarry • Recreation-related development or activities • Resource exploration and development • Sewage lagoon • Snow fence • Solid waste disposal site • Temporary tenting or camping • Water intake • Water reservoir • Water treatment plant • A use similar to the uses permitted in this zone


Salluit Land Categories
Category I land
Category II land
ᓴᓪᓗᐃᑦ
Salluit

ANNEX 5. DETAILS ON TURBIDITY VULNERABILITY

- A5.1 Pdf provided by LNA (4 pages: 1 table and 3 maps)
- A5.2 Pdf from email originally sent from LNA

HYDROGÉOLOGIE ENVIRONNEMENT

Tableau 1 : Détermination de la vulnérabilité des eaux exploitées à la turbidité

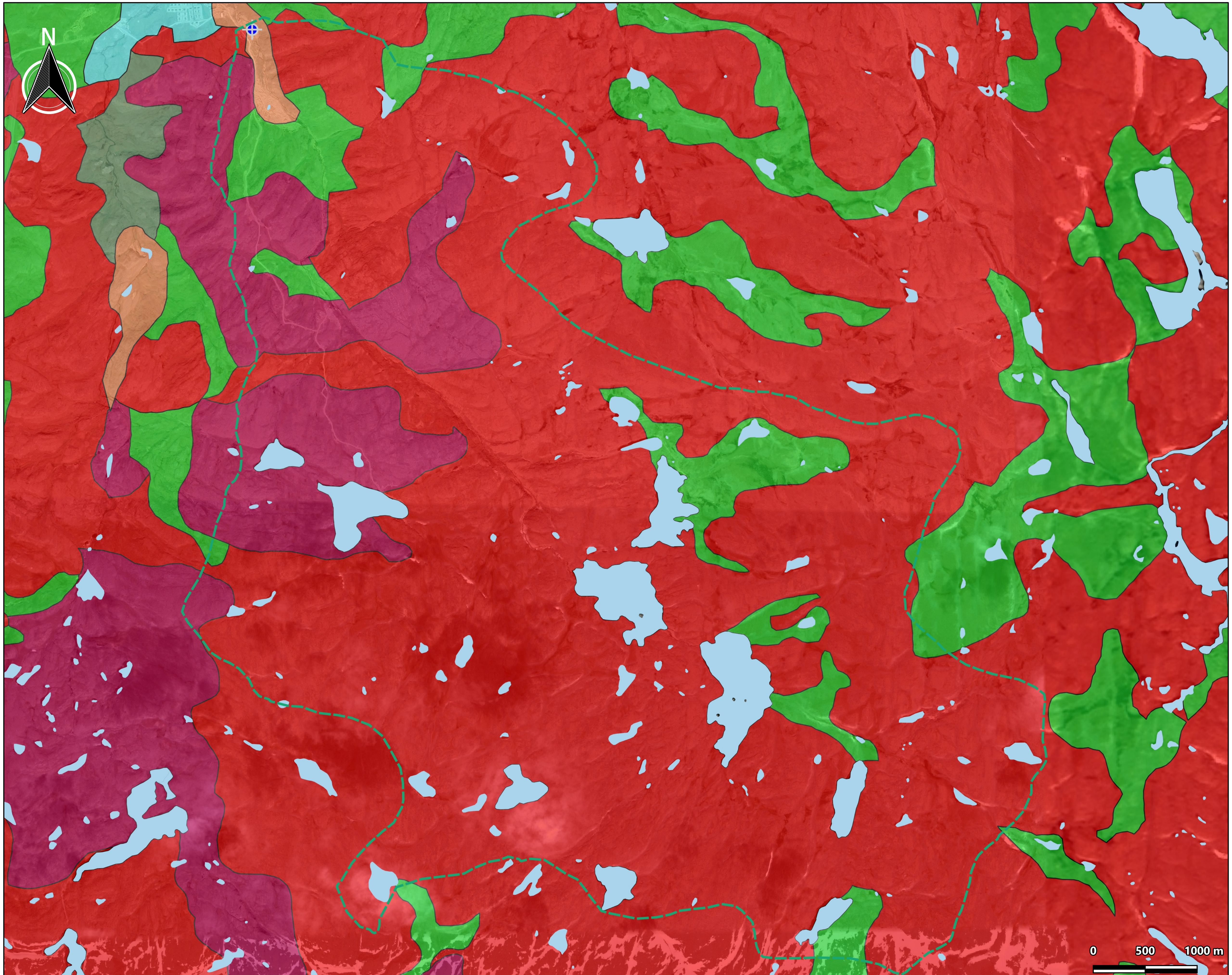
Client : Groupe Synergis

Projet : Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Salluit

N/Réf. : 20-6867-4663

Caractéristique du milieu	Description	Source des données	Risque associé pour la turbidité
Pédologie	Absence de donnée permettant de conclure dans le rapport car ce dernier se concentre sur le secteur habité du village.	Rapport "Caractérisation géotechnique et cartographie améliorée du pergélisol dans les communautés nordiques du Nunavik - Salluit"	N/A
Géologie	Majoritairement, la superficie de l'aire éloignée de la prise d'eau Salluit est dépourvue de dépôts de surface. En effet, environ 91% de la supeficie terrestre est occupée par des affleurements rocheux	Ministère des Forêts, de la Faune et des Parcs	Élevé
Relief	Utilisation du MNT pour calculer les pentes dans un logiciel SIG. La valeur de pente moyenne pour l'aire de protection éloignée du site de prélèvement est de 9,5%. Cependant, en bordure de la rivière et notamment dans la partie nord du bassin versant, des pentes importantes sont observées (pentes excessives supérieures à 40%). Ces fortes pentes favorisent le ruissellement et la mise en mouvement des particules notamment lors des fortes précipitations.	MNT (MERN)	Élevé
Couvert végétal	Les données de végétation au sein de l'aire de protection éloignée autour de la prise d'eau ont été divisées en deux catégories : couvert végétal représentant une protection vis-à-vis de la turbidité ou non. Ainsi, il apparaît que seulement 8% de l'aire est occupée par un type de végétation participant à la protection des eaux exploitées par rapport à la turbidité.	Ministère des Forêts, de la Faune et des Parcs	Élevé
Affectation du territoire	D'après la carte des affectations du territoire du village nordique de Salluit, les bordures de la rivière en amont de la prise d'eau appartiennent à la zone « nuna », laquelle est principalement dédiée aux activités traditionnelles et récréatives	Affectations du territoire de Salluit	Faible

Vulnérabilité retenue pour l'indicateur D	**Élevé**



Groupe Synergis

Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Salluit

Géologie des dépôts de surface

LÉGENDE

- Prise d'eau
- Étendue d'eau
- Aire de protection éloignée

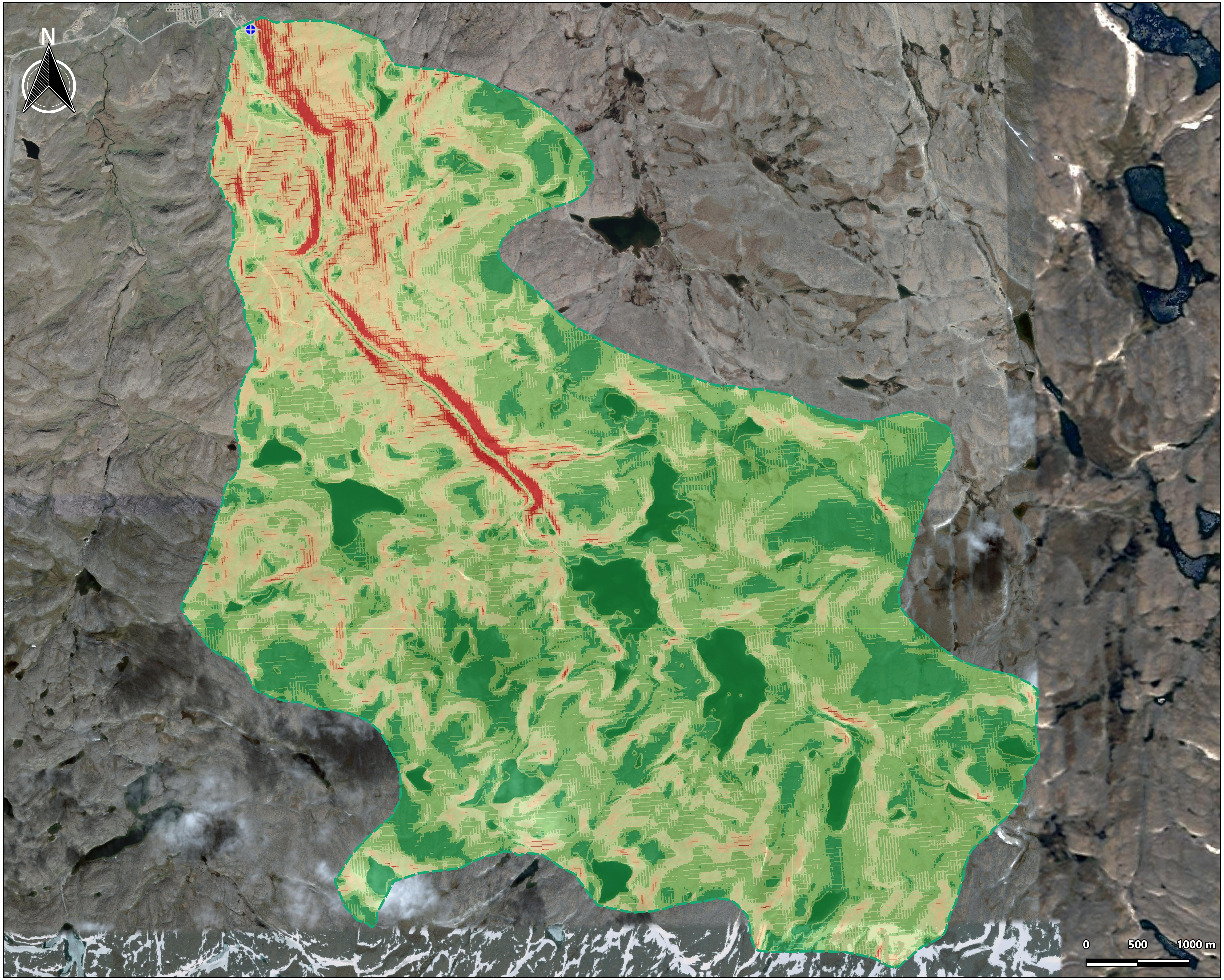
Dépôts de surface

- Dépôts marins - Faciès d'eau profonde
- Roc
- Till indifférenciés
- Littoral - Faciès d'eau peu profonde
- Roc à nu
- Dépôts fluvio-glaciaires, delta fluvio-glaciaire

Nom du fichier :
20-6867-4663_fig1_depots_surface_Salluit
Fond cartographique : Google satellite
Projection NAD83 MTM9

Échelle :	1 : 35 000	**Date :**	2021-02-12
Figure :	1	**Dossier :**	20-6867-4663
Approuvé par :	Jean-Philippe Tremblay, géo., hydrogéologue		
Préparé par :	Jérémy Targosz, chargé de projet		
Dessiné par :	Jérémy Targosz, chargé de projet		

LNA
HYDROGÉOLOGIE ENVIRONNEMENT
2425, avenue Watt, bur. 210
Québec (Québec) G1P 3X2
Téléphone : 418 657-7999
Sans frais : 1 877 657-7999
Télécopieur : 418 657-5777



Groupe Synergis

Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Salluit

Carte des pentes au sein des aires de protection

LÉGENDE

- Prise d'eau
- Aire de protection éloignée

Classes de pente

- Pente nulle 0 à 3%
- Pente faible 4 à 8%
- Pente douce 9 à 15%
- Pente modérée 16 à 30%
- Pente forte 31 à 40%
- Pente excessive 41% et plus

Nom du fichier : 20-6867-4663_fig2_pentes_Salluit
Fond cartographique : Google satellite
Projection NAD83 MTM9

Échelle :	1 : 35 000	**Date :**	2021-02-12
Figure :	2	**Dossier :**	20-6867-4663
Approuvé par :	Jean-Philippe Tremblay, géo., hydrogéologue		
Préparé par :	Jérémy Targosz, chargé de projet		
Dessiné par :	Jérémy Targosz, chargé de projet		

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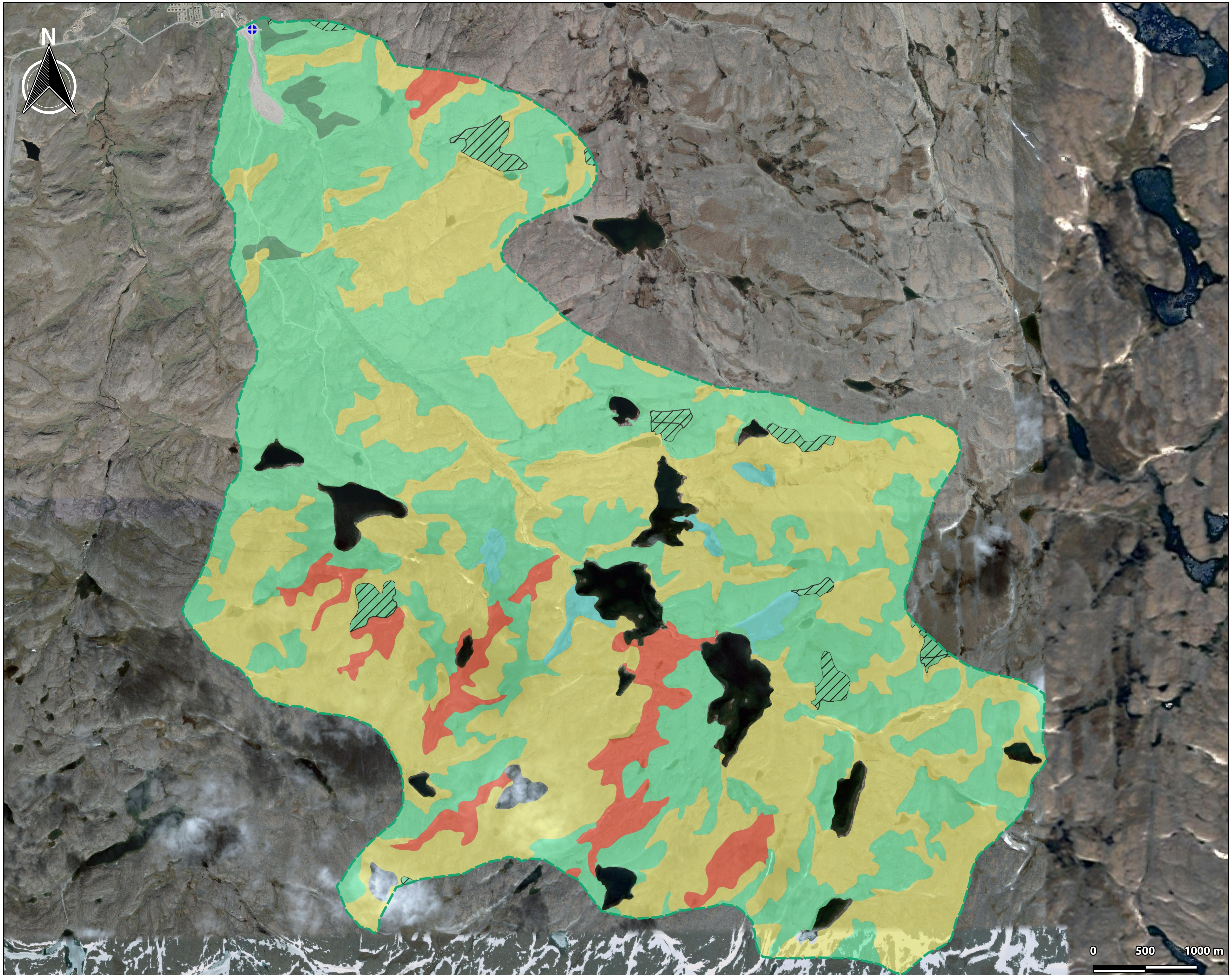

Groupe Synergis

Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Salluit

Cartographie du couvert végétal au sein des aires de protection

LÉGENDE

- Prise d'eau
- Aire de protection éloignée

Végétation cartographiée

- Affleurements et fragments rocheux
- Infrastructure humaine
- Toundra à arbustes prostrés
- Toundra à arbustes prostrés avec ostioles
- Toundra à arbustes prostrés dominée par le
- Toundra herbacée avec arbustes prostrés
- Tourbière arctique ou toundra humide

Nom du fichier :
20-6867-4663_fig3_vegetation_Salluit
Fond cartographique : Google satellite
Projection NAD83 MTM9

Échelle :	1 : 35 000	**Date :**	2021-02-12
Figure :	3	**Dossier :**	20-6867-4663
Approuvé par :	Jean-Philippe Tremblay, géo., hydrogéologue		
Préparé par :	Jérémy Targosz, chargé de projet		
Dessiné par :	Jérémy Targosz, chargé de projet		

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Demande d'avis externe - Études de vulnérabilité Villages de l'eau potable - Villages Nordique

J.Targosz | LNA <jtargosz@lnaqua.com>

Lun 2021-02-15 14:59

À : Rachel Hussherr <rachel.hussherr@nunaressources.ca>
Cc : Jean-Philippe Tremblay <jptremblay@lnaqua.com>; lguillemette@synergis.ca <lguillemette@synergis.ca>

2 pièces jointes (24 Mo)

20-6867-4663_Indicateur_D_Kagiq.pdf; 20-6867-4663_Indicateur_D_Salluit.pdf;

Bonjour Rachel,

Vous trouverez ci-joint notre avis concernant la vulnérabilité des eaux exploitées à la turbidité pour les prises d'eau Kangiqsualujjuaq et Salluit.

À partir des informations disponibles, nous avons attribué un niveau de risque (faible, moyen ou élevé) aux principales caractéristiques du milieu pouvant impacter la turbidité des eaux exploitées. Grâce au niveau obtenu pour chacun des paramètres, nous avons pu déterminer le niveau de vulnérabilité de l'indicateur D.

En l'absence de données abondantes et précises, nous avons choisi de définir les niveaux de vulnérabilité de façon sécuritaire.

En espérant le tout conforme à vos attentes, je demeure disponible pour toute interrogation.

Au plaisir,

ANNEX 6. MODEL/ TEMPLATE OF EVENTS LOG

Adapted from the model provided by the MELCC at the following link:
http://www.environnement.gouv.qc.ca/eau/potable/registre/modeles-source-approvision.htm

Développement durable, Environnement et Lutte contre les changements climatiques
Québec

Events log occurring throughout the procurement supply chain (article 22.0.4 of RRQDW)*

Identification of the withdrawal site

Location of the potable water production facility: Northern Village of Salluit
Identification of the withdrawal site:

Name : Salluit – Approvisionnement
Number : X2114282

Event details

Description of event: ____________________
____
____
____

Start date: ____________________ End date: ____________________

Types of problem encountered:

- ☐ Water shortage (strictly linked to a drying up of the water source)
- ☐ Obstruction or breakage at the withdrawal site
- ☐ Malfunction of the screening, filtration, disinfection system or the entire treatment (validate whether MELCC must be advised in accordance to Article 35.1)
- ☐ Other: ____________________

Affected equipments or processes :

Equipment: ☐ Strainer ☐ Water pipes ☐ Pumping system
Processes: ☐ Screening ☐ Filtration ☐ Disinfection
☐ Entire treatment system
☐ Others: ____________________
☐ None

Location of occurrence (note if necessary): ____________________
____

Categories of events to which the observations refer:

- ☐ Natural or anthropogenic events that affected the physical integrity of the withdrawal site
- ☐ Algae, cyanobacteria or aquatic plants proliferation
- ☐ Suspected or measured increases in ammoniacal nitrogen
- ☐ Others

Observations made by (name) : ____________________
Position :
Signature :
Date :

____
____
____

*Reminders:

- A separate register must be kept for each withdrawal site, ie for each separate water withdrawal installation;
- Each event must be listed separately (one event per page), even if two events occur simultaneously;
- An event whose effect extends over several consecutive days should be recorded as a single event. However, a similar event that occurs periodically must be recorded separately at each occurrence.

Details of some of the information to be entered in the register

Event information

Types of problem encountered: Check all types of applicable problems according to the classification established in section 22.0.4 of RRQDW.

Types of problems encountered	Examples
Water shortage (strictly linked to a drying up of the water source)	Low flow leading to an exposure of the water intake
	Drainage due to the breaking of a retention dam
Obstruction of the withdrawal site	Silting up
	Frazil
	Proliferation of aquatic plants or zebra mussels
	Accumulation of coarse debris
Breakdown of the withdrawal site	Damages caused by ice
	Subsidence of a retaining wall
	Tearing off / removing of the supply line
Malfunction of the screening, coagulation, settling, filtration, disinfection system or of the entire treatment system	Overgrowth of algae, cyanobacteria or other microorganisms causing taste and odor problems in treated water
	Proliferation of aquatic plants or zebra mussels causing problems with the screening system
	Presence of a contaminant in raw water (for example, ammoniacal nitrogen) which increases the consumption of chemicals (eg. chlorine) and prevents the achievement of treatment goals
Others (any other problem that does not belong to one of the three previous types of problems)	Presence of a contaminant in the raw water which does not affect the operation of existing treatment processes, but which cannot be treated by these processes (eg. chlorides in high concentrations or hydrocarbons). Note: Depending on the nature of the contaminant and the risks it represents for human health, its presence could lead to the temporary closure of the water intake.

Place where the event occurred: in some cases, it may be relevant to note the location of the event (eg. the location of the cyanobacteria bloom or the location of a spill).

Categories of events to which the observations refer/relate: Check all the categories concerned.

- Natural or anthropogenic events that have affected the physical integrity of the withdrawal site include events associated with a water shortage, an obstruction or breakage of the sampling site.

The "other" category includes all events that do not correspond to one of the first three categories.

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