New Thermal Generating Station in the Northern Village of Puvirnituq

Environmental and social impact assessment statement

Volume 1 – Report

September 2021

Produced by
Hydro-Québec

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Groupe – Distribution, approvisionnement et services partagés
September 2021

This environmental impact statement (EIS) is being filed with the Ministère de l'Environnement et de la Lutte contre les changements climatiques in accordance with section 196 of the Environment Quality Act *with a view to obtaining the necessary authorizations to carry out the project to construct a thermal generating station in the northern village of Puvirnituq.*

This environmental and social impact assessment statement is divided into two volumes:

- Volume 1 – Report
- Volume 2 – Appendices

This assessment was conducted for the Groupe – Distribution, approvisionnement et services partagés by Hydro-Québec's Direction principale – Santé, sécurité et environnement. The list of contributors is provided in Appendix A of Volume 2.

Executive summary

Hydro-Québec – Distribution, approvisionnement et services partagés is responsible, through the Direction – Réseaux autonomes, for supplying electricity to communities not connected to the main transmission system.

Project description

Following a planning study conducted in 2019, Hydro-Québec plans to build a new thermal generating station on the territory of the northern village of Puvirnituq to replace the existing one. The new generating station will supply electricity to the Puvirnituq community starting in 2026. After this date, the existing generating station will be dismantled.

With a nominal design life of 50 years, the generating station will initially be equipped with two 1.86-MW gensets and two 1.39-MW gensets, for a total installed capacity of 6.50 MW. The two 1.39-MW gensets could be replaced with 1.86-MW units to bring the total installed capacity to 7.44 MW, and the generating station will be designed to allow for the addition of a fifth 1.86-MW genset, which would increase its capacity to 9.30 MW. This firm capacity will ensure the system's reliability for more than 30 years. Energy production costs for this off-grid system will be optimized by integrating renewable energy—from solar panels in phase 1 and from a wind farm and energy storage system in phase 2.

The planned site for the construction of the generating station is about 2.5 km west of the center of Puvirnituq. The developed area will be approximately 15,000 m² and will include the generating station, a fuel depot with two 75,000-L outdoor storage tanks, a 4/12-kV step-up substation with two distribution feeder bays and storage spaces for operational needs. To provide access to the generating station, the road currently leading to the site will be redesigned and extended to be about 450 m long. A 1.5-km distribution line will run from the substation along Rue Tikiraaluk to connect to the existing grid.

Environmental impact assessment and public participation process

The thermal generating station is subject to the environmental and social impact assessment and review procedure under chapter III, title II of the *Environment Quality Act* (EQA), since it will have a capacity exceeding 3 MW.

As part of the impact assessment, Hydro-Québec launched a program to consult the populations affected by the new thermal generating station, namely the northern village of Puvirnituq, the Kativik Regional Government (KRG) and the Ministère de l'Énergie et des Ressources naturelles (MERN). In 2019–2020, Hydro-Québec held three meetings with the Puvirnituq municipal council as well as a consultation over community radio. However, due to COVID-19, Hydro-Québec had to adjust its information and consultation process so that community members could safely participate.

Environmental impacts of the project

The impacts of the project will be felt primarily during construction. The main activities associated with construction of the thermal generating station are access road construction, excavation and blasting, leveling, backfilling and earthwork, generating station construction, waste management, transport and traffic, worker presence and housing, employment, and the purchase of goods and services. This work will nonetheless be limited, small in scale and carried out over a relatively short period of approximately two-and-a-half years.

Biophysical environment

Components of the biophysical environment likely to be negatively affected during the work are the soil, surface water, and caribou and bird populations. During operation, soil and water quality could be minimally affected due to the potential for accidental spills.

The future generating station will be built on unconsolidated deposits consisting mainly of medium-to-coarse sand and rock outcrops, while the road is a made of reworked fill. A total area of 1.66 ha will be developed for the infrastructure. Earthwork, blasting, and foundation and access road construction could alter the surface soil composition and profile.

The generating station site is 145 m from an intermittent watercourse and a perennial watercourse, both of which flow into the Rivière de Puvirnituq more than 400-m away. The site is also surrounded by wetlands. The surface water is presumed to flow southeast toward the Rivière de Puvirnituq. The project has been optimized to avoid negative impacts on wetlands or aquatic environments. That being said, minor changes will be made to the site drainage around the generating station during construction and operation. Sediment supply to the aquatic environment will be negligible since the soils are essentially made up of rock and granular materials. In addition, the platform's slopes will be protected with riprap.

In the limited study area of the project, nine wetlands are present, including a shrub swamp affected by the development of the generating station over an area of 26.8 m^2. This same wetland will be indirectly affected by the construction of a drainage ditch, the draining of which will result in a loss of 520 m^2.

The project's extended study area is used by caribou from the Leaf River Herd. Caribou that frequent the Puvirnituq area are likely to use the spring and fall migration corridors and the summering area. Only a few transient individuals are likely to travel through the project's extended and limited study areas. The various construction activities will result in the loss of approximately 1.66 ha of habitat and minor loss of function owing to human disturbance avoidance behavior. The habitat loss remains a minuscule portion of the Leaf River Herd's summering area, which covers approximately 250,000 km^2.

The project site features low species abundance and diversity due to its location on a rocky plateau that is not favorable to species of interest, such as waterfowl and shorebirds. The principal impacts during the construction phase are tied to habitat loss (1.66 ha) at the generating station site. None of the special-status bird species are likely to be disturbed during construction provided that there is no encroachment on wetlands outside the generating station site.

Human environment

Components of the human environment likely to be negatively impacted during the work and during operations are air quality, greenhouse gases (GHGs) and climate change, the sound environment, land use, infrastructure and services, the health and safety of residents, sites of cultural, historical and archeological interest, and, to a lesser extent, the landscape.

The site for the generating station was chosen with the aim of minimizing negative impacts associated with noise and air quality for the Puvirnituq community. The project will have a positive effect, since we will be moving an existing and continuous source of noise and air pollution 2.5 km further from the village.

The project will help reduce GHG emissions, as the new generating station will be equipped with more-efficient, latest-generation engines. We also plan to incorporate wind energy and battery storage. Integrating renewable energy will reduce GHG emissions over the generating station's entire life cycle. Hydro-Québec aims to incorporate 46% to 62% wind energy into the power system as of 2027. The generating station will also have solar panels to power station services.

The choice of site for the generating station was made in agreement with local authorities and in line with their municipal development plan. Hunting and gathering activities will be disrupted during construction, but afterward, the presence of the generating station will not alter the current use of the surrounding land since game should continue to frequent the area. The gathering place currently located on the site of the future generating station is very important to the community and will be moved to a location of their choosing.

No archeological sites were found directly on the site of the new generating station, although the area is deemed to have "moderate" archeological potential and is therefore of interest. To validate this, Hydro-Québec will conduct a systematic archaeological inventory before breaking ground.

With regard to the impact on the landscape, the infrastructures will only occasionally be visible to mobile observers and will be barely perceptible from the village of Puvirnituq because the generating station will be farther away.

The risk of technological accidents is deemed low, since this is a known technology that is deployed in many operational generating stations and in which Hydro-Québec personnel are proficient. Furthermore, measures to prevent accidents and secure the facilities will be implemented. A noise-monitoring program will also be implemented during the operation phase to measure actual noise levels around the equipment and receivers.

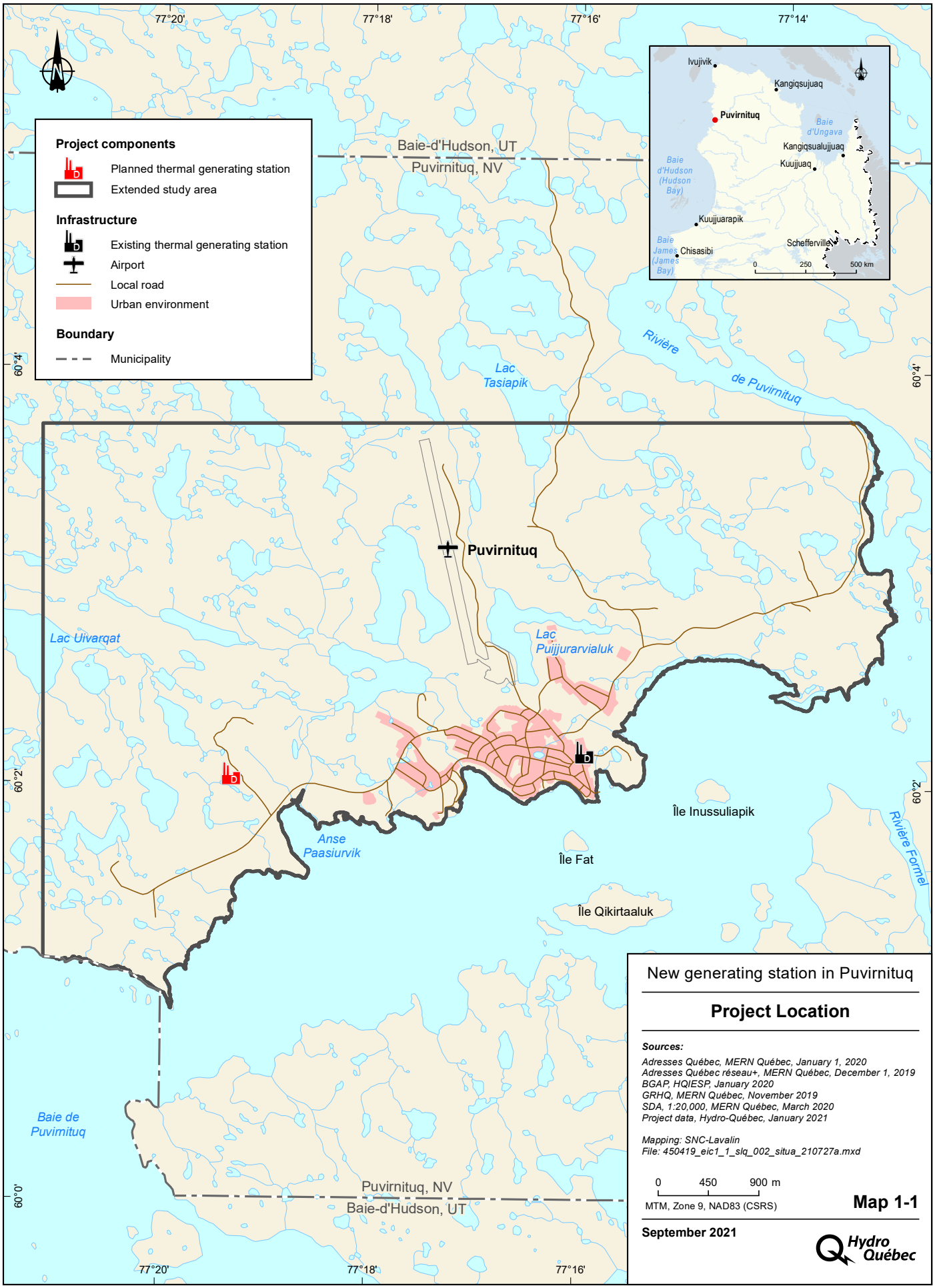
Hydro-Québec plans to apply standard mitigation measures, described in its *Standard Environmental Clauses*, as well as several specific mitigation measures during construction and operation.

The environmental and social impact assessment has established that, with the application of the proposed mitigation measures, the significance of residual impacts on the various components of the biophysical and human environments is minor.

Project schedule and cost

The construction phase of the new thermal generating station will take two-and-a-half years, from 2023 to 2025, once government approvals are obtained. The generating station commissioning is slated for December 2025. The cost of the project is roughly estimated at $85 million.

Lastly, we anticipate positive employment and economic spinoffs during construction of the generating station. Hydro-Québec will maximize the project's positive impacts for the local community with measures such as hiring labor and subcontractors locally whenever possible.



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1.1 Proponent's presentation

The Groupe – Distribution, approvisionnement et services partagés is responsible, through the Direction – Réseaux autonomes, for supplying electricity to communities not connected to the transmission system. To do this, the Direction – Réseaux autonomes is in charge of designing, operating and maintaining electricity generation infrastructures in these communities. The Groupe – Distribution, approvisionnement et services partagés is the proponent of the project to develop and operate Puvirnituq thermal generating station.

1.2 Mission and vision

To meet the needs of off-grid systems, the Groupe – Distribution, approvisionnement et services partagés prioritizes energy efficiency measures and the transition toward renewable energy sources.

Four key principles guide decisions regarding transition projects:

- a positive environmental impact
- reliability of electricity service
- favorable reception from communities
- reduced operating costs

In recent years, the Groupe – Distribution, approvisionnement et services partagés has launched transition initiatives in all off-grid systems.

2 Context and project justification

2.1 General project presentation

Hydro-Québec plans to build a new thermal generating station on the territory of the northern village of Puvirnituq to replace the existing one (see Project Location Map). This generating station will supply electricity to the Puvirnituq community starting in 2026. After this date, the existing generating station will be dismantled.

The generating station will initially be equipped with four generating sets (gensets)—two 1.86-MW and two 1.39-MW—for a total installed capacity of 6.50 MW.

The site will feature the generating station, a fuel depot with two 75,000-L outdoor storage tanks, a 4/12-kV substation with two distribution feeder bays and storage spaces. Later on, the generating station yard will be used to create housing for itinerant workers as well as energy storage shelters for the batteries and equipment needed for coupling with the future wind farm. The platform will have an area of approximately 15,000 m^2. To provide access to the generating station, the current road will be redesigned and extended, covering a distance of about 450 m. A 1.5-km distribution line will run from the substation along Rue Tikiraaluk to connect to the existing grid.

The generating station building will house all power generation, protection and control equipment and systems, and all amenities for maintaining and operating the generating station. Approximately 35 solar panels will be installed on the roof of the building to provide electricity to the generating station itself. In addition, the work of an Inuit artist from the community will be reproduced on a panel on the building facade. Incorporating Inuit art will help make the building less austere.

2.2 Project justification

In 2019, Hydro-Québec conducted a planning study to determine all the work required at Puvirnituq generating station in the short, medium and long term. This study led to the decision to build a new thermal generating station. It demonstrates that demand is growing rapidly and the current generating station's firm capacity (2.583 MW) will be exceeded in 2026 (see Figures 2-1 and 2-2), with its generating sets nearing the end of their service life. There are also long-term operability and legal-compliance issues with the existing building. Lastly, the current site does not allow for expansion and is not suitable for a temporary solution to increase the reliability of the facility.

The nominal design life of the new generating station will be 50 years. It will be designed to accommodate four gensets, for a maximum power of 7.44 MW, with the possibility of expanding it to add a fifth genset and reach 9.30 MW. This firm capacity will ensure the system's reliability for more than 30 years. Energy production costs for this off-grid system will be optimized by integrating renewable energy—from solar panels in phase 1, and from a wind farm and energy storage system in phase 2.

Figure 2-1: Energy Demand Forecast for Puvirnituq

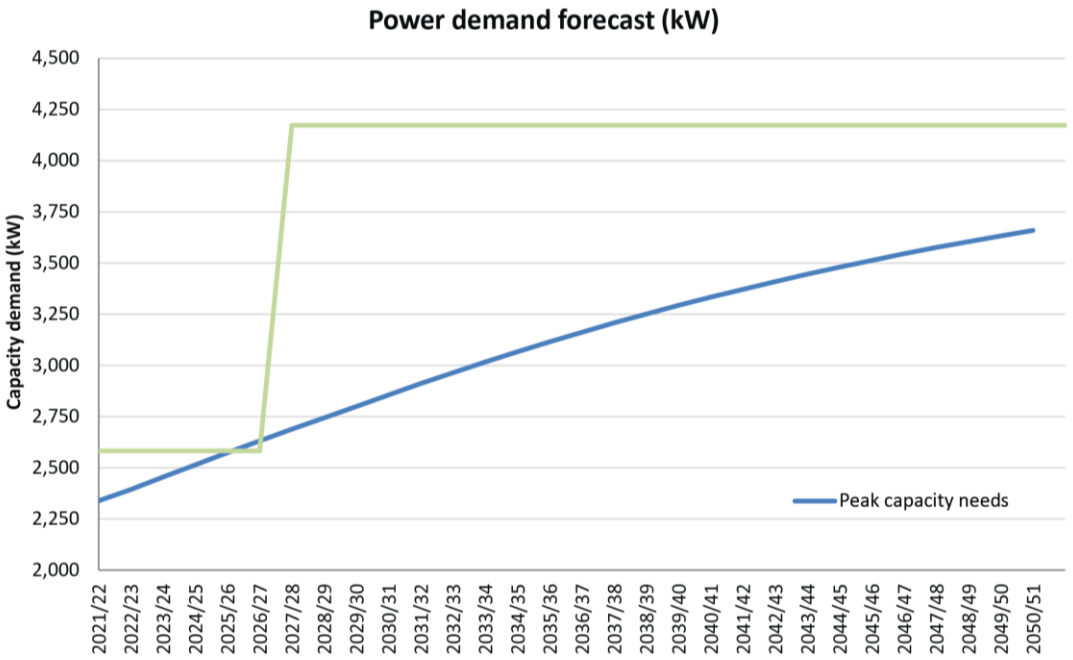
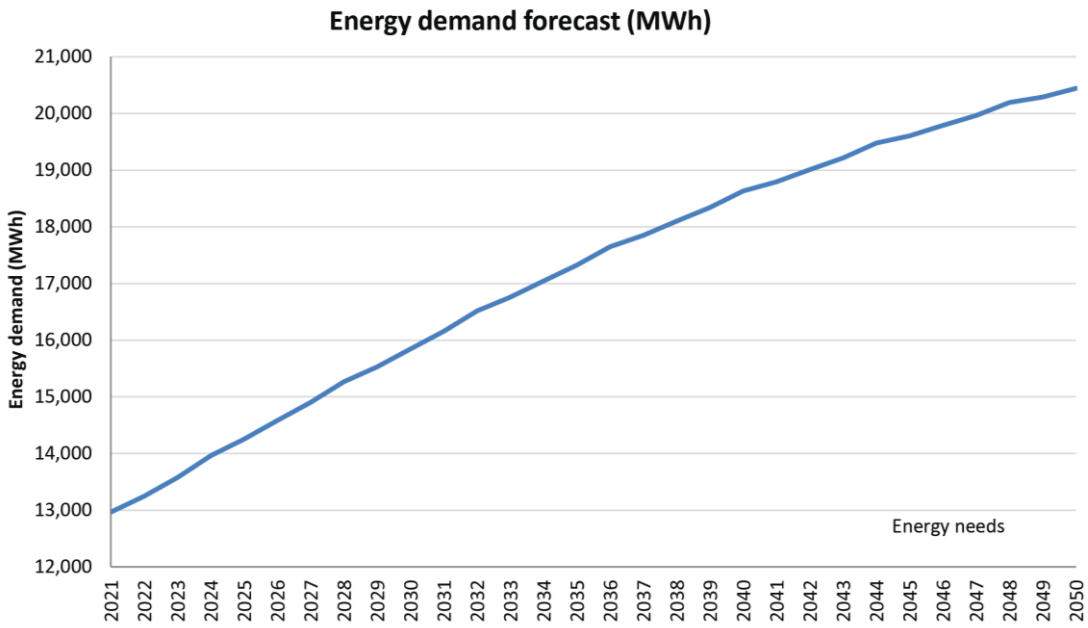


Figure 2-2: Power Demand Forecast for Puvirnituq



2.3 Alternative solutions to the project

The following solutions were studied:

- renovation and expansion of the existing thermal generating station
- construction of a hydroelectric generating station
- construction of a thermal generating station coupled with renewable energy-generating facilities

Renovation and expansion of the existing thermal generating station

Ensuring the long-term operability and growth of the existing Puvirnituq generating station would require significant investment. It would be difficult to carry out this work while maintaining operations during the many long phases that would be required. Moreover, the site does not allow for expansion due to its proximity to an oil pipeline not owned by Hydro-Québec. Building a new generating station is financially preferable to refurbishing the existing generating station, and it is less risky from a technical standpoint.

Construction of a hydroelectric generating station

Hydro-Québec studied the possibility of an 8.1-MW hydroelectric generating station on Lac de Puvirnituq. The development would also include a dam, spillway and dikes. Studied in 2019, this option would have low cost-effectiveness potential and require substantial investments. At a meeting in January 2020, the Puvirnituq municipal council rejected all hydroelectric options.

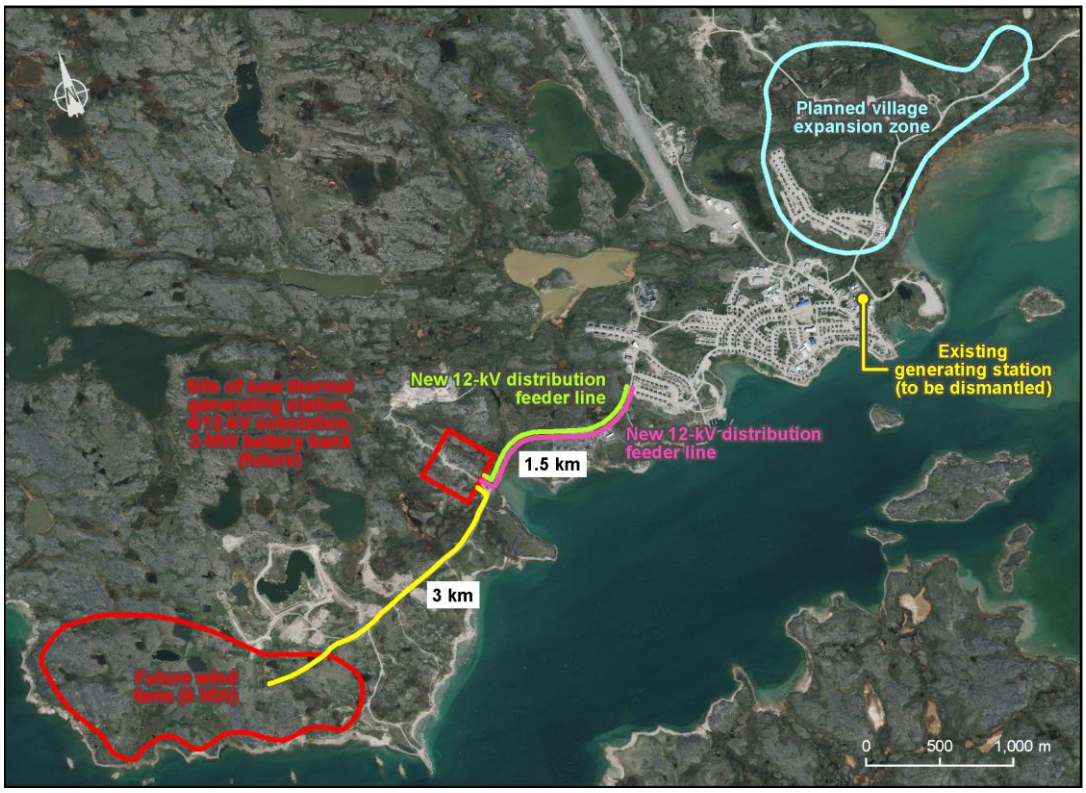
Thermal generating station coupled with renewable energy–generating facilities

Hydro-Québec therefore chose the option of building a thermal generating station combined with facilities that produce renewable energy. This project is cost-effective and simple to implement, with the existing generating station continuing to supply the village of Puvirnituq during construction. It can be done quickly, and a single step is necessary to meet all long-term operability and growth needs. The site, selected in collaboration with the local community, will result in fewer environmental impacts and improve quality of life for residents.

This new thermal generating station will ensure network reliability by using diesel-powered generating sets, as diesel has proven to be a reliable energy source in remote areas and is readily available and easy to transport and store. Solar panels and engine-heat recovery will make the building energy self-sufficient. A transformer substation will be built on the generating station site in order to incorporate wind energy output. An energy-storage system will maximize penetration of this clean energy. In addition to the current thermal generating station project, Hydro-Québec is studying a high-volume wind-energy project that will be very environmentally beneficial. Wind energy was selected because of the Puvirnituq municipal council's interest in this resource.

The conversion of the Puvirnituq system is designed to take place in two major phases. The first phase will be the construction of the thermal generating station and substation, and the second will be a wind energy–integration project. Figure 2-3 shows the locations of the various facilities.

Figure 2-3: Thermal Generating Station Coupled with a Wind Farm



2.4 Related project

The project to build a 1.5-km, 12-kV distribution line is related to this project. This line, to be built later, will run from the new generating station substation along the access road and Rue Tikiraaluk to connect to the existing system.

2.5 Legal context

2.5.1 Environmental and social impact assessment and review procedure

Chapter III, title II of the *Environment Quality Act* (EQA) describes the environmental and social impact assessment and review procedure applicable to the territory located north of the 55th parallel, with the exception of category I and II lands for the Crees of Poste-de-la-Baleine (the Cree community in this location is now called Whapmagoostui). Subsequent construction and operation of a fossil fuel–fired thermal generating station, having a heat capacity equal to or exceeding 3,000 kW, are subject to this procedure.

Subject to chapter III of title II of the EQA, the proponent of a project provides preliminary information about the project to the Minister of the Environment and the Fight against Climate Change (MELCC). The Minister then informs the proponent of

the nature, scope and extent of the environmental and social impact assessment to be carried out, taking into account the opinion of the Kativik Environmental Quality Commission (KEQC). This directive from the Minister presents a process aimed at providing the information necessary for the environmental and social impact assessment of the project proposed.

On July 16, 2020, Hydro-Québec provided the MELCC with the preliminary information on the generating station project. The guidelines for preparing the impact statement for this project were sent to Hydro-Québec on October 14, 2020.

2.5.2 Government approvals

The project is subject to the prior granting of government approvals, including these key requirements:

- delivery of a certificate of authorization under section 201 of the EQA following the environmental and social impact assessment and review procedure set out in chapter III of title II of the EQA
- order in council from the Québec government authorizing the construction of buildings for the production of electricity under section 29 of the *Hydro-Québec Act*
- MELCC authorization for certain elements of the project under section 22 of the EQA

The *Regulation respecting the regulatory scheme applying to activities on the basis of their environmental impact* came into force on December 31, 2020. It indicates that certain activities targeted by section 22 of the EQA may be subject to a statement of compliance or be exempt from an authorization, under certain conditions.

Once the necessary approvals are obtained and depending on the conditions governing such approvals, Hydro-Québec will begin to implement the project.

Furthermore, as specified in the directive from the Minister, the environmental and social impact assessment statement reports the findings of the proponent's environmental and social impact assessment. It must employ scientific methods and satisfy the requirements of the MELCC and the KEQC regarding analysis of the project and consultation of the public and Indigenous communities concerned. The objective is to enable the competent authorities to decide whether to authorize the project, taking into consideration the potential environmental and social impacts.

Associated developments and projects cited in section 4.2 of this statement are not subject to the environmental and social impact assessment and review procedure. They are, however, mentioned in this impact statement to provide a better overall understanding of the project. As applicable, Hydro-Québec will see to it that all government approvals that may be required to carry out its project are obtained in a timely fashion.

2.6 Hydro-Québec's environmental policy

Hydro-Québec is committed to promoting the responsible use of resources and ensuring sustainable development. Through its environmental policy, the company sets out its commitment to the environment and its strategies surrounding the environment and public health and safety.

The Our Social Role policy sets out Hydro-Québec's commitment regarding its social role. The company defines itself as a responsible corporate citizen committed to making an effective contribution to the economic, social and cultural success of the society in which it carries out its activities.

In addition, Hydro-Québec implements the following internal directives and procedures:

- Environmental Management Systems (DIR-07). This guidance document sets out the company's requirements regarding the implementation and maintenance of an environmental management system (EMS). It clarifies and completes the requirements of the international standard ISO 14001:1996(F).
- Environmental acceptability and favorable reception of new projects, rehabilitation work, and operation and maintenance activities (DIR-21). This guidance stems from the commitments undertaken in the Our Environment and Our Social Role policies. It sets out criteria, elements and company requirements to promote the environmental acceptability of new structures, rehabilitation work, operations and maintenance activities.
- Requirements concerning the prevention and control of pollution and nuisances (DIR-22). This is a tool the company and its officers use to carry out the due diligence and strict environmental management required to prevent pollution and nuisances and minimize their effects.
- Procedure for accidental contaminant spills (PR-DPPSE-447-01). Under existing legislation and the Requirements concerning the prevention and control of pollution and nuisances (DIR-22), this guideline sets out rules and measures for mitigating the environmental impact of an accidental contaminant spill.

- Heritage and multiple uses of land and facilities (DIR-23). This directive sets out the rules to be followed and measures to be taken regarding heritage and multiple uses of land and facilities. Hydro-Québec ensures the protection and enhancement of its equipment, facilities and properties through means that may go beyond environmental impact management. The company incorporates the concept of multiple uses into the design of its new structures and facilities, and strives to ensure versatility in its rehabilitation projects and maintenance activities, while taking the host community's concerns into consideration.
- Audible noise generated by electrical substations (TET-ENV-N-CONT001). The proponent has developed various guidelines, including one that specifies audible noise criteria for substations beyond Hydro-Québec property limits and the conditions for applying these criteria.

Lastly, all requests for proposals issued by Hydro-Québec include Standard Environmental Clauses (SECs), which establish general mitigation measures for at-source reduction of the company's environmental impacts.

3 Public participation

3.1 Information and consultation process

Hydro-Québec implemented a consultation program focused on informing and consulting people impacted by the new thermal generating station project.

The overall objectives of this program are as follows:

- raise awareness of the project (description, justification, environmental benefits and schedule)
- identify the community's concerns regarding the project
- respond to and follow up on stakeholders' information needs

Between 2019 and 2021, Hydro-Québec held meetings with the Puvirnituq municipal council to present the project and inform them of developments.

However, due to COVID-19 and travel restrictions in the region, Hydro-Québec had to adjust its information and consultation process so that community members could safely participate. Thus, a meeting was held on community radio in December 2020.

3.2 Identification of stakeholders

Since the project is taking place within municipal boundaries and on Category III lands, Hydro-Québec must obtain both an authorization from the northern village of Puvirnituq and a temporary occupation licence from MERN to be present on the territory.

Community members, especially land users, are informed and consulted during the draft-design phase to allow them to express their concerns.

Lastly, the Kativik Regional Government (KRG) is also a stakeholder in the project, since it is offering technical support to the northern village, particularly with regard to land use.

3.3 Information and consultation activities conducted

Between 2019 and 2021, Hydro-Québec held four meetings with the Puvirnituq municipal council to present the project and inform them of developments. The first meeting took place on September 5, 2019, and the second on January 23, 2020. The third and fourth meetings were held by conference call on December 16, 2020, and February 24, 2021.

Hydro-Québec also presented the project to community members on December 11, 2020, during an information session on local radio. This information session was the subject of a document explaining the project and a questionnaire that was distributed to community members on January 11, 2021.

Information meeting of September 5, 2019

Hydro-Québec held a meeting with the municipal representatives to discuss the following points:

- Hydro-Québec presented the various projects it plans to carry out over the next few years and the space constraints it must take into account.
- Hydro-Québec mentioned its interest in moving all of its equipment and facilities to a new location and presented the potential sites that were already the subject of a preliminary study in 2010.

At the end of the meeting, the municipal council and Hydro-Québec agreed to continue discussions in order to find a site that is suitable to everyone.

Information meeting of January 23, 2020

A second meeting was held on January 23, 2020, with the Puvirnituq municipal council to discuss the following items:

- Hydro-Québec provided further details on the proposed new generating station in Puvirnituq and the two potential alternatives.
- Hydro-Québec stated that it wishes to carry out a renewable energy project in a second phase and that the choice of site for the new generating station is related to the nature of that project.
- At the end of the meeting, the municipal council and Hydro-Québec agreed on the choice of a site and a project.
- Given that quorum was not reached, the municipal council mentioned that it would adopt a resolution confirming the choice of the site and authorizing Hydro-Québec to conduct studies at a future meeting. However, Hydro-Québec was asked to submit a formal request.

On February 27, 2020, Hydro-Québec sent an official request to the mayor of Puvirnituq to formalize the choice of the site and to be authorized to carry out work there.

On June 19, 2020, the municipal council of Puvirnituq sent Hydro-Québec a resolution (Resolution No. 20-06-38) authorizing it to conduct surveys on the proposed site.

Public information meeting of December 11, 2020

Due to the COVID-19 pandemic, Hydro-Québec adjusted its community consultation process. It presented the project in detail on local radio, and, on January 11, 2021, submitted a summary document and short questionnaire to members of the community.

Key takeaways were as follows:

- Hydro-Québec presented the project in greater detail and asked community members to share their thoughts on land use in the sector of the new generating station, as well as their concerns regarding the construction and operation phases.
- Several community members mentioned that they use the site for community gatherings.

Information meeting of December 16, 2020

On December 16, 2020, Hydro-Québec held a third meeting, by conference call, with the Puvirnituq municipal council. Key takeaways were as follows:

- Hydro-Québec elaborated on the design and preliminary layout of the new generating station, its environmental benefits, the next steps, the results of the field survey program conducted in the summer of 2020 and its proposal to integrate Inuit art into the building's facade.
- The municipal council asked Hydro-Québec about the integration of Inuit art on the building facade, the budget allocated by Hydro-Québec and what it is anticipating in terms of participation.
- At the end of the meeting, Hydro-Québec and the municipal council agreed to continue discussions on the project at a meeting to be held in early 2021.

Information meeting of February 24, 2021

On February 24, 2021, Hydro-Québec and the Puvirnituq municipal council held a fourth meeting, by conference call. Key takeaways were as follows:

- Hydro-Québec provided feedback on the consultation and the concerns expressed by community members about the project.
- Hydro-Québec presented a mitigation measure proposal for the relocation of the gathering site and its contribution.

- Hydro-Québec detailed the process for integrating Inuit art into the facade of the generating station, as well as an example (work by a local artist reproduced on the facade, budget allocated, criteria, proposed involvement of the council in the decision).
- Hydro-Québec presented the next steps of the project as well as information on the integration of renewable energy.
- The municipal council asked Hydro-Québec to review certain elements of the process of integrating Inuit art into the building's facade, particularly with regard to the budget allocated to the artist.

On March 23, 2021, in light of the comments made by the Puvirnituq municipal council at the February 24 meeting, Hydro-Québec emailed the mayor of Puvirnituq a revised proposal for integrating Inuit art into the building facade.

This new proposal still calls for a local artist to prepare a sketch of the work that will be integrated into the building's facade. However, Hydro-Québec wishes to include the local artist in the project's development and integration process by offering the individual a service contract.

The municipal council of Puvirnituq accepted this proposal at the meeting of March 24, 2021. The next day, the mayor sent confirmation to Hydro-Québec.

3.4 Hydro-Québec's undertakings

Hydro-Québec has made a commitment to the community to:

- provide information on the progress of the project on an annual basis;
- create and develop the new community gathering place; and
- arrange in-person meetings or conference calls with community representatives.

4 Project description

4.1 Analysis of options

4.1.1 Site options

4.1.1.1 Potential sites

Hydro-Québec evaluated four potential sites for the construction of a new generating station. It has established a number of criteria based on its experience in the Far North.

Siting criteria

The technical siting criteria used to select potential sites are as follows:

- Favor proximity to a road that is cleared of snow at all times by the municipality to facilitate access.
- Avoid the airport area to comply with the 50-m maximum building height restriction within the 4-km peripheral zone around this infrastructure.
- Look for bedrock to avoid problems caused by permafrost.
- Look for an elevated space to facilitate drainage and avoid snow accumulation.
- Give preference to good exposure to prevailing winds in winter to minimize snow accumulation around the generating station.
- Look for the proximity of gravel borrow pits where possible.
- Allow sufficient space around the new generating station to serve as a buffer zone.

The environmental siting criteria are as follows:

- Avoid proximity with the built environment and aim for a distance of more than 500 m from any dwellings to avoid any noise nuisance or air pollution for residents.
- Avoid residential and recreational areas.
- Allow sufficient space around the new generating station to serve as a buffer zone in the event of expansion of the village.
- Avoid areas used for hunting and gathering activities.
- Avoid areas valued by the community for cultural or other reasons.
- Stay away from watercourses.
- Avoid wetlands.
- Avoid habitats of special-status wildlife species.

Description of potential sites

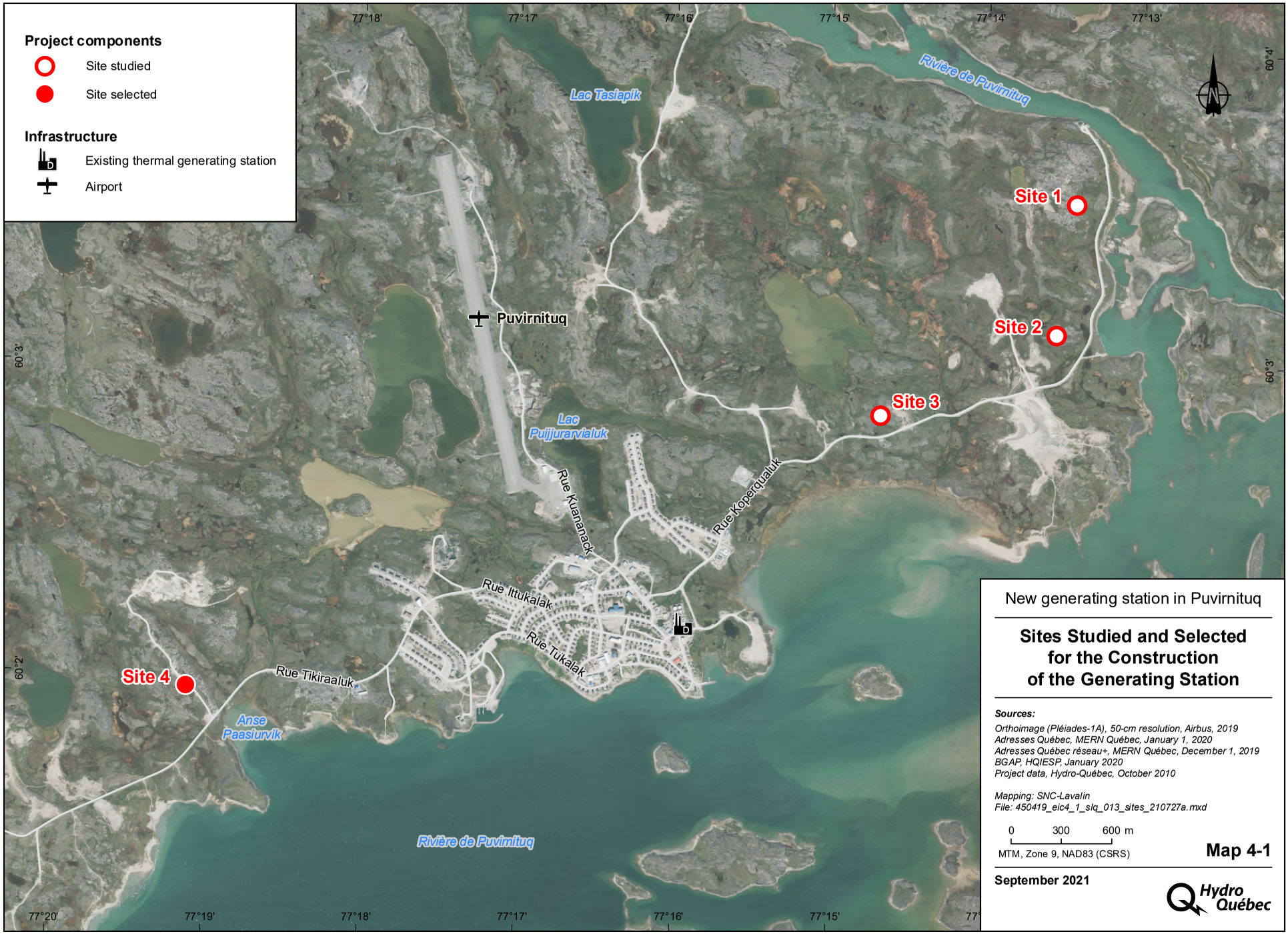
Four sites were preselected. The first three are located in the village's east end, along the road to the water pumping station, which is powered by a power line, and the fourth is located in the western part of the village, along the road to the dump, where there are no power lines. Map 4-1 shows where the sites are located and Table 4-1 compares their characteristics.

- Site 1 is 3.4 km from the nearest dwellings and 3.5 km from the airport, near the water pumping station and the road that runs along the Rivière de Puvirnituq. It is located on elevated land consisting of rock and moraine. No wetlands are present.
- Site 2 is located near the road, on bedrock slightly higher than the road. It is 2.9 km from the nearest dwellings and 3.1 km from the airport. Across the road, opposite this site, is an active gravel pit.
- Site 3 is an area disturbed by human activity, located 1.7 km from the nearest dwellings and 1.9 km from the airport. It contains backfill and rock. There is an access road, in poor condition but passable, running perpendicular to the road leading to it. Nearby, to the north, there is a road leading to borrow pits.
- Site 4 is located west of the village, 1.4 km from the dump, 1.7 km from dwellings and 2.5 km from the airport. The site has been reworked and is crossed by a road that leads to borrow pits. It consists of rock and backfill, and wetlands are found nearby.

Table 4-1: Potential Site Comparison Table

Criteria	Site 1	Site 2	Site 3	Site 4
Proximity to dwellings (in km)	2.9	2.3	1.2	1.3
Proximity to airport (in km)	3.5	3.1	1.9	2.5
Physical environment	Untouched nature	Proximity to a borrow pit	Disturbed environment	Disturbed environment
Soil type	Bedrock and moraine	Bedrock	Bedrock and backfill	Bedrock and backfill
Earthwork	Blasting and backfilling	Blasting	Backfilling	Blasting and backfilling
Power line	Present	Present	Present	Absent
Proximity of reservoirs (distance by road, in km)	4	3	1.7	3.2

Hydro-Québec and the Puvirnituq municipal council discussed potential sites in September 2019 and January 2020.



4.1.1.2 Selected site

In January 2020, a delegation from the Direction – Réseaux autonomes went to Puvirnituq to meet with the municipal council and agree on a site for the construction of the generating station. This meeting was a success: Site 4 was chosen by mutual agreement. The Puvirnituq municipal council then confirmed the choice of site by a resolution, which was sent to Hydro-Québec on June 19, 2020. This site meets Hydro-Québec's technical and environmental criteria and is suitable for the development of a wind farm near the generating station. In addition, this use is consistent with the council's urban development plans for the western part of the village. Hydro-Québec therefore took steps to obtain a temporary occupation licence from the government, which was issued by MERN on June 23, 2020. Located far from the village, the selected site facilitates the mitigation of impacts on community activities.

4.1.2 Technological options

For a thermal generating station project in Nunavik, there are limited technological options. The fuel type chosen is arctic diesel for logistical and supply reasons. The construction of a gas-fired generating station would require Hydro-Québec to take over supply and storage entirely, whereas in the village, tanks provide sufficient diesel fuel year-round.

Since the regulations require new EPA Tier 2 engines, which emit fewer contaminants, the choice of units was not examined.

To meet part of the building's energy demand, in addition to using rooftop solar panels, engine-heat recovery was chosen over a diesel heating system. The building will therefore not run on fossil fuels.

4.2 Project description

4.2.1 Site preparation

Location

The site of the new generating station is west of the village of Puvirnituq, at the following coordinates: latitude 60.034098°, longitude -77.321910°. Since it is located on Category III lands, Hydro-Québec requested and obtained official authorization from the community of Puvirnituq and a temporary occupation licence from MERN.

Site preparation

A platform will be built to accommodate the generating station, the substation, future worker housing and various equipment, including:

- two 75,000-L fuel tanks
- two shelters for future energy storage batteries
- a utility pole rack
- several 20-ft. shipping containers for storage
- three hazardous material recovery center (HMRC) containers
- a garage adjoining the generating station for lineworker equipment and SkyTrak lift truck
- sixteen 8-ft. x 10-ft. tables for storing distribution equipment

Generating station yard

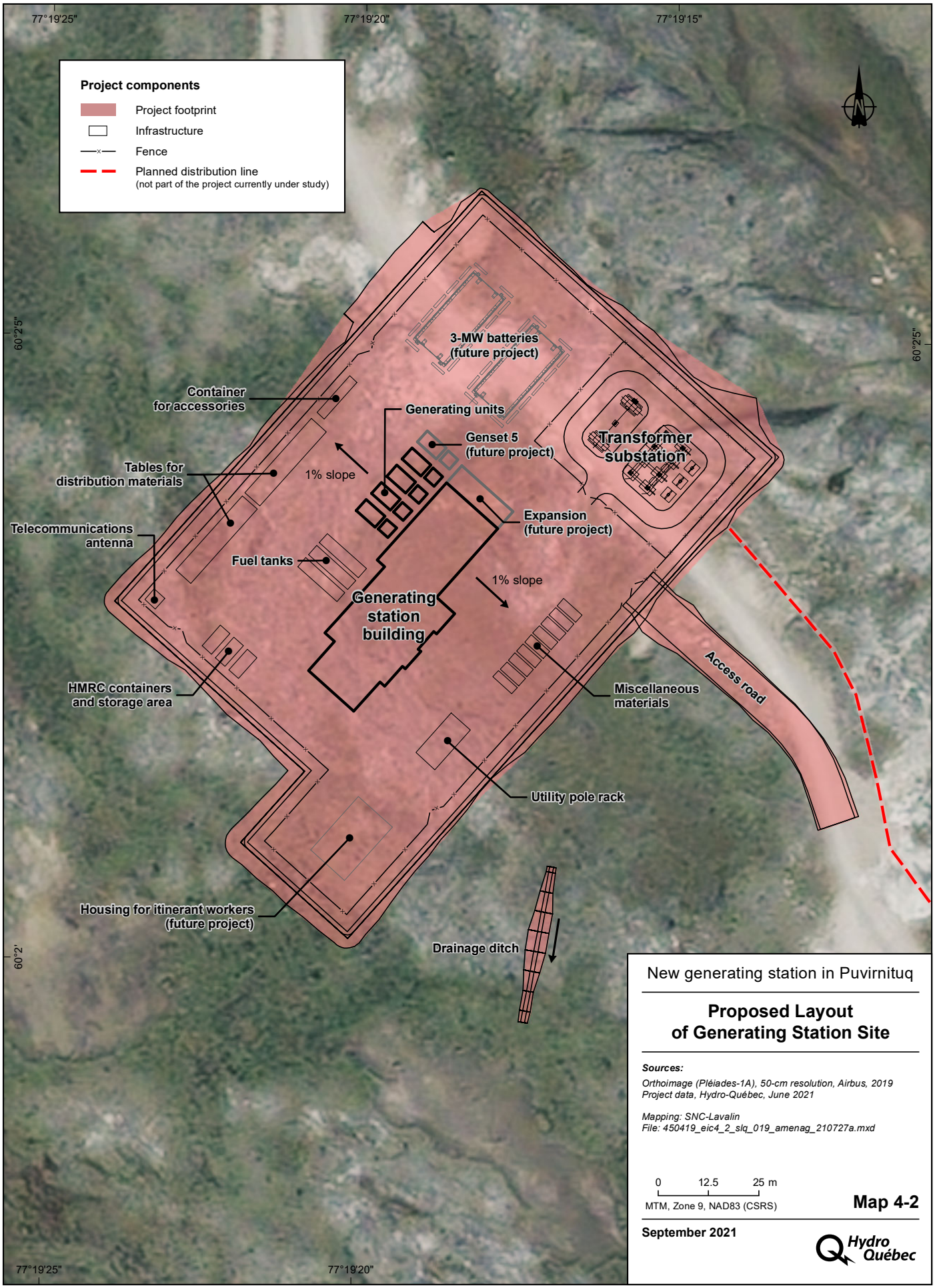
On the generating station site, a yard measuring about 158 m x 97 m, for a total area of about 15,000 m^2 (1.5 ha), will house the generating station, substation and related equipment and buildings.

A fence will be erected around the perimeter of the yard, 1 m from the top of the slope. An access gate will be installed at the main entrance, along with three others at strategic locations to facilitate snow removal.

Before fitting out the yard, approximately 633 m^3 of topsoil will have to be stripped and 2,047 m^3 of granular material cleared by blasting. Excavated material will be used in areas where non-frost-susceptible fill is not required, and the entire yard platform will be backfilled with MG112 granular materials (13,116 m^3). Subsequently, the yard structure will be built and backfilled with MG112 (4,255 m^3) and MG20b (4,163 m^3) granular materials. The average total thickness of granular materials overlying the natural soil will be approximately 1,400 mm.

On the periphery of the yard, the backfill will create an embankment with 2H:1V slopes protected by 675 m^3 of 200-0-mm stones on a thickness of 300 mm laid on geotextile.

The granular materials will come from borrow pits near the village of Puvirnituq.



New generating station in Puvirnituq

Proposed Layout of Generating Station Site

Sources:

Orthoimage (Pléiades-1A), 50-cm resolution, Airbus, 2019
Project data, Hydro-Québec, June 2021

Mapping: SNC-Lavalin
File: 450419_eic4_2_slq_019_amenag_210727a.mxd

0 12.5 25 m
MTM, Zone 9, NAD83 (CSRS)

Map 4-2

September 2021

Hydro Québec

Surface water drainage

Surface water from the new generating station yard will drain from the ±14.5-m-high point in the center of the yard to the periphery, at a 1% surface slope. Surface water from the northern part of the yard will flow primarily to the north, and surface water from the southern part to the south.

To prevent water from accumulating near the generating station site, two open ditches are planned, one at the northeast end of the site and the other to the south, between two wetlands, and earthwork will be carried out between the new access road ramp and the existing road.

4.2.2 Technical characteristics of the generating station

Generating station building

The building will have a surface area of approximately 1,055 m², and its foundations will consist of concrete slabs.

The building will consist of a steel structure assembled on site. The walls will be made of steel sandwich panels, which will serve as an interior finish, vapor barrier, insulation and air barrier. The roof will be made of, among other things, a two-component, elastomeric bitumen–based waterproofing membrane with composite reinforcement that will cover the insulation, lightly sloped toward drains. The height of the chimneys for each genset will be 12 m from the ground.

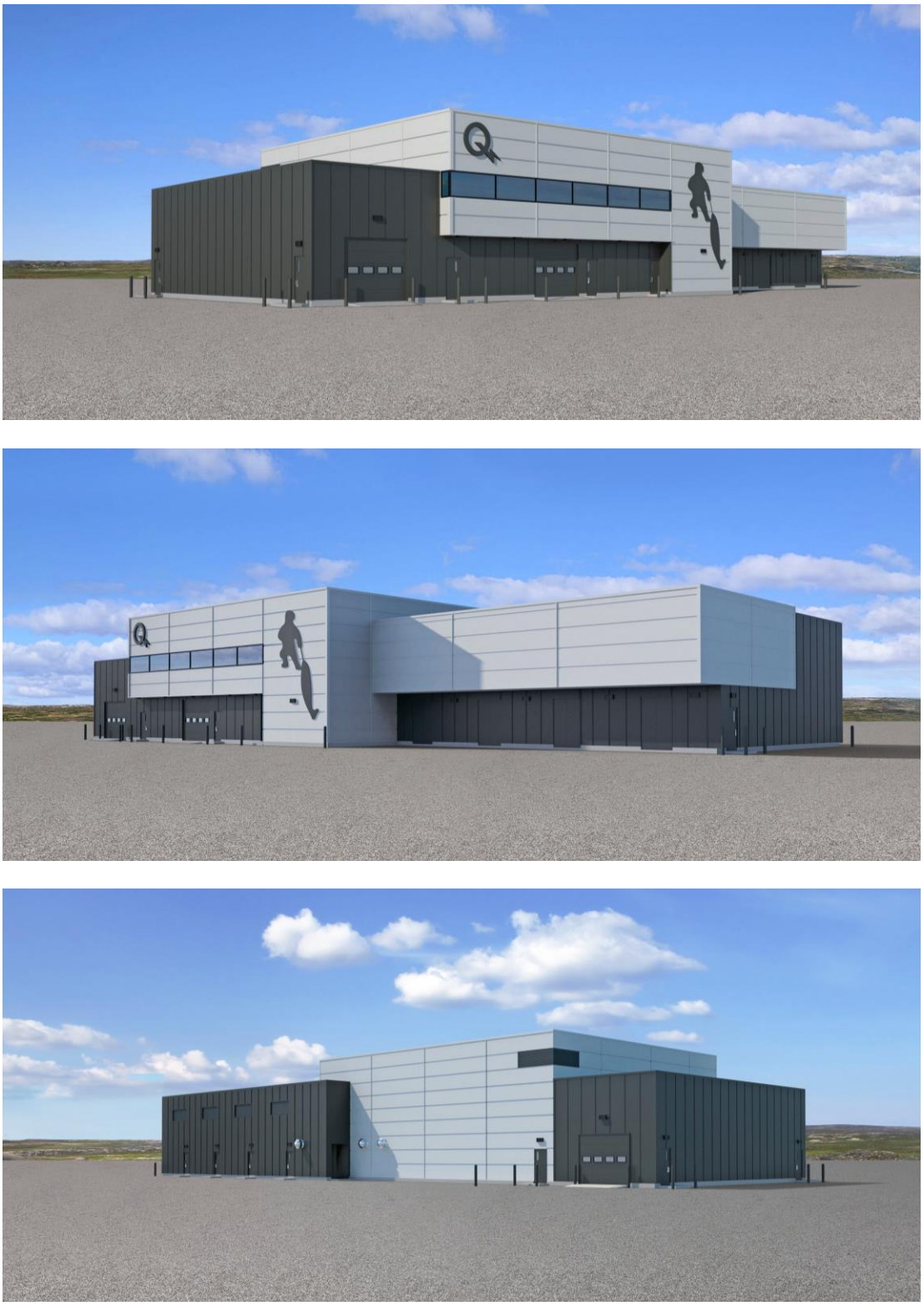
The machine hall will have four separate compartments, each of which will contain a generating set (genset), two overhead cranes for maintenance and repairs, a corridor, a pump room and tanks. A fifth genset may be added by expanding the generating station as demand grows.

The first floor will contain a workshop for mechanical repairs, a storage room for hazardous materials and residual hazardous materials, various discipline-specific storage locations and a loading dock. The second floor will house the control room, operators' offices, mechanical room and electrical room.

Lastly, a 140-m² garage for distribution equipment storage will be built onto the far end of the generating station.

The design concept will comply with applicable safety standards. The building will be given a civil protection classification under the Québec *Construction Code*, with a security level of 1. Figure 4.1 gives an overview of the generating station.

Figure 4-1: Model of Proposed Generating Station



Generating equipment

In this initial phase, the generating station will be equipped with four gensets, each in a separate compartment—two 1.86-MW and two 1.39-MW gensets—for a total installed capacity of 6.50 MW at commissioning. The two 1.39-MW gensets could be replaced with 1.86-MW units, which would bring the total installed capacity to 7.44 MW. The generating station yard will be designed to allow for the addition of another 1.86-MW genset to increase the capacity to 9.30 MW if required.

Poured-in-place concrete

Approximately 560 m^3 of concrete prepared from locally produced aggregate is expected to be used to build the foundation walls, footings, floor slabs and pilasters built into the foundation walls, as well as the bases of the supports and tanks.

4.2.3 Technical characteristics of the substation

The new 4/12-kV step-up substation will be built on the site of the generating station. The substation will occupy an area of 1,447.5 m^2, or 43.6 x 33.2 m. It will consist mainly of two three-phase, oil-insulated 4/12-kV transformers, two circuit breakers, four groups of three single-phase, epoxy-insulated 12-kV transformers, switchgear and various electrical equipment. All installed devices will be suitable for temperatures as low as -50°C.

The substation will have two feeder bays, with a third added when the planned wind farm is connected. At present, only the concrete bases and steel structure (column and beams) for this third feeder are scheduled to be built. The equipment and devices will be installed when the wind farm and the transmission line that will connect it to the substation are built.

4.2.4 Temporary facilities and infrastructure

During the construction phase, materials for the new generating station, including major components (gensets, control cubicles, radiators, etc.) will be shipped to the village via the commercial wharf on the west side of the village (see Map A, pocket insert), where barges will transport shipping containers and packaged materials. At the landing, wheel loaders handle the material to load the transport vehicles. The material will be transported to the work site by trailer trucks and wheel loaders via municipal roads. A material storage area will be provided on the work site. Depending on its needs, the contractor in charge of the work shall submit to Hydro-Québec, for approval, a layout plan for its work-site facilities, storage areas and roadways.

The local supplier will supply the equipment with fuel, transported by tanker.

Retention pits will be used only for the storage of wastewater from construction facilities. The municipality will empty them with a vacuum truck like it does for residences.

Once the work is completed, the sites used by the contractor for construction facilities, storage and roadways will be restored.

4.2.5 Housing and transport

Three work camps belonging to various owners already exist in the village. The contractor hired to do the work may, by agreement with the owner(s) concerned, use one or more of the existing camps to house approximately 35 workers.

4.2.6 Geotechnical surveys

From September 2 to 4, 2020, an outside business carried out geotechnical surveys in the limited study area to characterize the existing soil and determine the depth and nature of the bedrock to guide engineering for the positioning of the new generating station and the site preparation activities. A total of 22 observation wells were drilled using a hydraulic shovel rented from the municipality of Puvirnituq (with local operator).

4.2.7 Work methods

The following paragraphs describe the main construction activities.

Work-site preparation

This stage includes loading equipment on the boat and installing the contractor's work site. Once the contents of the vessel have arrived at the site, the contractor will proceed with the development of the temporary site for its construction facilities (construction trailers, storage containers, work camp if applicable, parking and storage areas, etc.).

Excavation and earthwork

The natural terrain will be stripped (633 m^3 of topsoil and 2,047 m^3 of rock) and layers of granular material will be laid (approximately 21,643 m^3 of backfill) to create the new yard platform (infrastructure, structure). This stage also includes the construction of open ditches for drainage. This work will be carried out using a variety of heavy equipment such as hydraulic shovels to excavate, dump trucks to transport granular materials, wheel loaders to load materials, and tracked bulldozers and compactors to deposit granular materials.

During the construction of the platform, approximately 2,047 m^3 of excavated material from the site will be blasted and reused to build the foundations for the generating station and substation.

Foundation work

The construction of the various foundations for the generating station, substation and satellite antenna will require excavation, formwork and concreting using hydraulic shovels, a telescopic forklift, a mobile concrete mixer and a compactor.

Substation

A telescopic forklift and a scissor lift will be needed to install the structures and components of the substation's electrical equipment.

Generating station

The construction of the generating station includes the following activities: construction of the structure, building envelope and interior architectural components; installation of the building's electrical and mechanical systems; telecommunications work; and installation of the major control equipment, electrical switchgear, and interior and exterior generation equipment (gensets, day and storage tanks, radiators, silencers, chimneys, etc.).

Final earthwork and fitting out of the yard

The laying of granular material for the road surface will complete the earthwork at the generating station site. The yard layout will provide the necessary space for the storage of the operator's materials (storage platform, pole rack, shipping containers, containers for storing used or new oil drums, containers for forklift accessories, etc.). This work will be carried out using tracked bulldozers, a compactor and a telescopic forklift.

Site restoration

Once construction is complete, a full site clean-up will be carried out, including the collection of all construction and other waste materials and their removal from the site. Hydro-Québec and the community of Puvirnituq will reach an agreement to determine what can be sent to the Puvirnituq landfill and what will be sent south. The entire work site will then be dismantled.

Clause 21 of Hydro-Québec's Standard Environmental Clauses (Hydro-Québec Innovation, équipement et services partagés, 2018; Appendix B) provides details of the interventions required for site restoration.

4.2.8 Labor

During the construction phase, an average of 19 workers will be required for the work. During the peak of construction, this number could rise to about 27, and occasionally even to 30. The workforce will come from various regions of Québec, depending on the contractor selected.

The work schedule at the work site is 10 hours per day, seven days per week, Monday to Sunday.

The following categories of workers are likely to be required:

- heavy equipment and hydraulic shovel operator
- truck driver
- lifting equipment operator
- carpenter-joiner
- assembler
- day laborer
- painter
- plasterer
- bricklayer
- electrician
- tinsmith
- pipefitter
- welder
- foreman
- superintendent
- project manager
- surveyor
- security guard
- housekeeper

Construction workers will need to have their competency certificate from the Commission de la construction du Québec.

4.2.9 Operation phase

Operating mode

There will be two phases in the thermal generating station's operation. The first is only one or two years after commissioning and consists of supplying the entire electrical load of the village by means of generating sets. The second phase will last for the remainder of the system's service life and will consist of powering the village using a combination of sources: wind turbines, gensets and batteries.

The construction of this modern thermal generating station will ensure the long-term reliability and efficiency of the electrical output of the Puvirnituq system. Despite wind energy's variability and intermittency, the design of this new infrastructure, with its stable and reliable energy supply, will provide the power system with the management capabilities required to maintain the stability of the various power flows from the sources associated with the combination of wind turbines, gensets and batteries.

The engine speeds of the gensets will vary throughout the day and the seasons according to needs.

The generating station will have four gensets. During phase 1, two out of four gensets will generally be used continuously, and only one will be used continuously during phase 2. Depending on exceptional network events, three or four gensets may be used sporadically during both phases.

Equipment will be maintained according to a plan based on manufacturer recommendations and Hydro-Québec's expertise, without interrupting service.

Tables 4-2 to 4-4 show the overall utilization of the gensets by phase of operation.

Table 4-2: Genset Use in Current Generating Station

Genset	Type	Capacity (kW)	Year (Commiss.)	Velocity (RPM)	Hours of Use
No. 1	LOW BSFC	600	1985	1,200	15,200
No. 2	LOW BSFC	1,135	1991	1,200	
No. 3	LOW BSFC	1,135	1991	1,200	
No. 4	LOW BSFC	1,880	2011	1,800	

Table 4-3: Genset Use in New Generating Station (Diesel Operating Mode)

Genset	Type	Capacity (kW)	Year (Commiss.)	Velocity (RPM)	Hours of Use
No. 1	EPA TIER 2	1,387	2026	1,200	14,200
No. 2	EPA TIER 2	1,861	2026	1,800	
No. 3	EPA TIER 2	1,861	2026	1,800	
No. 4	EPA TIER 2	1,387	2026	1,200	

Table 4-4: Genset Use in New Generating Station (Wind-Diesel-Battery Operating Mode)

Genset	Type	Capacity (kW)	Year (Commiss.)	Velocity (RPM)	Hours of Use
No. 1	EPA TIER 2	1,387	2026	1,200	9,000
No. 2	EPA TIER 2	1,861	2026	1,800	
No. 3	EPA TIER 2	1,861	2026	1,800	
No. 4	EPA TIER 2	1,387	2026	1,200	

Fuel supply

Hydro-Québec and the Fédération des coopératives du Nouveau-Québec (FCNQ) will sign a fuel-supply contract, and fuel transportation and storage will remain under the responsibility of Halutik Enterprises. Fuel will be delivered to the new generating station by tanker trucks from the Puvirnituq oil depot. An 8.5-day supply of fuel is expected to be available at the generating station site, stored in outdoor tanks. There should be an average of seven fuel deliveries per week.

The diesel storage system at the generating station site consists primarily of a fuel depot with at least two CAN/ULC-S653-compliant 75,000-L storage tanks with containment basins capable of holding at least 110% of the nominal volume, two transfer pumps, two multi-cartridge filter units and a mass flowmeter. The fuel depot is used to store diesel for continuous supply to the generating station engines.

A metering system (mass flowmeter) will be installed on the storage tanks to detect leaks and monitor fuel consumption. Tanks will be CAN/ULC-S653-certified (latest edition) and meet the criteria outlined in the technical specifications.

The monitoring of the level of the outdoor tanks will make it possible to validate, in real time, the integrity of the tanks. An unexplained 2% drop in level (when the automatic valve is closed) will trigger an alarm and the complete shutdown of generation at the station. In this case, the operator present at the scene will respond quickly.

The storage tanks will be filled by tanker trucks using a filling nozzle located on top of the tanks. A proximity indicator will indicate to the shared services controller that fuelling is in progress so that it can take into account, in its inventory monitoring, a possible transfer of fuel to the day tank.

Labor

The operation phase of the generating station will not generate additional jobs. It will be operated by the two employees who already operate the existing generating station and who are residents of Puvirnituq. Specialized employees from outside the village will perform maintenance according to pre-established schedules or in case of outages or breakdowns.

4.3 Developments and related projects

4.3.1 Access road

An access road connecting an old sand pit to Rue Tikiraaluk already crosses the site chosen for the future generating station. It will be reused over a distance of about 450 m.

This road already has a solid infrastructure and does not cross any watercourses. It will be made 7-m wide over a distance of about 450 m, and the curve and difference in elevation will be corrected. The total thickness of the granular structure will be 600 mm, which will require approximately 1,200 m^3 of backfill. The roadside slopes will be protected with approximately 86 m^3 of 200-0-mm stone, 300-mm thick, placed on a geotextile. The construction of the access road will not involve any excavation or blasting.

4.3.2 Borrow pit preparation

No new borrow pits are expected to be opened. Instead, Hydro-Québec intends to draw supplies from borrow pits already in operation, although these have not yet been identified. The supply of granular materials will be the subject of a call for tenders, after which one or more suppliers will be selected and will be responsible for obtaining the authorizations required to operate borrow pits. The location of the selected borrow pits and volumes drawn from each will therefore depend on the supply strategy retained later.

4.3.3 Distribution lines

The new generating station will be connected to the distribution system by two 12-kV lines approximately 1.5-km long. The two lines will be mounted on wooden poles and will follow Rue Tikiraaluk from the station to Rue Amarualik (see Map A, pocket insert).

4.3.4 Dismantling the decommissioned generating station

The existing generating station will be dismantled and the site rehabilitated after the new generating station is commissioned, in 2026. However, this project has not begun, and Hydro-Québec does not know, at the time of publication of this document, what will happen to the site once the building has been dismantled. Table 4-5 shows the major steps in the decommissioning.

Table 4-5: Sequence of Activities for the Dismantling of the Existing Generating Station and Environmental Rehabilitation of the Site

Step	Activity	Planned Date
1	Dismantle the existing generating station	2027
2	Conduct the environmental characterization of the site	2028
3	Carry out the environmental rehabilitation of the site	2029

4.4 Hazardous and residual waste

4.4.1 Waste materials

During the construction phase

Based on the experience gained in the construction of the most recent generating stations of this type, it is estimated that 300 m^3 of construction waste (wood, mineral wool, drywall, metal, etc.) will be generated by the work. A more precise volume can be provided at the detailed engineering stage, once the building type and construction methods have been confirmed.

Discussions have already been held with the municipality of Puvirnituq regarding the use of northern landfill sites during the work. A follow-up with the municipality is also planned before the project begins. Should the site not have sufficient capacity to handle the waste generated by the construction of the new generating station, some or all of the waste can be shipped south for disposal at an authorized site.

During the operation phase

In the operation phase, waste materials (mainly domestic waste) will be managed in the same way that it is at the current generating station, that is, the municipality will manage it, as is the case for the other buildings in the village, and will send the materials to the northern landfill. Although there is no recyclable waste collection in Puvirnituq, Hydro-Québec recycles plastic bottles, printing paper and ink cartridges at its work sites.

4.4.2 Residual hazardous materials

During the construction phase

It is estimated that the construction of the thermal generating station will generate approximately 325 m^3 of residual hazardous materials (RHMs). They will be collected and stored in rail containers, then transported twice a year to MELCC-authorized treatment facilities in southern Québec.

During the operation phase

In the operation phase, the RHMs generated will mainly come from the operation and maintenance of the generating station's equipment, particularly aerosols (degreasing, painting, cleaning, lubrication and insecticide products), empty containers (epoxy, coating, paint, thinner) and distillates (Varsol). They will be sorted and stored on the generating station site according to their format, either in drums or in metal cabinets or other types of containers depending on the material. RHMs will be stored in drums (e.g. oil drums) and placed in the rail containers for a maximum of 24 months. If storage is to extend beyond 24 months, authorization from MELCC will be sought for temporary outdoor storage of solid RHMs. Containers of RHMs will be shipped to hazardous material recovery centers (HMRCs) in the southern part of the province (Saint-Hyacinthe) for storage until they are picked up by the companies responsible for processing them. It is estimated that the amount of RHM generated by the new, operational generating station will be the same as that of the existing generating station. Table 4-6 presents the types and quantities of RHMs generated during the operation phase.

Table 4-6: Types and Quantities of RHMs Generated During Operation Phase

RHM Type	Quantity Generated Per Year
Antifreeze	1 to 3 barrels [a]
Dry cells	1 to 3 buckets [b]
Fluorescent tubes[c]	1 to 2 containers
Oil filters	4 to 8 barrels
Aerosols	1 to 3 barrels
Solids containing unspecified flammable liquid (porous materials and filters)	4 to 8 barrels
Empty, uncleaned packaging waste	1 to 4 barrels
Batteries, wet, filled with acid, electric storage	1 to 3 buckets
Batteries, wet, non-spillable, electric storage	1 to 5 buckets
Petroleum distillates or products	4 to 8 barrels

a. The volume of a barrel is 208 L.
b. The volume of a bucket is 20 L.
c. Fluorescent tubes will be gradually replaced with LED fluorescent tubes. This type of hazardous residual material will therefore be less and less common.

Appendix C presents the method of disposal of RHMs likely to be generated during the construction or operation phases of the new Puvirnituq thermal generating station.

4.5 Schedule

For each phase of the new thermal generating station project in Puvirnituq, government approvals, detailed engineering, procurement, construction and commissioning have been planned (Table 4-7).

Table 4-7: Project Timeline

Activity	Period
Detailed engineering	Summer 2021 to winter 2022–2023
Government approvals	Fall 2021 to spring 2023
Major material procurement	Summer 2021 to winter 2023–2024
Production, piling of granular material, earthwork	Summer 2023 to fall 2023
Construction of the generating station	Spring 2024 to December 2025
Commissioning of the generating station	February 2026

Construction will take two-and-a-half years, and the generating station is expected to be commissioned in February 2026 after a start-up period of a few months.

The generating station is expected to have a 50-year service life.

4.6 Project costs and local and regional economic spinoffs

The cost of the project is roughly estimated at $85 million. It will generate local economic spinoffs only during the construction phase. During the operation phase, the economic spinoffs will be the same as with the current situation. Hydro-Québec has provided for incentives for hiring local Inuit workers and subcontractors based in Puvirnituq. In addition to these incentives, the local spinoffs will include air transportation for personnel, housing, food purchases from village businesses, fuel purchases for equipment and local machinery rentals.

5 Description of the environment

5.1 Extended study area

The extended study area for the new generating station project covers 2,549.2 ha (see Map 5-1). It is located in the Nord-du-Québec administrative region, more specifically in the territory of Nunavik (north of the 55th parallel). It includes part of the northern village (NV) of Puvirnituq, located on the eastern shore of Baie d'Hudson (Hudson Bay). The extended study area was delimited to include the future generating station, the inhabited part of the village and the main existing infrastructures, and to exclude the marine area since no impact is anticipated.

The extended study area makes it possible to identify the various components of the environment potentially affected by the project in a more regional context. It is used to describe the components of the natural and human environments in broad terms.

5.2 Limited study area

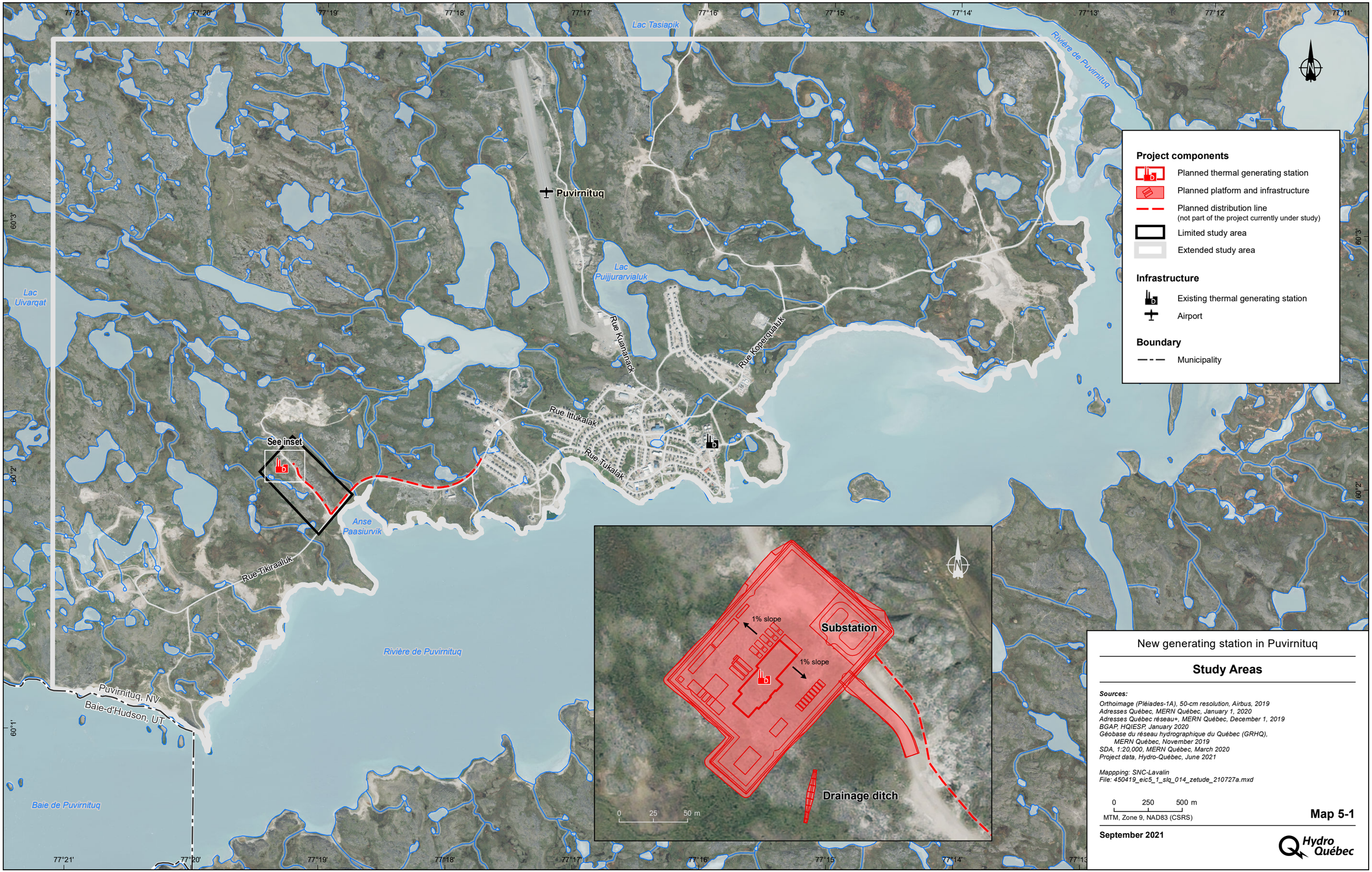
The 22.8-ha limited study area is located west of the urbanized area of Puvirnituq. It is bounded to the south by the access road to the village landfill, Rue Tikiraaluk, and overlaps to the north with the access road to a former extraction site (see Map 5-2). The limited study area is used to describe the components of the physical and biological environments that are more directly affected by the project. Where necessary, the current status of the components affected by the project are specifically described in Chapter 6 of this report.

5.3 Methodology

The description of the environment is based on various sources of information from different agencies and departments including:

- Base de données topographiques et administratives (BDTA)
- Centre de données sur le patrimoine naturel du Québec (CDPNQ)
- Hydro-Québec
- Québec, Ministère de la Culture et des Communications (MCC)
- Québec, Ministère de l'Énergie et des Ressources naturelles (MERN)
- Québec, Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC)
- Environment and Climate Change Canada (ECCC)
- NAV CANADA
- Kativik Regional Government (KRG)

The first step was to analyze the information to determine the presence of sensitive features that could be affected by the project activities. Field surveys were also conducted to identify these sensitive features and to analyze the impacts. Plant and wildlife surveys were conducted within the limited study area, and the analysis of the environment components focused on the extended study area. The specific methods and protocols used for the plant and wildlife surveys and for collecting data from the Inuit community are discussed in separate sections pertaining to these topics.



New generating station in Puvirnituq

Study Areas

Sources:

Orthoimage (Pléiades-1A), 50-cm resolution, Airbus, 2019
Adresses Québec, MERN Québec, January 1, 2020
Adresses Québec réseau+, MERN Québec, December 1, 2019
BGAP, HQIESP, January 2020
Géobase du réseau hydrographique du Québec (GRHQ), MERN Québec, November 2019
SDA, 1:20,000, MERN Québec, March 2020
Project data, Hydro-Québec, June 2021

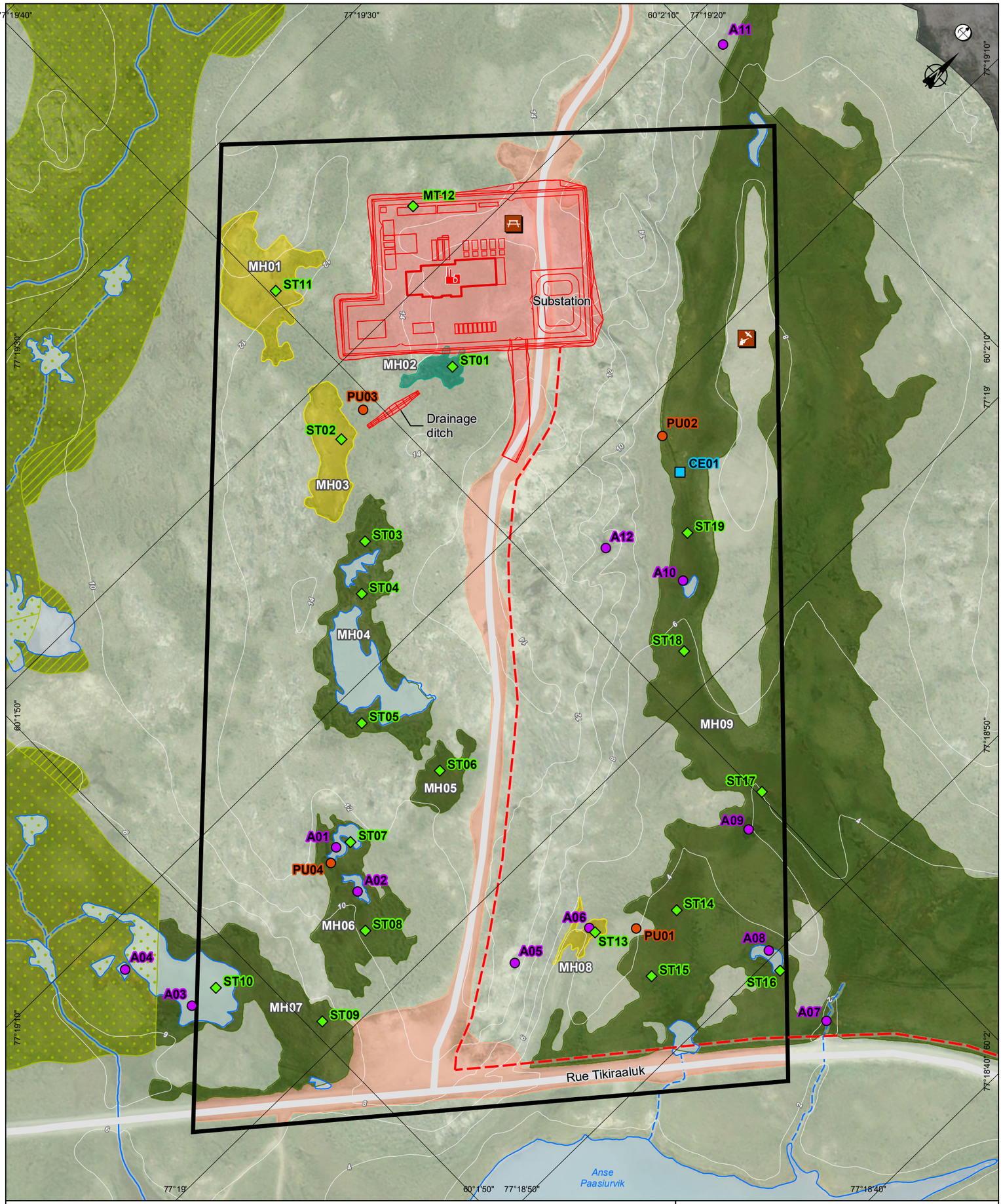
Mappping: SNC-Lavalin
File: 450419_eic5_1_slq_014_zetude_210727a.mxd

0 250 500 m
MTM, Zone 9, NAD83 (CSRS)

Map 5-1

September 2021

Hydro Québec



Hydrography

- Perennial watercourse
- Indeterminate watercourse
- Water body

Terrestrial environment

- Shrub tundra

Wetlands

Potential wetlands

- Undefined fen (Cartographie des milieux humides potentiels du Québec, MELCC Québec, November 2019)
- Undefined fen (Base de données des villages autochtones [BDVA], 1:2,000, MRN Québec, April 2013)

Characterized wetlands (2020)

- Open fen
- Shrub swamp
- Marsh

Biological surveys (2020)

- CE01 Watercourse characterization station
- ST01 Wetland characterization station
- PU01 Bird point-count location
- A01 Amphibian inventory station

Human environment

- Active or abandoned mining site
- Other disturbed environment

Land use

- Gathering place
- Waterfowl hunting area

Project components

- Planned thermal generating station
- Planned platform and infrastructure
- Planned distribution line (not part of the project currently under study)
- Limited study area

New generating station in Puvirnituq

Biophysical and Human Environments Limited Study Area

Sources:

Orthoimage (Pléiades-1A), 50-cm resolution, Airbus, 2019
Adresses Québec, MERN Québec, January 1, 2020
BDVA, 1:2,000, MRN Québec, April 2013
Cartographie des milieux humides potentiels du Québec, MELCC, November 2019
Végétation du Nord québécois, MFFP Québec, May 2020
Project data, Hydro-Québec, June 2021

Mapping: SNC-Lavalin
File: 450419_eic5_2_slq_006_mnh_zrestreinte_210727a.mxd

0 25 50 m
MTM, Zone 9, NAD83 (CSRS)
Contour interval: 2 m

Map 5-2

September 2021

Hydro Québec

5.4 Physical environment

5.4.1 Climate

A weather station is located at the Puvirnituq airport (see Map A, pocket insert). However, according to ECCC (Government of Canada, 2019a), only historical weather data is available for this area. The comprehensive weather data available closest to Puvirnituq is from the Kuujjuaq station. Kuujjuaq, however, is located approximately 550 km to the east and is characterized by a polar climate with moderate precipitation and a very short growing season: its climatic conditions are not considered representative of those in Puvirnituq. Puvirnituq is characterized by a semi-arid polar climate with a very short growing season (Gerardin and McKenny, 2001):

- Mean annual temperature varying from −9.4°C to −6.0°C
- Annual precipitation between 250 mm and 469 mm
- Growing season of 90 to 199 days per year

For wind conditions, hourly records from the Puvirnituq airport station were analyzed. Over the past few decades, ECCC and NAV CANADA have set up several weather stations and observation programs. The hourly wind records from station 7109223, operated at the airport by NAV CANADA since January 2014, are the most comprehensive. Annual and seasonal wind roses for the full years of data (2015–2019) are presented in Figures 5-1 and 5-2. On an annual basis, winds are slightly more likely to come from the east-northeast, the east and the south, but no one direction is really dominant. North and north-northeast winds are the least frequent. Calm winds are rare (less than 1%). Due to the low surface roughness at this latitude, the average wind speed at 10 m above ground (22.8 km/h) is much higher than in southern Québec. The seasonal wind roses (Figure 5-2) show differences between seasons, with southerly winds predominating in winter and west-northwesterly winds in summer.

Figure 5-1: Annual Wind Rose at the Puvirnituq Airport

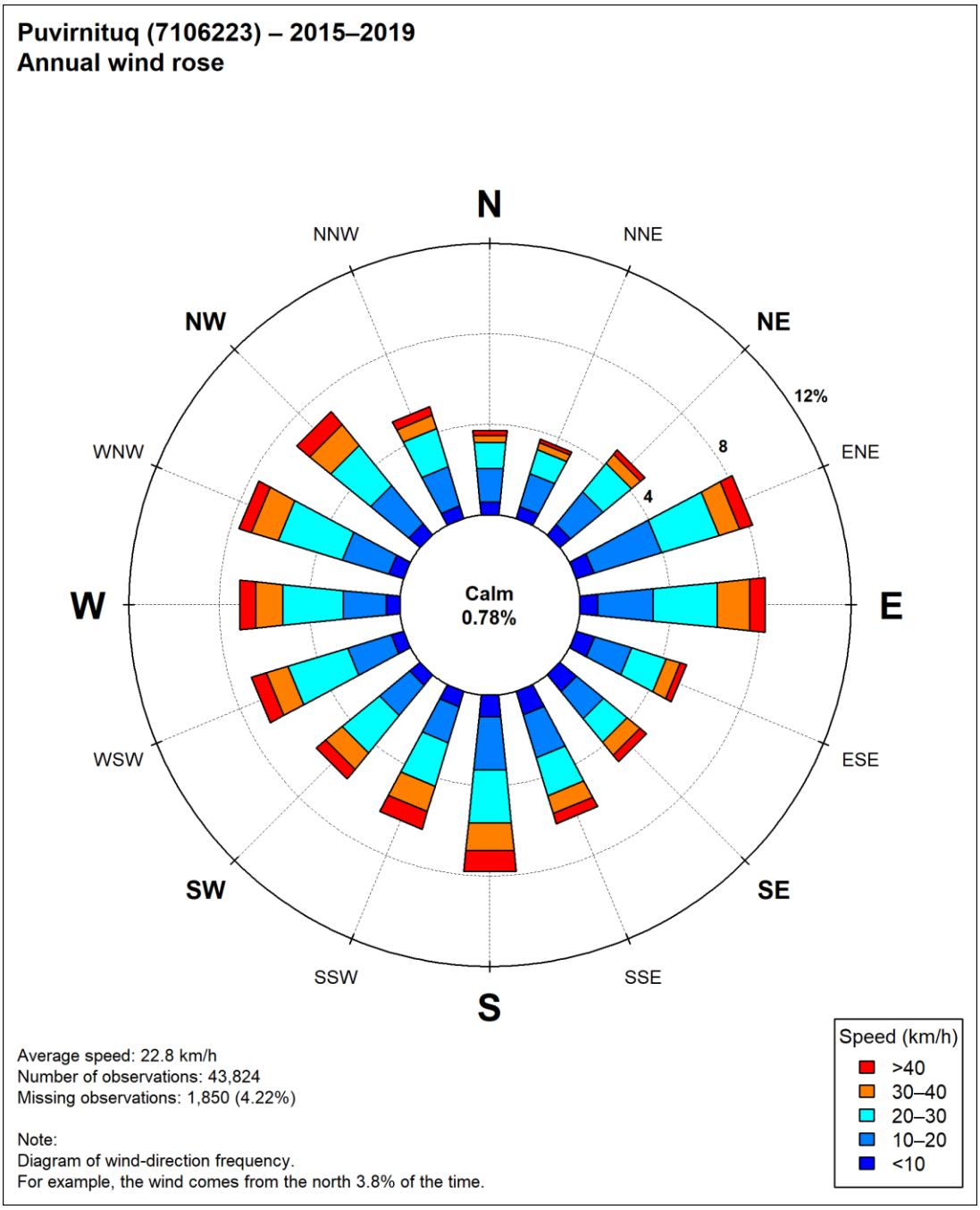
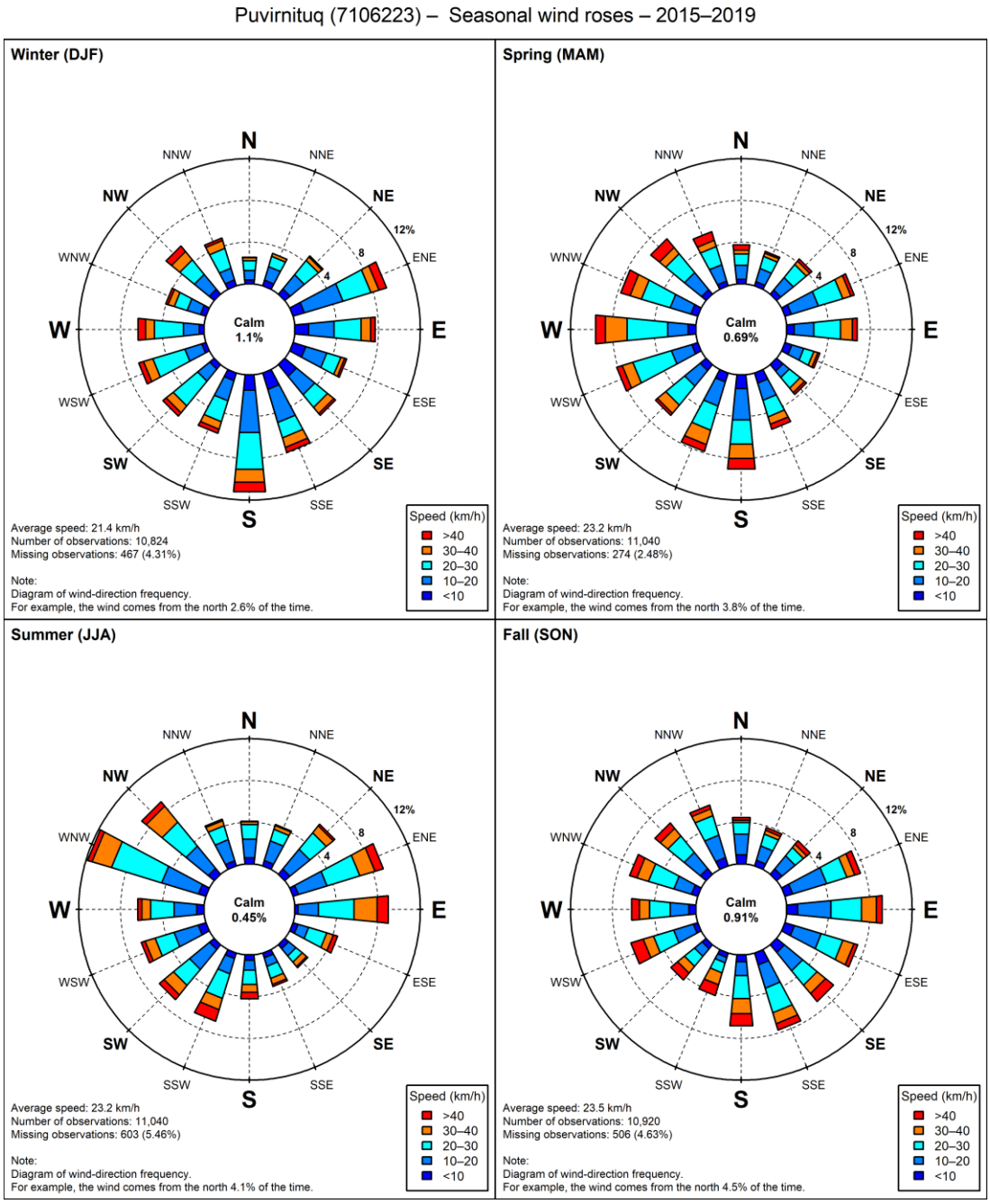


Figure 5-2: Seasonal Wind Roses at the Puvirnituq Airport



5.4.2 Climate change

The following section is a summary from a study conducted as part of this project on climate change resilience analysis (WSP, 2021). All relevant references can also be found in this study.

Between 1987 and 2016, the Baie d'Hudson region experienced a 1.5°C increase in mean winter temperature and a 0.5°C increase in mean summer temperature per decade, making it one of the fastest-warming regions in the world. Since the 1950s, annual precipitation has increased by 3% per decade (Hachem and Bleau, 2020).

Permafrost thawing

According to the revised map of susceptibility to ground subsidence associated with thawing permafrost of the Ministère des Forêts, de la Faune et des Parcs (MFFP) du Québec (2019), Puvirnituq is located in an area considered to be highly susceptible to this hazard, since it has continuous permafrost. Historical data indicate that permafrost has warmed by 0.7–1.0°C per decade in Nunavut (Derksen et al., 2019).

Coastal flooding

Most areas of the Canadian Arctic, including the Baie-James region, are currently undergoing isostatic rebound due primarily to melting glaciers that are reducing the vertical pressure on the ground. In some places in Baie-James, this rebound is among the highest in the world. At Puvirnituq, it was on the order of 0.89 cm per year during the historical period (from about 1,500 to 1,900). This phenomenon is expected to continue for at least another millennium (Hashem and Bleau, 2020).

Snow accumulation

Table 5-1 shows the evolution of solid precipitation under the influence of climate change at Puvirnituq. On average, its annual quantity will remain relatively stable under any scenario. But a redistribution is likely, involving a decrease in fall (due to higher temperatures) and an increase in winter.

Table 5-1: Projections of Climate Indicators Related to Snow Accumulation

Climate indicator	Historical value (recent past)	Short-term horizon		Long-term horizon		Trend
		Active scenario	Passive scenario	Active scenario	Passive scenario	
Total annual solid precipitation (mm)	192	209 [197; 211]	209 [198; 221]	208 [200; 226]	209 [177; 248]	↑
Total winter solid precipitation (mm)	69	86 [77; 97]	98 [83; 106]	93 [84; 105]	110 [98; 133]	↑
Snow load variation, recurrence period 1:50	N/A	−1.0%	−1.4%	−1.4%	−2.6%	↓

Source: Cannon et al. (2020), Ouranos (2020).

Strong winds and thunderstorm activity

With increasingly rising temperatures in all seasons, fall-specific atmospheric instability conditions, which are known to be difficult (high frequency of fog, freezing rain, high winds, etc.), could worsen and extend into January or February, and even March towards the end of the 21st century (Hachem and Bleau, 2020). In keeping with this trend, according to Cheng et al. (2014), the Puvirnituq area will also see a net increase in wind gusts over 90 km/h, up to 70% in the most pessimistic case (Table 5-2).

Table 5-2: Gust frequency projections

Climate indicator	Historical value (recent past)	Short-term horizon		Long-term horizon		Trend
		Active scenario	Passive scenario	Active scenario	Passive scenario	
Frequency of gusts over 90 km/h	6 in 5 years	+15% [0; 40]	+20% [−10; +45]	+20% [−10; +50]	+30% [−5; +70]	↑

Source: Cheng et al. (2014), CRIM (2021).

General temperature increase

Northern Québec is one of the regions of the world most affected by temperature increases because of its high latitude, which leads to a strong influence of polar amplification. Although temperatures tend to increase considerably in all seasons, the number of days with a maximum temperature above 30°C would remain close to zero. However, over the long term, such extreme events could occur as often as every other year (Table 5-3).

Table 5-3: Projections of Climate Indicators Related to General Temperature Increase

Climate indicator	Historical value (recent past)	Short-term horizon		Long-term horizon		Trend
		Active scenario	Passive scenario	Active scenario	Passive scenario	
Average annual temperature (°C)	−6.5	−3.8 [−4.5; −2.4]	−2.3 [−3.7; −1.2]	−2.8 [−4.4; −1.6]	0.7 [−2.2; 8.6]	↑
Average summer temperature (°C)	8.0	9.7 [8.7; 11.1]	10.5 [9.3; 12.2]	10.1 [8.9; 11.7]	12.7 [10.6; 15.4]	↑
Average winter temperature (°C)	−21.8	−17.2 [−18.3; −14.5]	−14.6 [−16.9; −12.5]	−15.4 [−17.9; −12.9]	−9.5 [−15.2; −6.3]	↑
Average maximum temperature in summer (°C)	11.7	13.3 [12.3; 14.9]	14.1 [12.7; 15.9]	13.6 [12.5; 15.4]	16.3 [14.0; 19.3]	↑
Average minimum temperature in winter (°C)	−25.3	−20.6 [−21.7; −18.1]	−18.0 [−20.0; −15.5]	−18.7 [−21.2; −15.8]	−12.7 [−18.2; −8.6]	
30-year cold record (°C)	−42.3	−35.7 [−39.9; −32.9]	−35.0 [−39.3; −31.6]	−33.9 [−38.9; −30.0]	−27.2 [−31.6; −21.7]	↑
Number of extremely cold days over 30 years (minimum temperature below −40°C)	5.88	0.06 [0.00; 2.00]	0.06 [0.00; 2.00]	0.12 [0.00; 4.00]	0.00 [0.00; 0.00]	↓
Number of very hot days (>30°C)	0.00	0.00 [0.00; 0.00]	0.00 [0.00; 0.00]	0.00 [0.00; 0.00]	0.03 [0.00; 0.53]	=
Number of cooling degree-days	0.0	0.1 [0.0; 7.5]	0.5 [0.0; 10.9]	1.0 [0.0; 14.3]	13.3 [0.7; 71.8]	↑
Number of heating degree-days	8,954	7,786 [7,013; 8,372]	7,316 [6,495; 7,920]	7,435 [6,533; 8,094]	6,163 [5,025; 6,994]	↓
Annual number of freeze-thaw cycles	57.7	51.2 [45.7; 59.1]	46.8 [42.2; 65.6]	48.5 [39.0; 65.3]	44.3 [38.0; 85.3]	↓
Number of winter freeze-thaw cycles	0.2	0.7 [0.1; 1.9]	1.0 [0.4; 4.9]	0.8 [0.1; 4.7]	3.9 [0.4; 17.9]	↑
Number of summer freeze-thaw cycles	11.2	5.5 [2.4; 7.3]	3.9 [1.6; 6.1]	3.9 [1.9; 6.2]	0.7 [0.1; 1.6]	↓

Source: Ouranos (2020); CRIM (2021).

Extreme liquid precipitation

The overall increase in average precipitation is already accompanied by an increase in the intensity and frequency of extreme precipitation events, which will continue to increase (Table 5-4). Climate projections of intensity-duration-frequency (IDF) curves should still be used with caution, due to the large uncertainties inherent in the statistical methods used, and the lack of good historical data in northern regions (Simonovic et al., 2016).

Table 5-4: Projections of Climate Indicators Related to Extreme Liquid Precipitation

Climate indicator	Historical value (recent past)	Short-term horizon		Long-term horizon		Trend
		Active scenario	Passive scenario	Active scenario	Passive scenario	
15-min IDF curve, return period 1:50 (mm)	12.69	16.55 [14.58; 19.36]	18.88 [16.77; 21.57]	17.64 [14.66; 18.65]	18.81 [16.36; 21.34]	↑
24-h IDF curve, return period 1:50 (mm)	57.76	69.80 [62.02; 80.06]	76.44 [66.28; 88.99]	74.00 [65.02; 81.08]	80.28 [72.36; 95.80]	↑
24-h IDF curve, return period 1:100 (mm)	63.26	77.99 [69.68; 94.30]	86.33 [73.10; 103.69]	86.09 [69.82; 94.14]	95.61 [80.96; 111.20]	↑

Source: Western University (2021).

5.4.3 Geology, geomorphology and surface deposits

The extended study area is part of the Péninsule d'Ungava natural province. The Péninsule d'Ungava is a large, gently undulating plateau sloping to the west. The altitude increases slightly from Baie d'Hudson and rarely exceeds 400 m (Li et al., 2019). In the extended study area, elevations range from 0 m to 30 m. More locally, the elevation of the land at the site selected for the generation station is approximately 10 m.

The extended study area is located in the Superior geological province, which occupies the central part of the Canadian Shield. The Superior province is largely composed of Neoarchean rocks, some of which are the oldest on Earth. The northern sector belongs to the Minto subprovince, which has significant units of charnockitic rocks (MERN, 2020).

Puvirnituq is located on bedrock covered with reworked till or emergent shoreline deposits. Bedrock and deposits form low, rather flat ridges with boulder fields and wetlands in between (Allard et al., 2007). In the Puvirnituq region, permafrost is continuous and generally thicker than 150 m (Allard and Séguin, 1987). Due to anticipated climate change in Nunavik, thawing permafrost could affect the environment and infrastructure. In the Puvirnituq region, the level of susceptibility to ground subsidence associated with permafrost thaw is considered high (MFFP, 2019).

During a geotechnical study on the site of the proposed generating station, the 22 exploration wells drilled confirmed the presence of surface rock over the entire site. Good quality bedrock was encountered at depths ranging from 0.38 m to 1.51 m. All exploration wells were drilled in a till deposit consisting of mostly sand and gravel with trace gravel, ranging from silt to silty. Under a thin layer of organic soil, the thickness of the deposits varied from 0.28 m to 1.46 m (Englobe, 2020).

5.4.4 Soils

A few contaminated sites were identified in the extended study area. The Treasury Board of Canada Secretariat reports the presence of two contaminated sites (TBS, 2019), while five sites with contaminated soil or groundwater are recorded in the MELCC Répertoire des terrains contaminés [inventory of contaminated lands] (2019). Table 5-2 provides a brief description of these contaminated sites, and Map A (pocket insert) shows their locations.

Table 5-5: Contaminated Sites Identified in the Extended Study Area.

Site	Location	Contamination type	Contaminant	Site rehabilitation	Source	Distance from the proposed thermal generating station (km)
Existing Puvirnituq thermal generating station	Existing Puvirnituq thermal generating station	Soil	Polycyclic aromatic hydrocarbons, C10 to C50 petroleum hydrocarbons	Completed in 2010	Inventory of contaminated lands	2.9
FCNQ fuel depot	FCNQ fuel depot	Soil	Petroleum hydrocarbons C10 to C50	Not completed	Inventory of contaminated lands	2.9
Povungnituk No. 2 – day beacon, posterior	Near the wastewater treatment pond	Suspected	Not available	Not available	Federal contaminated sites	1.2

Sources: TBS, 2019 and MELCC, 2020.

An environmental soil characterization study was conducted at the proposed project site. All the samples selected and submitted for chemical analysis showed concentrations for all parameters below criterion "A" of the MELCC's Guide d'intervention-PSRTC [response manual]. The access road, composed of fill material, shows no evidence of contamination, as do the soils tested at the project site.

5.4.5 Hydrography, hydrology and drainage

The village of Puvirnituq is located at the mouth of the Rivière Puvirnituq, which flows into the Baie d'Hudson. This 280-km long river originates from a small, unnamed mountain lake located west of the continental divide between the Baie d'Ungava, Baie

d'Hudson and Détroit d'Hudson (Hudson Strait) watersheds. The Rivière de Puvirnituq and the Baie d'Hudson are not affected by the project and are therefore excluded from the extended study area. In addition to these two elements, numerous streams and water bodies are scattered throughout the extended study area. A few significant lakes occupy the central and northern parts of the region, including Lac Tasiapiq and Lac Puijjurarvialuk (see Map A, pocket insert). In the limited study area, drainage occurs mainly to the southeast, towards the Rivière Puvirnituq.

5.5 Biological environment

5.5.1 Vegetation

5.5.1.1 Terrestrial vegetation

The extended study area covers a total area of 2,549.2 ha and in the shrub Arctic tundra bioclimatic domain (MFFP, 2019). The dominant vegetation consists of shrub species such as willow, dwarf birch, as well as herbaceous species, mosses and lichens. No tree-like species are present, and shrubs do not exceed two metres in height.

In the extended study area, the biophysical environment covers nearly 90% of the area, or 2,294 ha (see Table 5-3 and Map A, pocket insert). It is primarily shrub tundra, at 1,434.6 ha representing over 56% of the area, and wetlands, at 591.5 ha (just over 23%). The extensive water system covers 250.8 ha (10%). It consists of rivers, lakes and ponds. The bare patches cover a small area of 17.1 ha (>1%) and consist mainly of rock outcrops. The remainder, which is an anthropogenic environment of varied use that represents 255.2 ha, or 10% of the extended study area.

Table 5-6: Distribution of Biophysical Environment Types in the Extended Study Area

Environment type	Surface area (ha)	Proportion (%)
Terrestrial	***1,451.7***	***57.0***
Shrub tundra	1,434.6	56.3
Dry barrens	17.1	0.7
Wetlands and aquatic	***842.3***	***33.0***
Shrub swamp	0.1	<0.1
Marsh	0.6	<0.1
Water body	250.8	9.8
Open fen	10.5	0.4
Undefined fen	580.3	22.8
Anthropogenic	***255.2***	***10.0***
Varied anthropogenic	255.2	10.0
Total	**2,549.2**	**100.0**

In July 2020, a site visit was conducted to characterize the 22.8-ha limited study area. Table 5-7 presents the main plant species observed in the terrestrial environment. As mentioned earlier, the main species are shrubby (willow, birch and crowberry) and herbaceous (lapland reedgrass, sedge, fireweed). Bog birch replaces dwarf birch at these latitudes.

Table 5-7: Primary Terrestrial Vascular Plant Species Observed in the Limited Study Area

Common Name	Scientific name
Arctic daisy	*Arctanthemum arcticum ssp. arcticum*
Alpine bearberry	*Arctous alpina*
Common bearberry	*Arctostaphylos uva-ursi*
Siberian sea thrift	*Armeria maritima ssp. sibirica*
Bog birch	*Betula glandulosa*
Lapland reedgrass	*Calamagrostis laponica*
Norway sedge	*Carex norvegica*
Arctic white heather	*Cassiope tetragona*
Alpine mouse-ear chickweed	*Cerastium alpinum*
Fireweed	*Chamaenerion angustifolium ssp. angustifolium*
Dwarf fireweed	*Chamaenerion latifolium*
Mountain sandwort	*Cherleria biflora*
Dwarf hairgrass	*Deschampsia sukatschewii*
Snow draba	*Draba nivalis*
Fragrant wood fern	*Dryopteris fragrans*
Slender wheatgrass	*Elymus trachycaulus ssp. trachycaulus*
Black crowberry	*Empetrum nigrum ssp. hermaphroditum*
Field horsetail	*Equisetum arvense*
Alpine azalea	*Kalmia procumbens*
Leafy-stemmed saxifrage	*Micranthes foliolosa*
Lapland lousewort	*Pedicularis lapponica*
Common butterwort	*Pinguicula vulgaris*
Northern green orchid	*Platanthera aquilonis*
Alpine bluegrass	*Poa alpina ssp. alpina*
Arctic bluegrass	*Poa arctica*
Large-flowered wintergreen	*Pyrola grandiflora*
Beautiful willow	*Salix glauca var. cordifolia*

Table 5-7: Primary Terrestrial Vascular Plant Species Observed in the Limited Study Area (*cont'd*)

Common Name	Scientific name
Dwarf willow	*Salix herbacea*
Net-leaved willow	*Salix reticulata*
Bearberry willow	*Salix uva-ursi*
Tufted saxifrage	*Saxifraga cespitosa*
Moss campion	*Silene acaulis*
Dune tansy	*Tanacetum bipinnatum*
Small false asphodel	*Tofieldia pusilla*
Bog bilberry	*Vaccinium uliginosum*
Lingonberry	*Vaccinium vitis-idaea*

Section 5.5.1.3 provides a more specific overview of the special-status plant species that may be present in the extended and limited study areas.

5.5.1.2 Wetlands and aquatic environments

Wetlands

Wetlands in the extended study area were identified using the MELCC's mapping of potential wetlands in Québec (2019), the MFFP's northern Québec vegetation mapping (2020) and the MERN's database of northern Indigenous villages (2013).

The total area of wetlands present in the extended study area covers 591.5 ha (23.2%). Of this area, 580.3 ha are undefined peatland wetlands (see Table 5-8). Few marshes or shrub swamps are present (<0.1%).

Table 5-8: Distribution of Wetland Types in the Extended Study Area

Wetland type	Surface area (ha)	Proportion of the extended study area (%)
Shrub swamp	0.1	<0.1
Marsh	0.6	<0.1
Undefined fen	580.3	22.8
Open fen	10.5	0.4
Total	**591.4**	**23.2**

Sources: MELCC (2019), MFFP (2020) and MERN (2013).

In July 2020, a visit to the limited study area was conducted to validate and characterize the wetlands present. An area of 5.7 ha of wetland was mapped and characterized, representing almost 25% of the limited study area (see Table 5-9). The remainder of the limited study area is covered by shrub tundra and environments disturbed by human activity. Covering an area of 5.1 ha, the majority of the wetlands are open fen. The observed marsh and shrub swamps represent 0.6 ha and less than 0.1 ha respectively. Map 5-2 shows the distribution of wetlands in the limited study area.

Table 5-9: Distribution of Environment Types in the Limited Study Area

Environment type	Surface area (ha)	Proportion of the limited study area (%)
Wetland	***5.7***	***24.9***
Marsh	0.6	2.5
Shrub swamp	<0.1	0.2
Open fen	5.1	22.2
Other	***17.1***	***75.1***
Anthropogenic	1.8	8.0
Shrub tundra	15.3	67.1
Total	**22.8**	**100.0**

A total of 9 wetlands were identified and characterized at 18 stations: 5 bogs, 3 marshes and 1 shrub swamp. Table 5-10 presents the surface area of these wetlands within the limited study area, as well as the associated characterization station numbers.

Table 5-10: Area by Wetland Type Characterized in the Limited Study Area

Wetland No.	Type	Surface area (ha)	Characterization station No.
WL01	Marsh	0.3	ST11
WL02	Shrub swamp	0.1	ST01
WL03	Marsh	0.2	ST02
WL04	Open fen	0.6	ST03, ST04, ST05
WL05	Open fen	0.1	ST06
WL06	Open fen	0.4	ST07, ST08
WL07	Open fen	0.6	ST09, ST10
WL08	Marsh	<0.1	ST13
WL09	Open fen	3.3	ST14, ST15, ST16, ST17, ST18, ST19
Total	**–**	**5.7**	**–**

The main shrub species observed in the elevated plateau portions of the characterized bogs are rather recurrent and not very variable. These include dwarf birch *(Betula glandulosa*), black crowberry *(Empetrum nigrum ssp. hermaphroditum*), and planeleaf willow *(Salix planifolia*), with blueberry (*Vaccinium uliginosum*; *V. vitis-idaea*) and Labrador tea *(Rhododendron tomentosum*). The flatland portions are much larger and essentially dominated by herbaceous species. The open peat bogs WL04, WL05, WL06 and WL07 have a varied flora, with the dominant species being an amalgam of sedges *(Carex aquatilis var. aquatilis*; *C. saxatilis*; *C. rotundata*; *C. gynocrates*), cottongrass *(Eriophorum angustifolium ssp. Angustifolium*; *E. scheuchzeri*), needle spikerush *(Eleocharis acicularis*) and tufted bulrush *(Trichophorum cespitosum*). The large bog WL09 has flat areas dominated almost exclusively by either cottongrass or water sedge. The soil of these bogs is generally saturated with water, the water table being high, located between the surface and 40 cm deep. Rock was reached between 5 cm and 50 cm in environments WL04, WL05, WL06 and WL07. The thickness of organic matter varies from about 5 cm to 25 cm and is usually underlain by fine sand. The fens also have shallow pools of water that are more or less dry.

The three marshes are located on the edge of dry ponds. They consist mainly of sedges *(Carex aquatilis var. aquatilis*; *C. saxatilis*; *C. rariflora*) accompanied by needle spikerush and common cottongrass. Willows *(Salix planifolia*; *S. arctophyla*) and bog birch are among the few prostrate shrub species observed at the edge. The soil consists of fine sand that is more or less saturated with water. The water table was not affected, while the rock was affected at 8 cm for WL03 and 25 cm for WL01.

The shrub swamp (WL02) is a willow grove located in an enclosed depression. The dominant shrub species is planeleaf willow with bog birch and blueberry. The herbaceous species, which are not very diversified, are mainly Lapland reedgrass *(Calamagrostis lapponica*), mainly accompanied by the tufted bulrush. The soil consists of a thin organic layer 8 cm thick on the rock.

It should be noted that the majority of species encountered in the tundra domain do not have wetland water status (obligatory, facultative or non-indicative) as defined in the guide by Bazoge et al. (2015). For example, the species statuses for the state of Alaska presented by Lichvar et al. (2016, updated 2018) were used. The detailed characterization sheets are presented in Appendix D.

Aquatic environments

The aquatic environment of the extended study area was determined using data from the MERN topographic maps of northern Indigenous villages (2013) and an analysis of LIDAR topographic data. A total area of 250.8 ha is made up of water features, i.e., watercourses, lakes and ponds. The numerous small ponds are typical of the northern landscape and are mainly the result of of permafrost thaw (thermokarst ponds).

No watercourses are present in the limited study area. However, shallow and generally dry pools are found in the characterized bogs. These pools do not have a continuous channel between them. They are considered components of peatlands and are therefore included in the wetland environments.

Ecological functions of wetlands and aquatic environments

Wetlands and aquatic environments provide many ecological services due to their different functions throughout the ecosystem. These functions, presented below, come from the *Act to affirm the collective nature of water resources and to promote better governance of water and associated environments* (C-6.2, s. 13.1):

> (1) acting as a pollution filter, controlling erosion and retaining sediments by, among other things, preventing and reducing surface water and groundwater pollution and sediment input;
>
> (2) acting as a regulator of water levels by retaining meteoric water and meltwater and allowing part of it to evaporate, thereby reducing the risk of flooding and erosion and promoting groundwater recharge;
>
> (3) conserving the biological diversity that enables the environments and ecosystems to provide living species with habitat in which to feed, find cover and reproduce;
>
> (4) acting as a sun screen and natural wind-shield by maintaining vegetation, which prevents excessive warming of water and protects soils and crops from wind damage;
>
> (5) sequestering carbon and mitigating the impacts of climate change; and
>
> (6) protecting the quality of the landscape by preserving the natural character of a site and the attributes of the countryside associated with it, thus enhancing the value of adjacent land.

The primary ecological function of the wetlands identified in the extended study area is biodiversity conservation. The northern tundra is not very productive in terms of vegetation. For example, open fens with pools, shrub swamps and characterized marshes provide important feeding and shelter areas for northern wildlife. Although the process of organic matter decomposition is reduced at these latitudes (climate, reduced growing season, etc.), arctic fens also play a role in carbon sequestration and climate regulation. Lastly, in a sparsely vegetated landscape, the wetlands, although mainly composed of herbaceous species and prostrate shrubs, contribute to the preservation of the natural character of this particular environment.

5.5.1.3 Special-status plant species

A request was made to the Centre de données sur le patrimoine naturel du Québec (CDPNQ) [Québec natural heritage data center] to verify the presence of any plant species that are threatened, vulnerable or likely to be so designated (PSTVL) in the study area. An analysis of the habitat potential for PSTVL was also conducted using the *Les plantes vasculaires en situation précaire au Québec* guide (Tardif et al., 2016), volumes 1, 2 and 3 of *La Flore nordique du Québec et du Labrador* (Payette et al., 2013, 2015 and 2018) and the *Atlas des plantes des villages du Nunavik* (Blondeau, 2004). Surveys were conducted in July 2020 to verify the presence of special-status plant species in the limited study area.

According to information from the CDPNQ, there are no known occurrences of PSTVL in the limited study area. However, five occurrences of species likely to be designated as threatened or vulnerable, including four historical ones, have been identified near the village of Puvirnituq (see Table 5-11). These species are all non-vascular plants (mosses). The analysis of the habitat potential of vascular species also shows that the area may have habitat potential for 12 other special-status plant species.

No special-status species were observed in the limited study area during the surveys.

Table 5-11: Special-Status Plant Species Potentially Present in the Extended Study Area

Common name	Scientific name	Status in Québec	Habitat [a]	Best observation period	Presence in limited study area	CDPNQ
Vascular plant						
Arctic mouse-ear chickweed	*Cerastium arcticum*	SLDTV [b]	Terrestrial environments (rocky outcrops/screes, exposed scree slopes/ boulder/gravel fields, arctic tundra). Occurs in sunny areas only, on dry substrate, not related to pH.	Summer	No	–
Regel's mouse-ear chickweed	*Cerastium regelii*	SLDTV	Palustrine (rocky/gravelly shores) and terrestrial (arctic tundra) environments Occurring in sunny locations only, on mesic substrate. On river alluvium, solifluous soils and moss carpets.	Summer	No	–
Alpine hairgrass	*Deschampsia alpina*	SLDTV	Palustrine (rocky/gravelly shores) and terrestrial (exposed scree slopes / boulder/gravel fields) environments. Occurring in sunny locations only, on mesic and basic substrate.	Summer	No	–

Table 5-11: Special-Status Plant Species Potentially Present in the Extended Study Area *(cont'd)*

Common name	Scientific name	Status in Québec	Habitat [a]	Best observation period	Presence in limited study area	CDPNQ
Vascular plant *(cont'd)*						
Cayouette's draba	*Draba cayouettei*	SLDTV	Palustrine (rocky/gravelly shores) and terrestrial (arctic tundra) environments Occurring in sunny locations only, on mesic substrate. Exposed, periglacial environments with little snow cover and hilltops dotted with tundra ostioles and polygons.	Summer	No	–
Flattop whitlowgrass	*Draba corymbosa*	SLDTV	Saltwater estuarine (rocky/gravelly shores) and terrestrial (rocky outcrops/escarpments, exposed scree slopes / boulder/gravel fields, fine bare deposits (clay, silt)) environments. Occurring in sunny locations only, on dry and basic substrate. Well adapted to rocky and stony summits, exposed and with little snow.	Summer	No	–
Cutleaf daisy	*Erigeron compositus*	Vulnerable	Terrestrial environments (rocky outcrops/escarpments, exposed scree slopes / boulder/gravel fields). Occurring in sunny locations only, on dry, basic substrate. Bank of sand, gravel, pebbles and boulders.	Summer	No	–
Star saxifrage	*Micranthes stellaris*	SLDTV	Terrestrial environments (rocky outcrops/escarpments, exposed scree slopes / boulder/gravel fields). Occurring in sunny locations only, on dry, basic substrate. Scree slopes and rocky escarpments well supplied with water.	Summer	No	–
Bluff cinquefoil	*Potentilla arenosa ssp. chamissonis*	SLDTV	Palustrine (rocky/gravelly shores) and terrestrial (exposed scree slopes / boulder/gravel fields) environments. Occurring in sunny locations only, on mesic and basic substrate. Rock crevices and flats, escarpments, slopes, and ridges; dry tundra covered with lichens and dwarf shrubs. Occasional presence in snow patches.	Summer	No	–
Tall alkali grass	*Puccinellia angustata*	SLDTV	Wetlands (bare muddy shores) and terrestrial (exposed scree slopes / boulder/gravel fields) environments. Found only in sunny areas, on mesic, basic or ultrabasic substrates.	Late summer	No	–
Sulphur yellow buttercup	*Ranunculus sulphureus*	SLDTV	Wetlands (rocky/gravelly shores, wet meadows) and terrestrial (arctic tundra) environments. Occurring in sunny locations only, on mesic substrate. A calciphile species that generally colonizes moist soils in snow patches, stream banks and banks flooded by spring freshets.	Summer	No	–

Table 5-11: Special-Status Plant Species Potentially Present in the Extended Study Area *(cont'd)*

Common name	Scientific name	Status in Québec	Habitat [a]	Best observation period	Presence in limited study area	CDPNQ
Vascular plant *(cont'd)*						
Ross' stitchwort	*Sabulina rossii*	SLDTV	Terrestrial environments (arctic tundra, exposed scree slopes / boulder/gravel fields). Occurring in sunny locations only, on mesic and basic substrate. Two known occurrences observed in fens, snow patches and/or riverbanks.	Summer	No	–
Pink-flowered asphodel	*Tofieldia coccinea*	SLDTV	Terrestrial environments (rocky outcrops/escarpments). Occurring in sunny locations only, on mesic and basic substrate. Dry, mesic soils, stony in nature, and rocky outcrops. Calcicole species.	Summer	No	–
Non-vascular plant						
Wideleaf cinclidium moss	*Cinclidium latifolium*	SLDTV	Moist tundra, rich fens, often in limestone environments.	Summer	No	1 historic occurrence near the village
Slender grey rock moss	*Racomitrium canescens ssp. latifolium*	SLDTV	On dry sandy or rocky substrate, banks, escarpments.	Summer	No	1 historic occurrence near the village
Arctic rock moss	*Racomitrium panschii*	SLDTV	Arctic region	Summer	No	1 historic occurrence near the village
Oriental peat moss	*Sphagnum orientale*	SLDTV	Very wet or submerged sites, arctic pond borders, wet meadows.	Summer	No	1 occurrence of good precision, located at the edge of the bay, approximately 700 m from the inventory area
Arctic crisp moss	*Trichostomum arcticum*	SLDTV	On gravel substrate, fens, sedge meadow, calcareous bog, snow cap	Summer	No	1 historic occurrence near the village

a. According to Tardif et al. (2016), Payette et al. (2013, 2015 and 2018) and Blondeau (2004).

b. SLDTV: Species likely to be designated threatened or vulnerable.

5.5.2 Wildlife

5.5.2.1 Mammals

Sixteen species of terrestrial mammals potentially frequent the extended study area (see Table 5-9). Of these, three have special status: least weasel, wolverine and polar bear. However, the CDPNQ reports no mention of these species in the extended study area (MFFP, 2020). Caribou are also a species of interest due to their importance to the Inuit and the decline of migratory caribou populations in Nord-du-Québec. It should be noted that no bat species is likely to regularly frequent the extended study area, based on the ranges of this group of species recorded by Jutras et al. (2012).

Table 5-12: Terrestrial Mammal Species Likely to Frequent the Extended Study Area

Common name	Scientific name	Status in Québec	Status in Canada
Least weasel	*Mustela nivalis*	SLDTV [a]	–
Muskox	*Ovibos moschatus*	–	–
Southern red-backed vole	*Myodes gapperi*	–	–
Meadow vole	*Microtus pennsylvanicus*	–	–
Northern bog lemming	*Synaptomys borealis*	–	–
Wolverine	*Gulo*	Threatened	At risk
Barren-ground caribou	*Rangifer tarandus caribou*	–	–
Ermine	*Mustela erminea*	–	–
Ungava lemming	*Dicrostonyx hudsonius*	–	–
Arctic hare	*Lepus arcticus*	–	–
Grey wolf	*Canis lupus*	–	–
River otter	*Lontra canadensis*	–	–
Polar bear	*Ursus maritimus*	Vulnerable	At risk
Black bear	*Ursus americanus*	–	–
Arctic fox	*Vulpes lagopus*	–	–
Red fox	*Vulpes*	–	–

a. Species likely to be designated threatened or vulnerable.

Sources: Desrosiers et al. (2002), Feldhamer et al. (2003), Jutras et al. (2012) and Naughton (2012).

Barren-ground caribou

Caribou found in the surroundings of the extended study area belong to the Leaf River herd. This herd currently has no legal protection status at the provincial level. Federally, the eastern migratory population to which it belongs was designated as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2017 and is being reviewed for addition to Schedule 1 of the *Species at Risk Act*. Inventory data obtained in November 2018 indicate that the Leaf River herd's population is still in decline (MFFP, 2018).

The extended study area lies between the herd's calving ground, located further north, and the wintering ground, to the south (Taillon et al. 2016). The caribou that frequent the Puvirnituq sector are therefore likely to use the spring and fall migration corridors and the summering area. Only a few transient individuals are likely to travel through the extended and limited study areas. Caribou dung was observed during the land wildlife survey conducted on September 2 and 3, 2020.

Least weasel

The least weasel, a little-known predator, is a species likely to be designated threatened or vulnerable in Québec. There are few references to this weasel in Québec, and it is considered rare in Canada. This carnivore feeds primarily on micromammals (Feldhamer et al., 2003). Weasels select and vary their habitat according to the local distribution of their prey over time and the relative abundance of the various species of small mammals and their respective preferred habitats. This species' presence is still possible in the extended study area and limited study area, based on micromammal-friendly habitats, but should be considered undetermined due to the lack of data on its regional distribution.

Wolverines and polar bears

A wolverine would be very rare or extinct in Québec (COSEWIC, 2014). This species is designated threatened in Québec and of special concern in Canada. The polar bear is designated as vulnerable in Québec and of special concern in Canada. Inuit hunters have reported an increase in bear numbers since the 1960s along the coast and near communities (COSEWIC, 2018). Considering the scope of their home ranges and movements, as well as their presumed low numbers, the presence of wolverines and polar bears in the extended study area and limited study area would be infrequent and of very short duration, if any.

5.5.2.2 Birds

The Puvirnituq region overlaps two 100 km² squares (18UM65, 18UM75) of the Québec Breeding Bird Atlas. Consultation of this data indicates that sampling efforts in the extended study area has been considerable in recent years. The recurring presence of biologists from the Canadian Wildlife Service in Puvirnituq gives us a fairly complete picture of the breeding bird population. This is probably one of the places in Nunavik where the bird populations are best known. The list of possible, probable or confirmed breeding species based on this source is presented in Table 5-13; there are 41 species on the two squares (QBBA, 2020).

Table 5-13: Breeding Bird Species Present in the Extended Study Area and Their Nesting Status According to the Second Québec Breeding Bird Atlas

Species		Breeding status	
Common name	**Scientific name**	**Square 18UM65**	**Square 18UM75**
Horned lark	*Eremophila alpestris*	Possible	Probable
Least sandpiper	*Calidris minutilla*	–	Possible
Semipalmated sandpiper	*Calidris pussilla*	Probable	Probable
Wilson's snipe	*Gallinago delicata*	–	Probable
Canada goose	*Branta canadensis*	Confirmed	Confirmed
White-crowned sparrow	*Zonotrichia leucophrys*	Possible	Confirmed
Savannah sparrow	*Passerculus sandwichensis*	–	Probable
American tree sparrow	*Spizelloides arborea*	–	Possible
Rough-legged hawk	*Buteo lagopus*	Possible	Probable
Mallard	*Anas platyrhynchos*	–	Probable
American wigeon	*Mareca americana*	–	Probable
American black duck	*Anas rubripes*	–	Probable
Northern pintail	*Anas acuta*	Probable	Confirmed
Northern shoveler	*Spatula clypeata*	–	Possible
Tundra swan	*Cygnus olor*	–	Confirmed
Common eider	*Somateria mollissima*	Confirmed	Confirmed
King eider	*Somateria spectabilis*	–	Probable
Peregrine falcon [a]	***Falco peregrinus***	**Possible**	**Possible**
Greater scaup	*Aythia marila*	Probable	Probable
Herring gull	*Larus argentatus*	–	Possible
Glaucous gull	*Larus hyperboreus*	Possible	–
Great black-backed gull	*Larus marinus*	–	Probable
Common raven	*Corvus corax*	–	Confirmed

Table 5-13: Breeding Bird Species Present in the Extended Study Area and Their Nesting Status According to the Second Québec Breeding Bird Atlas *(cont'd)*

Species		Breeding status	
Common name	**Scientific name**	**Square 18UM65**	**Square 18UM75**
Common merganser	*Mergus merganser*	–	Probable
Long-tailed duck	*Clangula hyemalis*	Probable	Probable
Red-breasted merganser	*Mergus serrator*	–	Possible
Short-eared owl	***Asio flammeus***	–	**Possible**
Dark-eyed junco	*Junco hyemalis*	–	Possible
Black scoter	*Melanitta americana*	–	Probable
American robin	*Turdus migratorius*	–	Probable
Snow goose	*Chen caerulescens*	Possible	Possible
Red-necked phalarope	***Phalaropus lobatus***	–	**Confirmed**
American pipit	*Anthus rubescens*	–	Confirmed
Snow bunting	*Plectrophenax nivalis*	Confirmed	Possible
Lapland longspur	*Calcarius lapponicus*	Confirmed	Confirmed
Red-throated loon	*Gavia stellata*	Probable	Probable
Common loon	*Gavia immer*	–	Possible
Semipalmated plover	*Charadrius semipalmatus*	–	Probable
Green-winged teal	*Anas crecca*	Possible	Probable
Common redpoll	*Acanthis flammea*	–	Possible
Arctic tern	*Sterna paradisaea*	Possible	–

a. Species in bold are those with special provincial or federal status.

Source: QBBA, 2020.

To complete the picture of local bird populations, eBird data from 2015 to 2019 was also extracted (eBird, 2020). These data include nine new species in the study area: dunlin *(Calidris alpina*), white-throated sparrow *(Zonotrichia albicolis*), spotted sandpiper *(Actitis macularius*), solitary sandpiper *(Tringa solitaria*), American crow *(Corvus brachyrhynchos*), common goldeneye *(Bucephala clangula*), Iceland gull *(Larus glaucoides*), snowy owl *(Bubo scandiacus*), and hoary redpoll *(Acanthis hornemanni*). Finally, by integrating historical data from the ÉPOQ database (Larivée, 2011), two new species are added: rock ptarmigan *(Lagopus mutus*) and killdeer *(Charadrius vociferus*). This brings the total to 52 species in all databases.

It should be noted that willow ptarmigan *(Lagopus lagopus*) and rock ptarmigan *(Lagopus mutus*) are traditionally hunted, especially in winter, by the Inuit of Puvirnituq. Although the willow ptarmigan is absent from the various databases, this species can be considered an integral part of the local bird population.

Special-status species potentially present in the extended study area

Golden eagle

Known golden eagle nests in Québec are located primarily on the east coast of Baie d'Hudson (between the Grande rivière de la Baleine and the Rivière Nastapoka), in the coastal area of southern Baie d'Ungava and in the Côte-Nord region (Équipe de rétablissement de l'aigle royal au Québec, 2005). They are generally found on a cliff or escarpment and more rarely in a tree, although this species hunts in open areas.

However, the species has never been reported in Puvirnituq during the nesting period (QBBA, 2020; eBird, 2020). The absence of cliffs or large trees, not only in the limited study area, but also in the extended study area, means that its potential for presence must be considered low or very low.

Peregrine falcon

Although absent from the Puvirnituq region according to the various databases, this species is known to frequent the tundra of northern Québec, where it seeks out escarpments, cliff ledges or high structures near water and open areas (Équipe de rétablissement des oiseaux de proie du Québec, 2009). Cliffs 50 to 200 metres high would be preferred (ECCC, 2017).

The relatively flat terrain of Puvirnituq makes the probability of peregrine falcon nesting low for the entire extended study area. However, the species could nest on certain islands off Puvirnituq and use the extended study area as a hunting ground.

Short-eared owl

The short-eared owl's known breeding range covers almost the entire province, with the possible exception of the northern part of the Péninsule d'Ungava (Environment Canada, 2016). The extended study area therefore overlaps with its breeding range. Its preferred nesting habitats are open areas such as wetlands, Arctic tundra, taiga, bogs, coastal wetlands, coastal heaths, natural grasslands dominated by sand sage *(Artemisia filifolia*), estuaries and marshes (Environment Canada, 2016).

There are a few historical records of short-eared owls in Puvirnituq, the most recent being August 30, 2016. The species is reported on eBird, in the SOS-POP database and in the online data of the Québec Breeding Birds Atlas (QBBA, 2020). Nevertheless, the probability of encountering the species in the limited study area is considered medium, given its relative rarity.

Red-necked phalarope

The red-necked phalarope breeds in the subarctic and Low Arctic wetlands near ponds, lakes or freshwater streams. The drying up of freshwater ponds and the expansion of shrubs and trees in these wetlands due to climate change are expected to have a significant impact on the quality and availability of habitat for this species (COSEWIC, 2014).

The Red-necked phalarope is mentioned extensively in Puvirnituq, according to data from the Québec Breeding Birds Atlas as well as eBird and ÉPOQ. Due to the presence of small tundra ponds, the probability of encountering this species can be considered medium in the limited study area and high in the extended study area.

Bird surveys

Bird surveys were conducted on July 22, 23 and 24, 2020 in both study areas.

Methods

Breeding passerines in the study area were counted using point counts. Due to the small surface area of the limited study area, four point counts were set up, spaced at least 250 metres apart. The habitat for each point was briefly described, all located in the shrub tundra. The location of the listening stations is shown on Map 5-2.

Counts were conducted using the fixed-radius point count (FRPC) method (Bibby et al., 1992) and the unlimited-distance point count (known as IPA) method (Blondel et al., 1981). The FRPC method consists in counting all birds seen or heard within an imaginary 50-metre radius circle every 5 minutes over a total duration of 10 minutes. The IPA method was used at the same time. It differs from the FRPC in that it does not impose any distance limit between the birds counted, and it helps to establish a more comprehensive species list. The FRPC method began after a quiet period of about five minutes to allow the birds to recover from the disturbance caused by the observers' movements. This inventory was conducted during the breeding period, taking into account the northern latitude. To determine the level of certainty of species nesting, breeding evidence from the Québec Breeding Bird Atlas was used (QBBA, 2020).

To expand the list of species observed, the presence of any other bird species, particularly special-status species, was also noted during movements in the limited and extended study areas.

Results

The various inventories conducted in the limited and extended study areas identified 33 bird species, i.e., 12 confirmed breeders, 8 probable breeders, 12 possible breeders and 1 non-breeder (see Table 5-14). They also revealed the presence of three new species: white-rumped sandpiper, pectoral sandpiper, and black guillemot. The total number of species is therefore 55, according to the literature review and the surveys.

Table 5-14: Bird Species Observed in Puvirnituq and Their Breeding Status in the Limited and Extended Study Areas

Species		Field observations – July 2020	
Common name	**Scientific name**	**Nesting code [b]**	**Nesting status in the extended study area**
Horned lark	*Eremophila alpestris*	JE	Confirmed
White-rumped sandpiper	*Calidris fuscicolis*	X	Non-breeder
Pectoral sandpiper	*Calidris melanotos*	A	Probable
Least sandpiper	*Calidris minutilla*	A	Probable
Semipalmated sandpiper	*Calidris pusilla*	JE	Possible
Dunlin	*Calidris alpina*	A	Probable
Canada goose	*Branta canadensis*	H	Possible
Savannah sparrow	*Passerculus sandwichensis*	AT	Confirmed
White-crowned sparrow	*Zonotrichia leucophrys*	AT	Confirmed
Rough-legged hawk	*Buteo lagopus*	NO	Confirmed
American wigeon	*Mareca americana*	H	Possible
American black duck	*Anas rubripes*	H	Possible
Northern pintail	*Anas acuta*	JE	Confirmed
Northern shoveler	*Spatula discolor*	JE	Confirmed
Tundra swan	*Cygnus olor*	P	Probable
Common eider	*Somateria mollissima*	P	Probable
Black guillemot	*Cephus grylle*	H	Possible
Peregrine Falcon [a]	***Falco peregrinus***	**H**	**Possible**
Greater scaup	*Aythia marila*	JE	Confirmed
Herring gull	*Larus argentatus*	A	Probable
Glaucous gull	*Larus hyperboreus*	A	Probable
Great black-backed gull	*Larus marinus*	H	Possible
Common raven	*Corvus corax*	H	Possible
Long-tailed duck	*Clangula hyemalis*	JE	Confirmed

Table 5-14: Bird Species Observed in Puvirnituq and Their Breeding Status in the Limited and Extended Study Areas *(cont'd)*

Species		Field observations – July 2020	
Common name	**Scientific name**	**Nesting code [b]**	**Nesting status in the extended study area**
Red-breasted merganser	*Mergus serrator*	H	Possible
American robin	*Turdus migratorius*	H	Possible
Red-necked phalarope	***Phalaropus lobatus***	**DD**	**Confirmed**
American pipit	*Anthus rubescens*	AT	Confirmed
Lapland longspur	*Calcarius lapponicus*	JE	Confirmed
Red-throated loon	*Gavia stellata*	H	Possible
Common loon	*Gavia immer*	H	Possible
Semipalmated plover	*Charadrius semipalmatus*	JE	Confirmed
Common redpoll	*Acanthis flammea*	S	Possible

a. Species in bold are those with special provincial or federal status.

b. Breeding code (according to the Québec Breeding Bird Atlas):
Species observed – X: Observation of the species during its breeding period, but not in suitable habitat.
Possible nesting – H: Observation of the species during its breeding period in suitable nesting habitat. **S**: Singing male observed in its habitat during the breeding period.
Probable nesting – P: Pair observed in a suitable habitat during the species' breeding season. **T**: Presumed territory based on observation of an adult bird on two different days at least one week apart during this period. **C**: Breeding behavior involving a male and female (e.g., display, courtship feeding and copulation) or antagonistic behavior between two individuals in suitable nesting habitat during the species' breeding season. **V:** Bird visiting a probable nest site during the species' breeding season. **A:** Agitated behavior or alarm call of an adult in a suitable nesting habitat during the species' breeding season.
Confirmed nesting – CN: Nest building, including the carrying of nesting material, by all species except wrens and woodpeckers. **DD**: Individual attempting to draw attention away from a nest or young by feigning injury or by using any other distraction display. **NU**: Empty nest used during the atlas survey period, or the shells of eggs laid during the same period. **JE**: Recently fledged (nidicolous species) or downy (nidifugous species) young incapable of sustained flight. **NO**: Adult occupying, leaving or entering a probable nest site (visible or not). **FE**: Adult carrying a fecal sac. **AT**: Adult carrying food for young. **NF**: Nest containing one or more eggs. **NJ**: Nest with one or more young (seen or heard).

At the listening stations, the species-specific richness for 11 species was assessed based on the data collected, regardless of the distance (IPA).

Only six breeding pairs of four species were identified in the limited study area (see Table 5-15). As a result, there is a low abundance and reduced diversity of species.

Table 5-15: Maximum Number of Nesting Bird Pairs at Three Listening Stations in the Limited Study Area

Species	PU01	PU02	PU03	PU04
Savannah sparrow		1		
Semipalmated plover			1	
Lapland longspur	1	1		1
American pipit		1		

The site of the future generating station is located on a rocky plateau, which is not very conducive to the species of interest present in the extended study area, particularly waterfowl and shorebirds. Two special-status species were observed in 2020, the peregrine falcon (in flight) and the red-necked phalarope. The nesting sites of the red-necked phalarope are shown on Map A (pocket insert). As for the peregrine falcon, given that it breeds on cliffs or in quarries, the probability of nesting in the limited and even extended study area is nil. No suitable nesting cliffs were observed in the extended study area. It should be noted that the presence of short-eared owls could not be confirmed during the field surveys in either the limited or the extended study areas.

5.5.2.3 Reptiles and amphibians

A search of the Atlas des amphibiens et des reptiles du Québec (AARQ) database through the Saint-Lawrence Valley Natural History Society did not generate any records of amphibians or reptiles in the study areas (AARQ, 2020). The nearest confirmed occurrence is located more than 400 km from the extended study area. At northern latitudes, temperature is the most significant limiting factor for amphibians and reptiles (Bleakney, 1958).

Based on current knowledge, three anuran species may be found in the extended study area: wood frog (*Lithobates sylvaticus*), American toad (*Anaxyrus americanus*) and mink frog (*Lithobates septentrionalis*) (Fortin et al., 2016; AARQ, 2020). The wood frog is believed to be an amphibian whose northern range limit reaches the highest latitudes in Québec, slightly beyond the 58th parallel. The validated records are all from the vicinity of Kuujjuaq, a community formerly known as Fort Chimo (Fortin et al., 2016). The preferred habitat for these anurans is found in the extended study area, in wetlands, watercourses, lakes, ponds and puddles. The same is true in the limited study area, where marshes, shrub swamps, isolated pools and fens are potential breeding habitats for these species.

The extended study area is also well beyond the range of salamanders, snakes and turtles. In Québec, the most northerly salamanders and reptiles (common garter snake) are recorded near Chisasibi and Radisson, close to the 54th parallel (Rodrigue and Desroches, 2018). Therefore, it is highly unlikely for a species of salamander or reptile to be found in the extended study area.

Herpetological inventory

An anuran inventory was conducted on September 2 and 3, 2020. For anurans in northern environments, a particularly favorable survey period is at the end of the summer, after the peak of tadpole metamorphosis. In addition to adults, there is a multitude of juveniles, which significantly increases the probability of identifying a particular anuran species. Since the three above-mentioned species theoretically breed at different times, it would not have been possible to conduct a spring inventory of the breeding chorus covering all of them during a single field visit.

Two methods were used to carry out the anuran inventory. The first consisted in walking around isolated bodies of water and wetlands in search of tadpoles, juveniles and adults of all three species. The second was active land searches within approximately 300 m of isolated water bodies and wetlands.

A total of 12 active research stations (Map 5-2) were selected, all of which were located in pools, 9 of which were associated with fens, 2 of which were associated with rocky ridges set back from the wetlands, and 1 of which was associated with a marsh. Several wetlands within the limited study area were dry or nearly dry at the time of the inventory, but enough remained to provide a representative sample. The air temperature was 16°C on September 2 and 12°C on September 3. The water temperature ranged from 12°C to 19°C, according to the station.

No amphibians were observed during the inventory, despite intensive searching on a sunny day on September 2, which should have favored the observation of tadpoles in the pools, and on a rainy day on September 3, which should have favored the observation of moving specimens. Similarly, no amphibians were observed during the bird and wetland inventory. These results strongly suggest the absence of amphibians in the limited study area and in the periphery. Reptiles were not observed either, which was expected.

5.5.2.4 Special-status wildlife species

The CDPNQ does not report any occurrences of wildlife species that are threatened, vulnerable or likely to be so designated in Québec within the extended study area (MFFP, 2020). Based on known distribution ranges (Desrosiers et al., 2002; Felhamer et al., 2003; Jutras et al., 2012; Naughton, 2012; AARQ, 2020; QBBA, 2020; MFFP, 2020), habitats considered suitable for species and habitat availability, seven special-status wildlife species are likely to frequent the extended study area. Table 5-16 presents the probability of occurrence of these seven species in the limited study area. Information on each species is presented in Sections 5.3.3.1 and 5.3.3.2.

The list of special-status bird species potentially present in the study area was determined using data from the Québec Breeding Bird Atlas (QBBA, 2020), ÉPOQ (Larivée, 2018) and eBird (2020). Although the CDPNQ (2020) makes no mention of

any in the extended study area, the Direction régionale du Nord-du-Québec states that three special-status bird species are likely to be found there. According to these various sources, four bird species that have special status and have previously been in the extended study area (see Table 5-16). Peregrine falcon and red-necked phalarope were observed in the limited study area, while the latter appears to nest in the extended study area.

Table 5-16: Summary of Special-Status Wildlife Species Likely to be in Habitats Located in the Extended Study Area and Probability of Occurrence in the Limited Study Area

Common name	Status in Québec [a]	Status in Canada [b]	Probability of occurrence in the limited study area [c]
Mammals			
Least weasel	Species likely to be designated threatened or vulnerable	–	Undetermined [d]
Wolverine	Threatened	Of concern	Low
Polar bear	Vulnerable	Of concern	Low
Birds			
Golden eagle	Vulnerable	–	Low
Peregrine falcon	Vulnerable	At risk	Low
Short-eared owl	Species likely to be designated threatened or vulnerable	At risk	Moderate
Red-necked phalarope	–	Of concern	Moderate

a. Designation under the Act respecting threatened or vulnerable species.

b. Designation under the *Species at Risk Act*.

c. Subjective assessment based on the species' known distribution range, reported presence around the study area, ecology of the species and the presence and abundance of potential habitats available in the study area.

High probability: the species' distribution range clearly overlaps the extended study area, potential habitats are present in the limited study area and the species is not particularly rare.

Moderate probability: the extended study area is located within the species' distribution range, potential habitats are present in the limited study area and the species is not particularly rare.

Low probability: very few potential habitats are present in the limited study area or the availability of potential habitats is unknown, but appear to be insufficient, or the surface area of the limited study area is particularly small in relation to the range of the species' movements, or the species is present in very low numbers in the project region.

Zero probability: no potential habitat is present in the limited study area.

d. The situation and ecology of this species in Québec remain too little known for a reasonable judgment to be made.

5.5.2.5 Habitats and wildlife sites of interest or regulated

No mapped wildlife habitat, within the meaning of the *Regulation respecting wildlife* (C-61.1, r.18), overlaps the extended study area (MFFP, 2015).

The MFFP has not reported any wildlife sites of interest (MFFP, 2020).

5.6 Human environment

5.6.1 Administrative framework and land tenure

5.6.1.1 Organization of the territory

The extended study area is located in the Nord-du-Québec administrative region (10) and is part of Nunavik, which covers the territory north of the 55th parallel (with the exception of Whapmagoostui Cree lands). Nunavik is composed of 14 northern villages, some Inuit-owned lands, one Naskapi village and two unorganized territories with no inhabitants. The extended study area is entirely within the boundaries of the northern village of Puvirnituq (see Map 1-1). Note that there is no road link between Nunavik and southern Québec; this territory is accessible only by plane or boat.

The *James Bay and Northern Québec Agreement (JBNQA*) and the *James Bay and Northern Québec Land Regime Act* divided the land regime in the territory of Nunavik into three categories:

- Category I: lands transferred to the Inuit landholding corporations in each of the northern villages for community purposes and available for commercial, industrial, residential or other uses;
- Category II: provincial lands where Inuit have certain rights, including certain exclusive hunting, fishing and trapping rights;
- Category III: provincial public lands accessible to all in accordance with Québec's laws and regulations governing public land, but subject to the rights, conditions and restrictions set out in the JBNQA, which provides, among other things, that the Inuit have an exclusive right to harvest certain aquatic species and certain furbearing animals.

Along with the Inuit of Ivujivik and part of the Inuit of Salluit, the Inuit of Puvirnituq refused to sign the JBNQA in 1975. Instead, they formed a movement called Inuit Tungavinga Nunamini (Makivik Corporation, 2019).

There are no Category I and II lands in the Puvirnituq sector. The extended study area only overlaps with Category III lands.

5.6.1.2 Administrative framework

Nunavik's current administrative structure stems from the JBNQA and the *Act respecting Northern villages and the Kativik Regional Government*. The Act provides for the creation of the Kativik Regional Government (KRG), a regional entity, as well as the creation of 14 northern villages (KRG, 2019). Institutions established under the JBNQA include Makivik Corporation, landholding corporations, the Kativik School Board (now Kativik Ilisarniliriniq) and the Nunavik Regional Board of Health and Social Services (NRBHSS).

KRG's mandate is to provide public services to the people of Nunavik in several areas, including economic development, police services and civil protection, sports and recreation, and airport management. KRG is also responsible for providing technical assistance to the 14 northern villages, particularly in the following areas: legal affairs, municipal management and accounting, engineering and public transit (KRG, 2019). The KRG administrative office is located in Kuujjuaq.

Makivik Corporation is responsible for protecting the rights, interests and financial compensation arising from the JBNQA, ensuring compliance with this agreement and upholding its integrity. This non-profit organization is also a major partner in the development of Nunavik (Makivik Corporation, 2019a).

Since 2002, the Nunavik Landholding Corporation Association (NLHCA) has represented all landholding corporations for the northern villages. All villages have a landholding corporation that is responsible for administering Category I and II lands, except in the village of Puvirnituq.

Lastly, local administration is provided by the municipal council of each northern village, which is the mandatary body for service management and municipal and community administration. Municipal services include public safety, public health and hygiene, town planning and land development, public services (water supply, lighting, heating, municipal roads, traffic and transportation), recreation and culture. The council is composed of a mayor and councillors, elected or appointed. The mayor is head of Council and the city's chief administrative officer.

5.6.1.3 Land designation and use

Land use in the extended study area was determined based on the Puvirnituq land use and zoning plan (KRG, 2011), complemented by photointerpretation using orthophotographs at 50-cm resolution taken in 2019. The land use and zoning plan subdivides the urban environment of Puvirnituq into various zoning categories: residential, public and institutional spaces, commercial and services, industrial activities, special-use areas, airport activities and communications, unloading area and beach, conservation and potential development area. The various land use categories are shown on Map A (pocket insert).

The extended study area is dominated by the biophysical environment, which occupies 2,294 ha, or 90.0% of its total area. This biophysical environment is primarily made up of shrub tundra (56.3%, or 1,435 ha) and wetlands (23.2%, or 591 ha). Water bodies cover 9.8% (251 ha) of the extended study area, and dry barren areas cover 0.7% (17 ha).

The human environment covers only 10.0% (255 ha) of the extended study area. The built-up area, which includes the residential, institutional and commercial sectors, covers 89 ha (3.5%), and the industrial zone, 8 ha (0.3%). Public infrastructure and services, which include the airport area, the northern landfill and the wastewater treatment pond, account for 2.3% (60 ha) of the extended study area, and active or abandoned mine sites account for 66 ha (2.6%). Multi-use riverbanks are some of the riparian areas of the Rivière Puvirnituq, which borders the village, and account for 0.5% (12 ha) of the total area of the extended study area. Lastly, 0.8% (20 ha) of the total area is occupied by other disturbed environments of unspecified use. Table 5-17 summarizes the land use types and their area and proportion within the extended study area.

Table 5-17: Distribution of Land Use Types in the Extended Study Area

Types	Surface area (ha)	Proportion (%)
Biophysical environment	***2,294***	***90.0***
Shrub tundra	1,435	56.3
Wetland	591	23.2
Dry barrens	17	0.7
Lake or river	251	9.8
Human environment	***255***	***10.0***
Built environment	89	3.5
Industrial environment	8	0.3
Utilities and infrastructure	60	2.3
Multi-use riverbanks	12	0.5
Quarries and gravel pits (active or abandoned)	66	2.6
Other disturbed environment	20	0.8
Total	**2,549**	**100**

The limited study area is made up of a biophysical environment covered by shrub tundra (67.1%) and wetlands (24.9%). An area of 1.8 ha (8.0%) is occupied by an environment disturbed by human activity, which consists mainly of access roads that intersect the limited study area. The closest built environment to the limited study area is located approximately 1 km away.

On June 19, 2020, the Puvirnituq municipal council accepted the choice of location for the future generating station and sent Hydro-Québec a resolution (No. 20-06-38) authorizing it to conduct land surveys on the proposed site. Hydro-Québec also obtained a Development Permit from the municipal council on May 5, 2021 (resolution No. 21-05-50).

5.6.1.4 Development projects

Several potential development sectors, for which the nature of the projects that would be carried out is still unknown, have been identified in the village of Puvirnituq, and one of them overlaps the limited study area (see Map A, pocket insert).

5.6.1.5 Land use by the Inuit

The health context (COVID-19) did not allow Hydro-Québec to conduct interviews with residents. After agreement with the local authorities, another approach was adopted. Hydro-Québec mailed out a short questionnaire to document land use in the study area and to gather the concerns of Puvirnituq residents about the project. The questionnaire, preceded by information about the project, was self-administered and not targeted, so the questions had to be simple and few in number. It was accompanied by a map of the extended study area, on which the respondents could make note of their activities, in addition to writing answers in a space reserved for each question. The questionnaire was addressed to all occupants of the house and did not include any personal questions. Thus, no consent form was required.

To present the project and answer any questions, a radio program was produced in Puvirnituq. An Indigenous relations advisor from Kuujjuaq, a Hydro-Québec employee, came to facilitate the meeting.

Based on statements collected, the limited study area is used for goose and caribou hunting, berry picking and as a gathering place (see Photo 5-1). Fishing occurs outside the limited study area.

Photo 5-1: Gathering Place on the Site of the Proposed Generating Station

5.6.2 Utilities and infrastructure

5.6.2.1 Transportation

There is one airport in the extended study area, located north of the village (see Map A, pocket insert). Puvirnituq is the hub of the east coast of Hudson Bay, with the airport being the gateway to the more remote communities that are only accessible by air (Air Inuit, 2020).

The village of Puvirnituq has a local network of paved roads for driving only within the community. The road network does not connect with any other communities. A few unpaved roads can be used to access sites outside the village (extraction sites, landfill site).

The extended study area also includes marine infrastructures in the western sector of the village, including a boat launch, a commercial wharf and community wharves (floating docks). A breakwater surrounds these infrastructures and provides safety for the marine operation of fishing boats and supply boats. In the eastern part of Puvirnituq there is a second breakwater with floating docks attached (see Map A, pocket insert).

5.6.2.2 Electrical energy

The existing Puvirnituq thermal generating station is located east of the urbanized area. An oil pipeline carries fuel from the village supply boat to the fuel depot next to the generating station (see Map A, pocket insert).

5.6.2.3 Telecommunications

There are eight telecommunications antennas in the extended study area, primarily in the village center and in the Puvirnituq airport area (see Map A, pocket insert).

5.6.2.4 Drinking water and sewage

The Puvirnituq community water intake is located in the Rivière Puvirnituq near the northeastern boundary of the extended study area (see Map A, pocket insert). The water is pumped to the drinking water production facility located in the village. As most Nunavik communities are built on permafrost or rocky outcrops, they have no water supply or sewage system, as it is impossible to build underground conduits. Once the water is disinfected, it is pumped into tanker trucks to be distributed to all the buildings in the Puvirnituq community, which is equipped with a drinking water reservoir and another reservoir for wastewater. When the wastewater reservoirs are full, they are also emptied by tanker truck (N360, 2019). Wastewater is directed to a treatment pond located west of the village (see Map A, pocket insert).

5.6.2.5 Waste management

The KRG is responsible for implementing the waste management plan for Nunavik. It is also in charge of infrastructure improvements for northern landfill sites and wastewater treatment ponds across the entire territory of Nunavik. Every Nunavik community has to manage the operations of its own northern landfill, however, as well as waste collection. Household and commercial waste is collected weekly, and all the waste materials are combined and deposited in the community's landfill. Puvirnituq has two northern landfills, one in the northwestern sector of the village and a larger one in the southwestern portion of the extended study area (see Map A, pocket insert). Household waste stored at the landfill is burnt in the open air and then roughly compacted by machine. Covering materials may be included, depending on their local presence and the time of year (KRG, undated).

Less than 5% of waste materials are recovered or reused in Nunavik. The distance from major centers, the lack of roads connecting the communities in Nunavik and the high cost of marine freight transportation constitute major logistical constraints for recycling, as does the lack of human resources working on recycling projects. There are, however, programs to recover tires, industrial batteries and vehicle batteries, for shipment by boat (KRG, undated).

5.6.2.6 Extraction site

Several extraction sites (quarries or sand pits) are scattered throughout the extended study area, mainly in its eastern and southwestern portions (see Map A, pocket insert). There is only one active title (exclusive lease) for a site north of the airstrip. A few hundred metres north of the proposed site of the generating station is a former sand pit accessible by a road that crosses the limited study area.

5.6.2.7 Public safety

In Nunavik, police services are provided by the Kativik Regional Police Force (KRPF). The KRPF has a police station in each village, and the number of officers working in the stations depends on the size of the population. In addition to a police station, Puvirnituq has a fire service with a fire station and a vehicle for ambulance services.

5.6.2.8 Cultural and religious heritage

Two places of worship are located in the urbanized area of Puvirnituq: an Anglican church (St. Matthew's) and an evangelical church (Full Gospel Church). There is also a cemetery (see Map A, pocket insert).

5.6.2.9 Recreational activities

Among the infrastructures present in Puvirnituq and intended for recreational activities, there is an arena, an indoor pool, a gymnasium, a baseball field and two playgrounds.

Each year, the Puvirnituq Snow Festival offers a variety of traditional activities, including a snow sculpture contest involving Inuit artists (Air Inuit, 2020).

5.6.2.10 Tourism

Inuit Adventures offers tourist packages in Nunavik, including the "Ways of the Inuit" tour in Puvirnituq. This package explores the natural and cultural history of the Inuit people through a variety of traditional activities, including throat singing, carving and fishing (Inuit Adventures, 2018).

The village is home to the Puvirnituq Cooperative hotel. Located in the heart of the village, it has 40 rooms and a conference room for 50 people.

5.6.3 Socioeconomic profile

Population

According to Statistics Canada (2017a; 2017b), Puvirnituq had a population of 1,780 inhabitants in 2016, 51% women and 49% men (see Table 5-18). From 2011 to 2016, the population varied by 5.1%, which is lower than the population increase in Nunavik for the same period (9.1%) but higher than that of Québec as a whole (3.3%). Along with Kujjuaq, Inukjuak and Salluit, Puvirnituq is one of the four communities in Nunavik with a population of over 1,000 (KRG, undated).

The average age of the Puvirnituq population (25.8 years) is almost the same as that of Nunavik as a whole (32.0 years) but lower than that of the province (41.9 years; see Table 5-18). It is slightly higher for women (26.2 years) than for men (25.5 years). Puvirnituq has a higher proportion of people under the age of 15 (37.6%) and a lower proportion of people 65 and over (about 3.9%) than Québec as a whole (16.3% and 18.3%, respectively). The proportions of the population of Puvirnituq by age category are similar between men and women, except for the 65 and over category, where there are more women. The distribution of the population of Nunavik based on age is the same as that of the community of Puvirnituq (Statistics Canada, 2017a; 2017b).

Table 5-18: Sociodemographic Data of Puvirnituq Compared to that of Nunavik and Québec

Parameter	Puvirnituq			Nunavik	Québec
	Men	Women	Total		
Population in 2016	870	915	1,780	13,188	8,164,361
Population in 2011	–	–	1,692	12,090	7,903,001
Change in population from 2011 to 2016 (%)	–	–	5.1	9.1	3.3
% of population aged 0 to 14	37.4	37.7	37.6	27.5	16.3
% of population aged 15 to 64	58.0	57.9	58.1	64.7	65.4
% of population aged 65 or over	3.4	4.4	3.9	7.7	18.3
Average age	25.5	26.2	25.8	32.0	41.9

Source: Statistics Canada, 2017a; 2017b.

5.6.3.1 Households and housing

In 2016, the average household size in Puvirnituq was 3.9 people. This average is basically equivalent to that of Nunavik, at 3.6 people, but higher than that of Québec as a whole, which was 2.3 people per private household. The percentage of single-parent families was higher in Puvirnituq and in all of Nunavik—45.4% and 38.0% of the total number of families—than in Québec as a whole (16.8%). Nearly 75% of single-parent families in Puvirnituq are headed by women. The majority of Inuit in Nunavik rent their homes, at a rate of 97.8%, compared to 100% in Puvirnituq

(Statistics Canada, 2017a, 2017b). Table 5-19 presents the available data on households and housing for Inukjuak, Nunavik as a whole and Québec.

Table 5-19: Characteristics of Private Households and Housing in Puvirnituq Compared to Nunavik and Québec

Parameter	Puvirnituq	Nunavik	Québec
Total number of people in private households	1,750	13,115	7,965,455
Total number of private households	450	3,630	3,531,665
Average number of people in private households	3.9	3.6	2.3
Single-parent families (%)	45.2	38.0	16.8
Total number of private dwellings	450	3,625	3,531,660
Rented dwellings (%)	100	97.8	38.7

Source: Statistics Canada, 2017a; 2017b.

5.6.3.2 Demographic outlook

According to the Institut de la statistique du Québec (ISQ), the population of the KRG (considered to be a regional county municipality (MRC)) will increase from 13,300 inhabitants in 2016 to 16,700 in 2041, an increase of 25.5%. This MRC is among those that are projected to see the biggest increase in population by 2041. While Québec will be subject to an overall aging of its population in the next 25 years, KRG territory will have one of the lowest proportions of people aged 65 or over, at 8.6% compared to 26.3% for Québec as a whole. In 2041, the proportion of the population aged 0 to 19 is projected to be 36.8% for the KRG, and 19.5% for Québec. According to the ISQ's demographic projections, in 2041, the KRG will have the lowest average age of all MRCs in Québec—31.4 years—compared to 45.7 years for all Quebecers (ISQ, 2019).

5.6.3.3 Education and training

Kativik Ilisarniliriniq (formerly the Kativik School Board) is the school board that manages educational services in Nunavik. In the community of Puvirnituq, the Ikaarvik school provides preschool and primary education to more than 150 students, and the Iguarsivik school offers secondary education to more than 250 students. The Puvirnituq Adult Education Centre is also located in this building. Finally, there are two childcare centers (CPEs) in Puvirnituq, in the northern (Sarliatauvik Childcare Centre) and western (Arqsuivik Childcare Facility) sectors of the village (see Map A, pocket insert).

In terms of education levels, Puvirnituq has a much higher percentage of the population with no certificate, diploma or degree (72.2%) than Nunavik (58.3%) and the province of Québec (19.2%; see Table 5-20). This percentage is lower for women in this community (68.5%) than for men (74.5%). The percentage of the population with a

high school diploma or equivalency certificate is relatively similar for Puvirnituq (13.4%) and Nunavik (15.6%), but lower than that for the province of Québec (22.3%). While 58.5% of the population of Québec holds a postsecondary certificate, diploma or degree, that percentage is 14.3% for Puvirnituq and 26.1% for Nunavik (Statistics Canada, 2017a; 2017b). In Puvirnituq, more men have an apprenticeship, trade, college, CEGEP or other non-university certificate or diploma, while more women have a university certificate or diploma (see Table 5-20).

Table 5-20: Level of Education (Population Aged 15 and up) in Puvirnituq, Compared to Nunavik and Québec (%)

Highest level of education achieved	Puvirnituq			Nunavik	Québec
	Men	Women	Total		
No certificate, diploma or degree	74.50	68.50	72.20	58.30	19.20
High school diploma or equivalency certificate	8.50	17.10	13.40	15.60	22.30
Postsecondary certificate, diploma or degree	16.00	13.50	14.30	26.10	58.50
Apprenticeship or trades certificate or diploma [a]	58.80	20.00	38.70	47.70	22.30
College, CEGEP or other non-university certificate or diploma [a]	17.60	46.70	35.50	21.80	19.50
University certificate or diploma below bachelor level [a]	0	0	6.40	6.20	6.10
University certificate, diploma or degree at bachelor level or above [a]	17.60	26.70	22.60	24.20	35.10

a. Data from "Postsecondary certificate, diploma or degree" category.

Source: Statistics Canada, 2017a; 2017b.

5.6.3.4 Economy and employment

The Statistics Canada data (2017a; 2017b) presented in Table 5-21 show that the labor market participation rates in Puvirnituq and Nunavik are slightly higher (67.7% and 70.9%) than that of Québec as a whole (64.1%). The employment rate in Puvirnituq (59.9%) is similar to that of Nunavik as a whole (60.1%) and of Québec (59.5%). The unemployment rate is clearly higher in Nunavik (15.4%) and Puvirnituq (11.6%) than in Québec as a whole (7.2%). Women in Puvirnituq have higher participation rates (69.4%) and employment rates (63.1%) than men (67.0% and 55.7%). The unemployment rate is twice as high for men (15.5%) as for women (7.8%). On average, women have a higher total income ($39,365) than men ($31,370). Nunavik has the highest total average annual household income, at $93,444. This figure is $81,359 in Puvirnituq and $77,306 for Québec as a whole.

Table 5-21: Labor Market Participation Rate, Employment Rate, Unemployment Rate and Average Income in Puvirnituq in 2015, Compared to Nunavik and Québec

Parameter	Puvirnituq			Nunavik	Québec
	Men	Women	Total		
Participation rate (%)	67	69.4	67.7	70.9	64.1
Employment rate (%)	55.7	63.1	59.9	60.1	59.5
Unemployment rate (%)	15.5	7.8	11.6	15.4	7.2
Total average income for population aged 15 and up ($)	31,370	39,365	35,511	–	–
Total average household income ($)	–	–	81,359	93,444	77,306

Source: Statistics Canada, 2017a; 2017b.

The local economy in Nunavik is characterized by local markets at the community level, a high cost of living and doing business, low consumer purchasing power and a low level of education in the active population. Since 2011, mining companies have been the main employers in Nunavik and therefore have a significant impact on the region's economy. The public administration sector also plays an important role in the regional economy (Makivik Corporation et al., 2014).

In Nunavik, the primary sector relies mainly on mining exploration and operations. In 2012, it represented over 40% of all economic activities, but it was only 2% for Québec as a whole (Robichaud and Duhaime, 2015). Hunting, fishing and trapping activities are rarely carried out for the purpose of trade, but it is difficult to evaluate the proportion of the Nunavik economy they currently comprise and how many Inuit take part in them regularly or occasionally (Makivik Corporation et al., 2014).

The secondary sector is far less important in Nunavik than in the rest of Québec. In 2010 and 2011, it represented 3.7% of the Nunavik economy, compared to 18.7% for Québec as a whole. Construction is the main area of activity, and the manufacturing industry is barely present (Duhaime et al., 2015).

The tertiary sector represented 75% of all economic activity in Nunavik in 2010 and 2011, similar to the percentage in Québec as a whole (Duhaime et al., 2015). The role played by public administration is crucial to the regional economic vitality of Nunavik. Funds channelled by the public administration to the purchase of goods and services, to investment and to transfer payments to individuals fuel this economy, in sums far higher than the personal expenditures of the inhabitants of the region (Duhaime and Robichaud, 2007).

In Nunavik's 14 villages, there are cooperatives that are members of the Fédération des coopératives du Nouveau-Québec (FCNQ). In addition to serving as grocery stores and general stores, they offer other services such as banking, post office and hotel management (FCNQ, 2018). In some villages, stores from the Northern/North Mart

chain also offer food products, clothing and other general merchandise (Northern/North Mart, 2020). These two businesses are major employers.

In Puvirnituq specifically, jobs are primarily in education, social, community and government services, and sales and service. Women are more represented in business, finance and administration, health, social and community services, and education, while men are predominantly employed in trades, utilities, and natural resources (Statistics Canada, 2017a). The Puvirnituq cooperative is active in the following sectors: retail sales, distribution of petroleum products, hotel services, restaurants, real estate, cable television and adventure tourism (FCNQ, 2018).

5.6.3.5 Health and social services

In Nunavik, the health and social service network is comprised of the Nunavik Regional Board of Health and Social Services (NRBHSS) and two institutions, the Inuulitsivik Health Centre and the Ungava Tulattavik Health Centre. The NRBHSS is responsible for overseeing the health and social service programs in Nunavik's 14 villages, and the health centers offer social services at a local community service center (CLSC), a child- and youth-protection center (CPEJ), an acute-care hospital center (CH), a residential and long-term care center (CHSLD) and a rehabilitation center for youth with adjustment difficulties (CRJDA). The Inuulitsivik Health Centre, in Puvirnituq, is responsible for the villages along the coast of Baie d'Hudson, and the Ungava Tulattavik Health Centre, in Kuujjuaq, is responsible for the villages along the coast of Baie d'Ungava (NRBHSS, 2020).

A few doctors, about 100 employees and midwives provide health care at the Inuulitsivik Health Centre. The CRJDA provides rehabilitation and social reintegration services to youth with behavioral, psychosocial or family problems in a group home setting. The CLSC and the ECYC (see Map A, pocket insert) are under the jurisdiction of the Inuulitsivik Health Centre (Inuulitsivik Health Centre, 2019; RRSSSN, 2020). Finally, a seniors' residence (Sailivik Elders' Home of Puvirnituq) is located in the western sector of the village, across from the Arqsuivik daycare center (Map A, pocket insert).

5.6.4 Cultural context

Inuit culture is rooted in a semi-nomadic past of hunters, fishers and gatherers. It was only beginning in the 1950s that the modern world upset this way of life. Prior to that, the Inuit lived in small camps with their extended families. Although the location of these camps changed with the seasons, they were within a hunting territory, and life was governed by the availability and movement of wildlife resources. Over time, the Inuit developed the skills and knowledge required to exploit the resources in their territory, which was shaped by a very harsh polar climate. The seasonal rhythms of life for the Inuit, unfolding in this unpredictable environment, allowed them to develop flexible adaptation strategies for unforeseeable situations (Stilwell, 2012, in SNC-Lavalin, 2015).

Despite a now-sedentary lifestyle, the relationship with the land and with open spaces is still at the heart of Inuit culture. The values, social organization, traditions, skills and knowledge that define Inuit culture have been deeply influenced by the geography and the northern climate (Association Inuksuk, 2020; Qumaq, 2010).

Community and family life today differs greatly from life in the past. The Inuit have had to adapt to many social changes, most of which were imposed on them by neocolonial government policies of sedentation. These changes included the introduction of new religions, the imposition of new education, justice and health systems, federal residential schools, the displacement of Inuit families into villages, the arrival of new diseases, the slaughter of sled dogs and more. Furthermore, with the establishment of villages, the Inuit had to adapt to new legal and decision-making organizational structures (Labrèche, 2012).

Despite sedentation—which led to a profound change in the Inuit way of life—mutual aid, sharing and solidarity still form the core of Inuit values. Harvesting and sharing traditional foods remain an intrinsic part of societal organization for the Inuit (Gombay, 2005; National Post, 2018).

The history of the community of Puvirnituq has been marked by tragic events. Indeed, the word "Puvirnituq" means "putrefied." It was given this name because all the inhabitants had succumbed to a winter famine and a strong odor was emitted when the thaw came (Avataq Institute, 2020).

Puvirnituq is an important cultural and artistic center in Nunavik: it is in this village that a cooperative was created to sell soapstone carvings. This community is also known for its defence of Inuit culture (Antomarchi, 2009).

5.6.5 Quality of life

Social determinants of health are a set of social and economic factors that influence people's health and their living and working conditions (Canadian Public Health Association, 2020). An analysis of the social determinants of health for the Inuit people demonstrates that health and quality of life are independent concepts. Life balance, life control, education, material resources, environmental/cultural connections and access to social resources are some of the key determinants of health (Canadian Polar Commission, 2014). For the Inuit, health and well-being are tied to cultural values. This means that their attachment to the land and its use is one of the main factors that contribute to their overall health (SNC-Lavalin, 2015). This holistic view of quality of life and well-being "*fosters social cohesion that is supported and strengthened by family, friends, community and the nation at large. Positive relationships, including those with the land, living beings, and ancestors, strengthen the sense of belonging to the world and foster the desire to live well."* (Lévesque, Radu and Trand, 2018 in Van Campenhout and Lévesque, 2018).

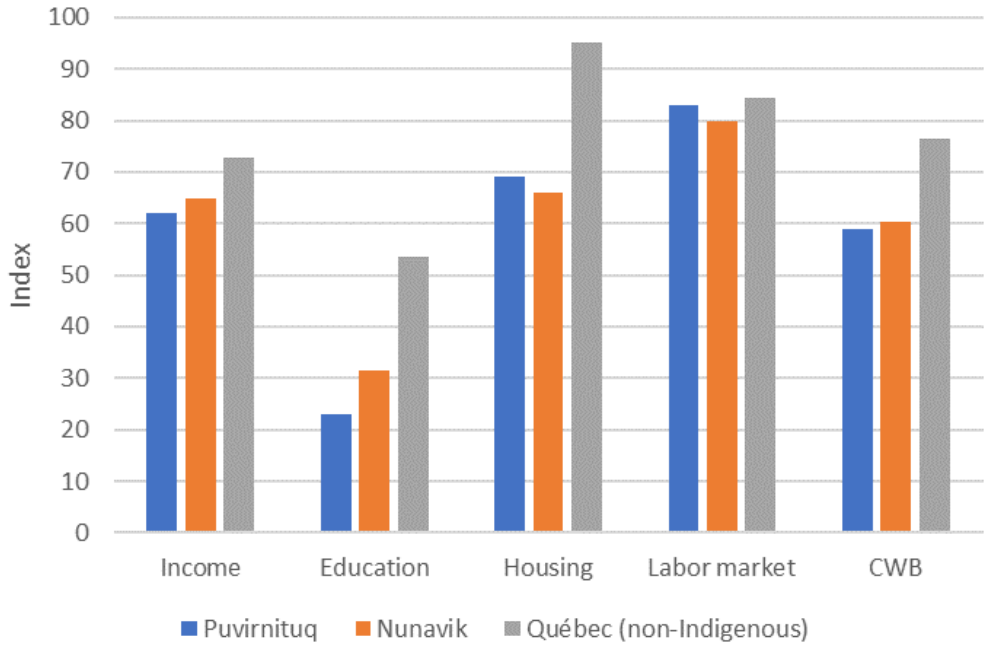
The Inuit of Nunavik are grappling with many social problems, including food insecurity, which affects a significant number of households, and seniors in particular. According to the Parnasimautik Consultation Report (Makivik Corporation et al., 2014), 44% of annual income is dedicated to food. Furthermore, living in a remote and isolated area leads to additional transportation costs for most goods, which, in turn, leads to a higher cost of living in Nunavik than in the rest of Québec (Duhaime, 2008). Daily household items are 97% more expensive than in southern Québec. Despite the existence of some government incentives or programs that aim to compensate for the effects of remoteness, this phenomenon has more serious impacts for certain groups such as pregnant women and children (Makivik Corporation et al., 2014).

Many Inuit families are also affected by a lack of housing, which leads to the phenomenon of overcrowding. Due to prohibitive construction costs and climate constraints, the real estate market has been unable to meet the growing housing needs of Inuit families (Dutil, 2010), which has a major effect on the quality of life of the Inuit. Overcrowding and lack of privacy are closely tied to social and health problems in families living in these conditions. For example, tuberculosis is 25 times more prevalent in Nunavik than elsewhere in Québec, and the lack of space and personal privacy is desperate. This issue is often cited as a factor that increases social tension and violence, undermines mental health and affects school performance and retention (Makivik Corporation et al., 2014; Duhaime, 2009).

This reality is reflected in the Community Well-Being (CWB) index for 2016. The CWB index has four components—education, labor force activity, income and housing—and the index score ranges from 0 to 100.[1] It is calculated using census data collected by Statistics Canada. Figure 5-3 shows the CWB scores for Puvirnituq, Nunavik and non-Indigenous communities. The graph shows significant differences, especially in terms of education and housing, when the data are compared with those of Québec's non-Indigenous population.

[1] The "education" component is made up of two variables: high school education or more and university studies. The "labor force" component includes two equally weighted variables: job market participation and employment. The "income" component is defined based on total income per inhabitant. Lastly, "housing" includes quantity and quality scores (dwelling requiring major repairs) (Indigenous Services Canada, 2020).

Figure 5-3: Community Well-Being Index for Puvirnituq, Nunavik and Non-Indigenous Communities in Québec in 2020



Source: Indigenous Services Canada, 2020.

The Inuit are also facing high rates of violence (physical and sexual violence and property crimes), as well as a significant increase in crime in the communities over the past several years. The main reported crime is conjugal and family violence, strongly correlated with drug and alcohol use problems. In this regard, 80% of criminal incidents reported in Nunavik appear to be related to substance use problems (Anctil, 2008).

Lastly, one of the most worrisome aspects of Inuit health is the high rate of psychological distress and suicide attempts: Nunavik has the highest suicide rate in Québec, representing 24% of deaths, or about 10 times higher than the other regions of the province (INSPQ, 2008).

5.6.6 Air quality

There is no government air quality monitoring station in Puvirnituq or anywhere else in Québec's far north. Due to the distance from major urban or industrialized areas, the air quality is good most of the time. The oil used to heat homes and domestic hot water and the diesel generating sets used to run the electricity-producing thermal generating station are the main sources of atmospheric pollution that could affect the local air quality, mainly due to nitrogen oxides (NO_2) and fine particular matter ($PM_{2.5}$).

As Puvirnituq is located at 60°N latitude, it is highly likely for the region to be affected by periods of arctic haze during the winter. According to Phillips (2013), this haze is

composed mainly of sulphur and nitrogen compounds (as a gas, fine liquid or solid particles called aerosols) of human origin, along with naturally occurring substances such as sea salt, wildfire ash and soil dust carried by the wind all over the planet. Haze covers most of the area above 60°N. Concentrations tend to peak at the top of the inversion layer (400 m to 800 m above ground level) and decrease beyond that. Arctic pollution levels are also generally 10 to 20 times higher than those over Antarctica and 10 times greater than over non-industrial areas of North America. This phenomenon results from the combination of at least three mechanisms: wintertime inversions form invisible barriers through which accumulated pollution cannot escape; large weather systems that control the movement of pollutants into, through and out of the Arctic are quite vigorous in winter and usually have a northward flow; and in winter, the air passes over what is essentially a frozen desert and there is little rain or snow to wash out pollutants.

5.6.7 Heritage and archaeology

5.6.7.1 Regional and historical context

The archaeological potential was analyzed as part of this study. The following sections present the main findings of this analysis.

Human occupation of Nunavik is relatively recent. Between 80,000 and 6,000 before present (BP), most of North America was covered by ice. About 4,500 years ago, the settlement of the Eastern Arctic began with groups of hunters from the Bering Strait (Eastern Siberia and Alaska), who were traveling eastward in search of game. Two major cultural groups are represented in Nunavik: the pre-Dorset and Dorset peoples, of the Arctic small-tool tradition, and the Thule culture Inuit, who are the ancestors of the present-day Inuit.

The pre-Dorset people occupied Nunavik from 4,400 years to 2,400 years BP. The oldest known site in the region, KcFr-5, is located in Ivujivik and dates back to 4,400 BP. The Dorset people, descendants of the pre-Dorset people, occupied Nunavik from 2,400 to 900 BP. Their disappearance is not explained and has generated debate in the Arctic archaeological community. In Nunavik, however, the end of the Dorset period seems to have preceded the arrival of the Thule culture Inuit or to have occurred at the same time. The Thule culture Inuit arrived in the Eastern Arctic around 750 BP. Their subsistence economy was essentially based on whaling, as their settlement pattern is tied to this practice. To date, the oldest Inuit site in Nunavik, JeGn-2, was discovered on Île Smith (in Akulivik) and dates from 740 ± 2 BP.

The historical period officially began in the 15th century with the first contact between the Inuit and the English, French and Danish explorers seeking a passage to Asia. This period is linked to the development of trading posts and religious missions. The first post in the region, Fort Richmond, was established by the Hudson's Bay Company (HBC) in 1750 at Lac Guillaume-Delisle. It closed in 1756 due to lack of profitability.

In 1921, the Révillon Frères company opened a post at Kangiqsuruaq, on a bay located about 30 km south of Puvirnituq. The post is named Povungnituq, apparently because of its proximity to Puvirnituq. In 1923, the HBC opened a neighboring post. The rivalry between the two companies continued until 1936, when Révillon Frères closed all its stations and declared bankruptcy.

Taamusi Qumaq says:

> PUVIRNITUQ means "putrefied." It was here that an entire community of Inuit died in a famine one winter; not a single survivor remained to tell of the event. The following spring, the igloos melted, and people found the corpses giving off the odour of putrefaction. The community was named to commemorate the event, although it's not a very felicitous name for a town.
>
> The first Qallunaat did not arrive in Puvirnituq until 1952. This was about the same time that the Inuit began living in houses. (Avataq, undated)

In the summer of 1952, the HBC moved its post from Kangiqsuruaq to the present site of the community of Puvirnituq, where many Inuit were already living. In 1953, Peter Murdoch became the manager. In 1955, government assistance began. In 1956, Umikallak (Father André Steinmann), a Catholic missionary who spoke fluent Inuktitut, moved to Puvirnituq, established a mission and built a small chapel. In 1970, the federal education system was eliminated in favor of the provincial system, which allowed for an increase in the number of courses with Inuit cultural content: instruction began to be provided not only in English, but also in French and Inuktitut.

In the 1970s, the Inuit of Puvirnituq strongly opposed the Baie-James hydroelectric project launched by the Québec government. In 1978, along with the Inuit of Ivujivik and half of the Inuit of Salluit, they founded an association of dissidents, the Inuit Tungavingat Nunamini (ITN), which refused the application of the JBNQA in their communities. One of the most significant figures in Nunavik's dissent and history is undoubtedly Taamusi Qumaq. A hunter, a great defender of Inuit culture and mayor of Puvirnituq from 1962 to 1968, Qumaq was a true self-taught intellectual. Among his many accomplishments, he helped establish Nunavik's first art cooperative in 1958, wrote and published a unilingual Inuktitut dictionary, and created the Saputik Museum in 1978.

5.6.7.2 Archaeological potential

Method

The archaeological potential study includes an inventory of known sites in the study area and an assessment of areas of archaeological potential. This theoretical assessment was made by analyzing different cultural and environmental elements related to the geomorphological evolution of the landscape and from the historical sources available for the territory (aerial photos and historical photos). Traditional Inuit place names were also used to identify areas of potential archaeological interest. Areas that may have been occupied or used by pre-Inuit or Inuit groups were mapped according to four levels of archaeological potential: very strong, strong, moderate and weak.

Inventory of known sites

Little archaeological research has been done at Puvirnituq. There are four archaeological sites in the study area: JaGh-1, JaGh-3, JaGi-2 et JaGi-3 (see Map 5-3), all of which are of Inuit origin. JaGh-1 was a Thule-Inuit winter camp of 13 Qarmait (semi-subterranean houses), now destroyed. This site was roughly located between the present Northern Store and the Anglican Mission. JaGh-3 was a summer camp located on the west side of the village, near the seniors' residence. Initially there were 13 historic tent structures. However, the precise location of this site and its remains are unknown. Further west, JaGi-2 and JaGi-3 are two Inuit sites (with no specific cultural affiliation), established on a large boulder field between the municipal dump and a borrow pit.

JaGi-2 has four circular depression housing structures, seven storage pits and two *qajaq* (kayak) caches. In the immediate vicinity of the site, a pylon used as a marker for Inuit airplanes was erected in the 1980s, altering a structure on the site. JaGi-3 initially had 10 storage pits and a large boat cache. However, in the late 1990s or early 2000s, a municipal cemetery and access road were developed adjacent to the site. At this time, we do not know what is left of JaGi-2 or JaGi-3. A visual field inspection will be conducted to determine the condition of these two sites or to assess what has survived at each.

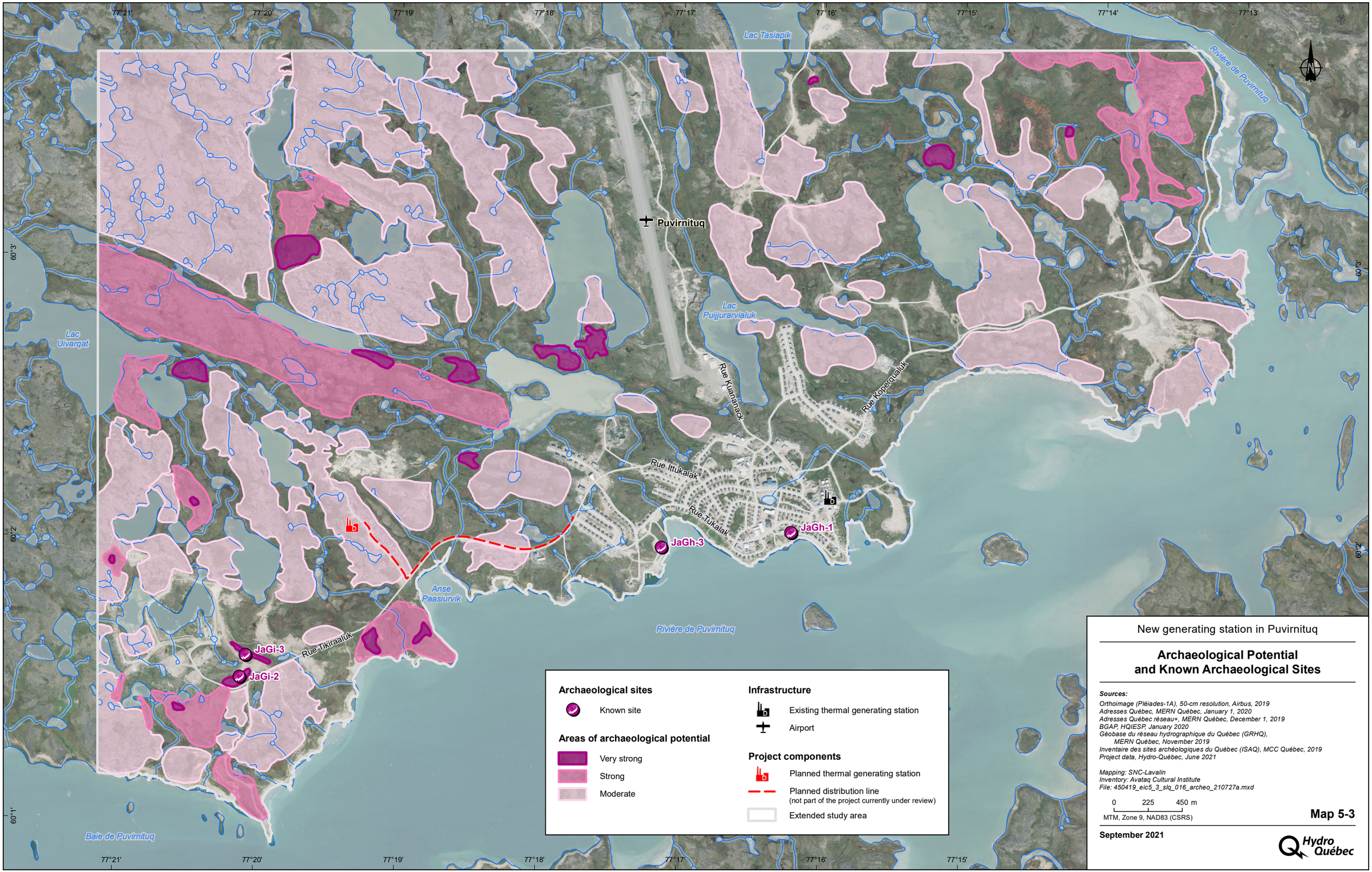
Areas of archaeological potential

Areas where anthropogenic structures were seen on satellite imagery are indicated on Map 5-3 as areas of very high archaeological potential. The areas with high archaeological potential correspond mainly to boulder fields or marine terraces well defined on satellite images. They also represent sectors close to archaeological sites or whose place names are evocative. Areas where anthropogenic (probably archaeological) structures were seen on satellite imagery are included in these areas.

Moderate potential areas are more varied: they may be areas that are likely to be topographically similar to high potential areas, but for which satellite imagery is less defined (and whose status is therefore difficult to determine with precision). They may also correspond to areas that would previously have had high archaeological potential, but which are now disturbed. Finally, there may be large areas with rocky ridges and small, interesting spaces between wetlands.

Areas of low potential are not listed; they are usually densely populated areas, swamps or other wetlands, ostiole fields, and completely destroyed, reworked or disturbed areas such as borrow pits.

The sector chosen for the construction of the new Puvirnituq generating station has moderate archaeological potential. Based on satellite imagery, this area appears to be a relatively flat, low ridge, likely formed of reworked till, with several rocky outcrops. Between the flats and the outcrops, the low-lying areas consist of numerous swamps and wetlands, which reduces their archaeological potential. A systematic archaeological inventory should be conducted to validate the presence or absence of archaeological structures.



New generating station in Puvirnituq

Archaeological Potential and Known Archaeological Sites

Sources:

Orthoimage (Pléiades-1A), 50-cm resolution, Airbus, 2019
Adresses Québec, MERN Québec, January 1, 2020
Adresses Québec réseau+, MERN Québec, December 1, 2019
BGAP, HQIESP, January 2020
Géobase du réseau hydrographique du Québec (GRHQ), MERN Québec, November 2019
Inventaire des sites archéologiques du Québec (ISAQ), MCC Québec, 2019
Project data, Hydro-Québec, June 2021

Mapping: SNC-Lavalin
Inventory: Avataq Cultural Institute
File: 450419_eic5_3_slq_016_archeo_210727a.mxd

0 225 450 m
MTM, Zone 9, NAD83 (CSRS)

Map 5-3

September 2021

Hydro Québec

5.6.8 Landscape

5.6.8.1 Regional landscape

Based on the reference ecological classification developed by the MELCC, the extended study area is part of the natural province of the Péninsule d'Ungava. Surrounded by Baie d'Ungava, Baie d'Hudson and Détroit d'Hudson, this natural province forms an immense, gently undulating plateau, comprised of very rocky soil and bedrock dating back to the formation of the Earth. The summits rarely exceed 400 metres, other than in the far northeast of the natural province, near Détroit d'Hudson, where they may reach 650 metres. A great many small bodies of water are scattered across the plateau. Covered with continuous permafrost, this natural province has the harshest climate in Québec, a semi-arid polar climate with a very short growing season. It is dominated by lichen, grasses and low-growing, prostrate woody vegetation. Shrub tundra is present in sheltered areas, as well as a few conifer stands on the floor of large valleys in the southern part of the natural province (Li et al., 2019).

5.6.8.2 Landscape of the extended study area

The landscape of the Puvirnituq region is characterized by a broad plateau dotted with countless lakes and rivers (Makivik Corporation, 2019b). The shallow topography and lack of forest cover generally provide open and deep views of the area. Located 4 km from Baie de Puvirnituq, the village is bordered by the river of the same name. The lack of hills around the village limits views of the village and the coast from the hinterland. Coastal waters are predominant.

The landscapes of the extended study area can be divided into four types: the village core, disturbed areas, tundra and wetlands, and the Rivière de Puvirnituq water body. The village core is composed mainly of residential, institutional and commercial areas, as well as a few industrial areas. Disturbed areas are concentrated in the northern (airport, extraction sites and access roads) and western (extraction sites, northern landfill, sewage lagoon and access roads) portions of the extended study area. Tundra, with extensive wetlands, rocky outcrops and several water bodies scattered throughout, is the dominant landscape type in the extended study area. The water body of the Rivière de Puvirnituq occupies the entire southern part of the extended study area.

The site of the future generating station is part of a landscape composed of tundra, wetlands and water bodies, and is located in an area already disturbed by mining operations. The site is mainly visible to occasional mobile observers who use the road to the west, or to residents who use the area for hunting, fishing, trapping, berry picking and snowmobile or ATV traffic. Fixed observers located in the residential area west of the village of Puvirnituq are likely to have a permanent but distant view of the planned thermal generating station (see Photos 5-2 to 5-4).

Photo 5-2: Typical Tundra and Wetland Landscape of the Extended Study Area

Photo 5-3: Looking West from the Village of Puvirnituq

Photo 5-4: View Towards the Village and the Rivière de Puvirnituq from the Site of the Planned Generating Station

6 Impact analysis and mitigation measures

This chapter describes the impacts that the new thermal generating station could have on the biophysical and human environments during the construction and operation phases. The impact assessment method is explained (Section 6.1), the issues are analyzed (Section 6.2), the valued environmental components are identified (Section 6.3), the sources of impact are described (Section 6.4) and the general mitigation measures are outlined (Section 6.5).

Sections 6.6, 6.7 and 6.8 describe the environmental components that will be affected by the proposed facility, including survey results, and present an impact analysis along with specific mitigation. The chapter concludes with Section 6.9 on cumulative impacts.

6.1 Impact assessment method

The impact assessment is based on the description of the project and the host environment, information gathered from the public participation process, scientific literature and lessons learned from previous projects:

- The description of the project serves to determine the sources of impact, i.e., the aspects of future facilities that, during construction or operation, could have a positive or negative effect on an environmental component.
- The description of the host environment explains the natural and social setting for the project.
- The public participation process exposes the concerns expressed by the affected groups.
- The scientific literature and lessons learned from earlier projects help determine the sources of impact, assess certain impacts that recur from one project to the next, and select appropriate mitigation and compensation measures.

The impact analysis has four stages:

- Describe the current conditions pertaining to each affected environmental component, with the appropriate level of detail.
- Describe sources of impacts connected with building and operating the proposed facility.
- Determine the potential impacts on each affected environmental component and select the appropriate general and specific mitigation measures.
- Describe and assess the residual impacts, i.e., the impacts remaining after the implementation of mitigation measures, and describe any compensation measures.

Only the valued components of the environment for which an impact is anticipated are assessed. The rationale for the selection of components for assessment (or not), which is also based on the project issues, is stated prior to the application of the impact assessment method.

General mitigation measures and project-specific measures are identified prior to the assessment of residual project impacts. These measures are designed to reduce negative impacts. Hydro-Québec has a number of tools to determine the general or specific mitigation measures to be applied in the context of a project, including Standard Environmental Clauses (SECs), which group together a series of measures that contractors responsible for carrying out construction work must put in place. Hydro-Québec also incorporates mitigation measures into project tender documents to ensure that they are applied on the jobsite.

The impact assessment carried out according to the method outlined in Appendix E is aimed at determining the significance of a project's residual impacts on environmental components during its construction or operation. The assessment takes general and special mitigation measures into account, and covers both the positive and negative impacts of the project. The significance of an impact is determined based on three criteria: intensity, scope and duration. Impacts are classified according to their significance as major, moderate or minor.

6.2 Issues

The issues represent the major concerns raised by the parties involved in the project, the analysis of which could influence the government's decision as to whether or not to authorize the project. They are determined by taking into account the potential interactions between the project and the valued components of the environment and the concerns expressed by the parties involved.

For the new thermal generating station in Puvirnituq, the proposed project, available knowledge of the natural and human environments, and meetings held by Hydro-Québec with the Inuit community and other stakeholders were taken into account to determine the following issues:

- survival and movement of land animals and birds, including special-status species
- maintaining air quality, reducing greenhouse gases and fighting climate change
- preservation of the soundscape
- maintaining resident safety and quality of life and protecting public health
- reconciliation between land uses and traditional community activities
- preserving archaeological resources

The valued environmental components targeted for impact analysis are related to project issues. These are described in the following paragraphs.

Survival and movement of land animals and birds, including special-status species

The survival and movement of land animals and birds and the destruction or alteration of their habitats or the possible destruction and alteration of habitats for species at risk are elements, specified in the project directive, for which impacts must be assessed. Special-status species are also legally protected by the federal and provincial *Threatened or Vulnerable Species Act* and the *Species at Risk Act*.

Caribou and birds are the valued components of the project to be considered. Caribou were selected because their presence was confirmed in the limited study area during field surveys, this species is valued by the Inuit and human activities are known to affect caribou behavior. It should be noted that the extended study area overlaps with the annual summer range of the Leaf River herd (Taillon et al., 2016).

Birds were also selected as a valued component, particularly species of precarious status likely to breed near the limited study area, namely the red-necked phalarope, peregrine falcon and short-eared owl. Habitat loss is one of the primary threats to this group.

Local people have expressed concerns about the disturbance of geese and the risk of collision with the distribution line. Goose hunting is an important activity in northern communities, taking place every spring and fall during the migration.

Geese could be disturbed by noise during construction and, to a lesser extent, by the operation of the generating station. These disturbances are, however, occasional and are related to the duration of the construction or to the comings and goings of the few staff members during the operation.

The distribution line from the power station to the village is not, strictly speaking, part of the environmental permit. However, its presence close to the coast (50–300 m) could pose a collision risk for birds. This line will run along rue Tikiraaluk to the village and will be located between likely staging and feeding areas, between the Rivière de Puvirnituq and some wetlands (Map A, pocket insert).

Geese and ducks are among the species at risk of collision with power lines due to their flight type and gregarious behavior (APLIC, 2012). These collisions occur in most cases near water bodies (<250 m), but the majority of studies seem to show a risk of collision with the higher transmission lines, not with the distribution lines. While there is a risk of collision, the impacts of the lines on waterfowl populations are negligible, and mitigation measures are generally recommended for protected species with low abundance and restricted distribution.

The risk of collision is low, but due to the concerns expressed by the residents of Puvirnituq, the situation will be monitored and, if necessary, corrective measures will be taken.

Maintaining air quality, reducing greenhouse gases and fighting climate change

Maintaining air quality, reducing GHGs and fighting climate change are objectives that contribute to the protection of the environment and species, human health and quality of life.

The reduction of GHG emissions is one of the main measures recommended in the Québec *2013–2020 Climate Change Action Plan*. The province has committed to GHG reduction targets that challenge the entire industrial sector. In addition, players in this sector must demonstrate that they preserve air quality by complying with standards and criteria specified in provincial regulations.

The operation of the generating station is likely to emit GHGs and substances that can affect air quality. It is important to mention that the dismantling of the existing thermal generating station, which is at the end of its life and located in the center of the village of Puvirnituq, will eliminate this source of emissions near several sensitive receptors.

Preservation of the soundscape

Each living environment has its own soundscape, which comes from environmental noise, neighborhood noise and activity noise. Noise is considered a potential source of nuisance that can affect the quality of life and, in the worst cases, have repercussions on psychosocial and physiological health. Québec and many municipalities have therefore adopted standards and criteria to control the population's exposure to noise.

Operation of the thermal generating station will be a source of noise. Perceptible on the periphery of the installations, it will mainly come from the operation of the generating sets. The future generating station is far from the built environment, unlike the current generating station, which is located in the center of the village. The dismantling of the existing thermal generating station at the end of its life will eliminate this source of noise and improve the situation.

Preserving the soundscape will help maintain the quality of life of the village's population and is an issue in this impact study.

Maintaining resident safety and quality of life and protecting public health

The *Directive pour la réalisation d'une étude d'impacts sur l'environnement* states that the purpose of an environmental assessment is to protect human life, health, safety, welfare or comfort. The effects of potential contamination of the biophysical environment on the health of the population must therefore be considered.

For the new generating station project in Puvirnituq, compliance with applicable government criteria, requirements and standards is a primary factor in promoting public safety and physical health. This compliance is also fostered by the introduction of additional best practices or mitigation measures, as well as the application of an appropriate environmental monitoring and follow-up program.

The issue of public safety and quality of life for residents is associated with the valued component of the human environment discussed in this study, namely quality of life, health and safety.

Reconciliation between land uses and traditional community activities

According to the land use analysis documented for this project, the limited study area is a site used for hunting, fruit and berry picking and gathering. In the case of the first two activities mentioned, this is a minor issue, as they will still be possible, although slightly displaced. The gathering place at the future generating station is highly valued by the community and will be moved to a location chosen by the community. The presence of the new generating station on this site will therefore disturb hunting, fruit and berry picking and gathering habits: it will displace them, but not prevent them.

Preserving archaeological resources

Although most known archaeological sites are recorded, not all are legally protected. However, the *Cultural Heritage Act* provides for the possibility of assigning legal status to archaeological properties and sites. The analysis of archaeological potential carried out as part of this project showed that the generating station site is located in an area with average archaeological potential. An inventory will therefore be conducted prior to construction to confirm the presence or absence of sites. Archaeological excavations could also be conducted as an additional mitigation measure.

The valued component of sites of cultural, historical and archaeological interest is not an issue. Preservation of artifacts will be ensured if any are found.

6.3 Identification of valued environmental components

The valued environmental components were identified by taking into account elements of the environment deemed important by the various project stakeholders, as well as the considerations of government agencies and those expressed by the MELCC in the project directive.

The following valued environmental components were selected for the analysis of the anticipated impacts of the project:

- soil
- surface water
- wetlands
- caribou
- birds
- air quality
- greenhouse gases and climate change
- soundscape
- services and infrastructure
- land use
- economic spinoffs
- health, safety and quality of life
- archaeological sites
- landscape

Some environmental components were excluded from the impact analysis for the reasons explained below.

Special-status vegetation and plant species

The project site is covered by shrub tundra and rock outcrops. The shrub tundra, which is also very common in the region, represents almost 56% of the extended study area. No tree-like species are present, and shrubs do not exceed 2 m in height. In addition, no special-status plant species were observed in the limited study area. Accordingly, these components were not included in the impact assessment.

Aquatic environments and wildlife

The surveys carried out for this project confirmed that no perennial or temporary watercourses or water bodies are located within the limited study area. A total of eight shallow pools, more or less dry, are present in the minerotrophic open fen. No permanent or temporary encroachment will occur during the construction of the generating station.

In addition, as mentioned in Section 6.5, Hydro-Québec's environmental clauses will be applied during the work, which include several protective measures for sensitive areas and the aquatic environment. All work near watercourses or water bodies will be managed to minimize impacts on aquatic wildlife. The mitigation measures planned for the construction and operation phases will ensure the protection of the aquatic environment and its wildlife. As no direct or indirect impacts on aquatic wildlife are anticipated, this component was not included in the impact assessment.

Land wildlife

No amphibian, reptile or bat species were confirmed to be present in the limited study area or even in the project area, either through surveys conducted as part of this project (amphibians) or through data from other sources. Common terrestrial mammal species were excluded from the impact analysis because they were not associated with any particular issue during the consultations, and none of the anticipated impacts (e.g., habitat disturbance, loss and alteration, mortality due to machinery and vehicles) are likely to substantially alter the abundance of these species across the project area. Furbearers have good movement and dispersal capabilities, while small mammals have reproductive rates that make them insensitive to minor changes in their environmental. In the vast majority of cases, the affected individuals will move to adjacent habitats, making mortality due to machinery movement negligible.

With respect to special-status land mammal species, the least weasel, even if present, would experience negligible impacts: it occurs at low densities in North America, and the few individuals concerned would move to the many suitable habitats located in the periphery. In addition, this small member of the weasel family is versatile in terms of habitat use and has high reproduction rates when its prey is abundant, which would make its population relatively insensitive to the environmental changes associated with the project. Considering the scope of their home ranges and movements, as well as their presumed very low numbers, the presence of wolverines and polar bears in both study areas would be infrequent and of very short duration, if any. The potential impacts of the project on these two predators are therefore low. Furthermore, the limited study area does not present any particular interest for these species, an interest that is all the more reduced because the surface area of the site under study is very small.

6.4 Sources of impact

The sources of impact are related to the project implementation stages that could alter the environment in whole or in part, either temporarily or permanently. They are determined from knowledge of the project's technical characteristics, construction methods and planned mode of operation. The main construction, operation and maintenance activities that could constitute sources of impact are as follows:

Construction phase

- Development of the access road
- Excavation and blasting
- Levelling, backfilling and earthwork
- Construction of the generating station and related buildings and infrastructure
- Waste management
- Transportation and traffic
- Housing and worker presence
- Employment and purchases of goods and services

Operation phase

- Presence of infrastructures
- Operation of the generating station and fuel management
- Management of residual hazardous waste materials
- Servicing and maintenance of generating station

Development of the access road

The development of the access road consists of improving the existing road over approximately 450 m. It will be necessary to add fill (1,198 m^3 of granular material) to the road surface to allow heavy equipment to travel it and to the slopes of the embankment to prevent erosion.

Excavation and blasting

At the generating station site, the contractor will blast and excavate approximately 2,047 m^3 of rock to lay the generating station foundation. The spoil will be reused to level the ground.

Levelling, backfilling and earthwork

The platform will be graded and cleared with approximately 2,164 m³ of granular material.

Construction of the generating station

The construction of the generating station includes the following stages:

- Laying the foundations of the buildings
- The erection of buildings
- The installation of the equipment

Waste management

The project will generate construction waste (approximately 200 m^3). Upon agreement with the municipality prior to the work, a decision will be made to direct the waste either to the municipal landfill or south of the province.

Transportation and traffic

During the construction phase, the development of the road and the construction of the generating station will involve the transportation and circulation of labor, heavy vehicles and construction equipment.

Housing and worker presence

During the construction phase, workers will be housed in existing worker camps. Those from the south of the province will be present in the village for two years.

Employment and purchases of goods and services

The project will lead to the hiring of some local workers as well as the acquisition of local goods and services.

Presence of infrastructures

The presence of the generating station, substation and related infrastructure will prevent any use of the area where these elements will be located, which may limit certain land uses in the vicinity.

Operation of the generating station

The new generating station will operate on a full-time basis and will be equipped with more powerful and efficient gensets and other equipment than the current generating station.

Management of residual hazardous waste materials

Residual hazardous materials (RHM) will be sorted and stored on the generating station site in drums and other types of containers, which will then be shipped to Hazardous Materials Recovery Centers (HMRCs) in southern Québec. It is estimated that the amount of RHM generated by the new operating facility will be the same as that of the existing generating station.

Servicing and maintenance of generating station

Maintenance of the generating station will require actions to ensure the reliability and proper functioning of the facility. It consists of checking the equipment and carrying out repairs or replacements, as is the case for the current generating station.

The project implementation stages are presented in Section 4. The matrix of impacts (see Table 6-1) presents the interaction between the sources of impact and the valued environmental components.

It should be noted that the activities associated with the construction of the distribution line and the dismantling of the existing generating station and the rehabilitation of the site will be carried out in a second phase. They are therefore not covered in this impact study.

Table 6-1: Matrix of Potential Impacts of the Project

Environmental components	Development of the access road	Excavation and blasting	Levelling, backfilling and earthwork	Generating station construction	Waste management	Transportation and traffic	Housing and presence of workers	Employment and purchases of goods and services	Presence of infrastructures	Generating station operation and fuel management	Management of residual hazardous waste materials	Servicing and maintenance of generating station
Physical environment												
Soils	X	X	X	X	X	X				X	X	X
Surface water	X	X	X		X	X				X	X	X
Biological environment												
Wetlands		X	X									
Caribou	X	X	X	X		X				X		
Birds	X	X	X	X		X						
Human environment												
Air quality	X	X	X			X				X		X
GHG emissions and climate change		X	X			X				X		
Soundscape	X	X	X	X	X	X				X		
Infrastructure and services					X	X	X					
Land use	X			X	X	X			X			
Economic spinoffs								X				
Health, safety and quality of life					X	X	X			X		
Archaeology	X	X	X									
Landscape									X			

6.5 General mitigation measures

Hydro-Québec automatically applies general mitigation measures to reduce, at the source, the impact of its operations on the environment. These measures are described in Hydro-Québec's Standard Environmental Clauses (SEC) (Hydro-Québec Innovation, équipement et services partagés, 2018). General mitigation measures are particularly effective in limiting or preventing potential impacts on the physical environment (contamination, disturbance of soils and surface drainage, restoration of the environment). Protection measures are applied to sensitive areas, and all work carried out near watercourses is managed in such a way as to minimize the impact on aquatic wildlife and environmental components. The SECs are outlined in Appendix B.

Although Hydro-Québec is committed to systematically implementing all of the SECs in its projects, the following sections apply specifically to the new Puvirnituq thermal generating station project:

- Clause 1 – General
- Clause 2 – Noise
- Clause 5 – Snow Removal
- Clause 6 – Accidental contaminant spills
- Clause 7 – Drainage
- Clause 9 – Wastewater
- Clause 10 – Excavation and earthwork
- Clause 11 – Drilling and boring
- Clause 15 – Plant and traffic
- Clause 16 – Hazardous materials
- Clause 17 – Waste materials
- Clause 19 – Heritage and archaeology
- Clause 20 – Air quality
- Clause 21 – Site restoration
- Clause 22 – Petroleum product tanks and storage facilities
- Clause 23 – Blasting
- Clause 24 – Contaminated soil
- Clause 26 – Work in wetlands

Besides the measures listed in the SECs, Hydro-Québec will implement specific mitigation measures to further reduce the impacts of the project on the environment. The specific mitigation measures applicable are described in the following sections, which deal with impacts on the biophysical and human environments.

6.6 Impacts on the physical environment and mitigation measures

6.6.1 Soils

Present conditions

The future generating station will be built on loose deposits consisting mainly of medium to coarse sand and rocky outcrops. The access road will consist of a reworked embankment. The site has low slopes and no unstable conditions. Phase I of the environmental site assessment and environmental soil characterization did not reveal any contamination.

Anticipated construction-phase impacts and mitigation measures

Soil surface and profile

The planned construction work will require the development of an area of 1.66 ha, including 1.48 ha of natural land, which will be used for the infrastructure (platform, access road and ditch). Grading, blasting, foundation and access road construction could alter the surface soil composition and profile.

At this stage of the project, it was determined that the granular material would be sourced from existing borrow pits. If the establishment of a new borrowing source or the expansion of an existing one were required, the contractor would be responsible for obtaining the necessary authorizations. The exact location of the borrow sources will be known at the time of awarding the mandate for the production and supply of granular materials.

Transportation and machinery traffic should not cause much rutting, given the predominant type of surface deposits (sand and rock) and the very small area of low bearing capacity in the work area (30 m^2). In addition, the presence of permafrost will be taken into account during the work.

Before proceeding with the earthworks, a thin layer of organic surface soil will be stripped if necessary and placed in the work area. It will be used at the end of the work to cover the exposed mineral soils and carry out site restoration. The slopes of the platform will be covered in riprap to prevent erosion.

During the work, to limit the impact on the ground, Hydro-Québec will apply SECs 10, 15 and 23 regarding excavation and earthworks, equipment and traffic, and blasting. Upon completion of the work, the work areas and exposed surfaces will be restored in accordance with SEC 21.

Soil quality

Accidental spillage of petroleum products from the use of machinery and inadequate management of construction waste pose risks of soil contamination during construction.

In addition to the measures regarding accidental contaminant spills and contaminated soil, the contractor is required to apply the measures regarding equipment, traffic, hazardous waste management and waste materials (see SECs 6, 15, 16 and 17 in Appendix B).

General mitigation measures

The mitigation measures included in Hydro-Québec's SECs will greatly reduce impacts on soils during the construction phase.

In summary, the contractor will apply the following clauses:

- Clause 6 – Accidental contaminant spills
- Clause 10 – Excavation and earthwork
- Clause 15 – Plant and traffic
- Clause 16 – Hazardous materials
- Clause 17 – Waste materials
- Clause 21 – Site restoration
- Clause 23 – Blasting

Anticipated operation-phase impacts and mitigation measures

Soil surface and profile

No impact on soil stability is anticipated during the operation of the station. The platform on which the future generating station will be installed will be designed according to the design standards for such infrastructure in a northern environment, taking into account the widespread presence of permafrost in the area. This design ensures that the presence of the generating station will not affect the existing permafrost.

Soil quality

During the operation phase, fuel storage and refueling activities at the generating station and the management of used oil pose risks of soil contamination in the event of an accidental spill. Transportation, storage and management of products will be carried out in accordance with applicable provincial and federal regulatory requirements.

During this phase, there will be little change in the volume of dangerous goods transported as the new generating station will replace the existing one. The fuel (diesel) will be transported to the generating station from the port of Puvirnituq by tanker trucks (about 10,000 L to 15,000 L) over a distance of about 2.5 km. An average of seven fuel deliveries per week will be made.

Specific mitigation measures

Fuel will be stored in ULC-S653-compliant outdoor tanks and used oil will be recovered, in accordance with accepted practices, inside the main building, where it will be stored in drums and other types of containers. Used oil and other residual hazardous waste will be shipped to residual hazardous waste recovery centers in southern Québec for treatment.

As indicated in Section 8, Hydro-Québec will implement safety measures and an emergency response plan to prevent accidental spills and to implement the required spill response.

Assessment of residual impact

During construction, the ground will be disturbed and restored in the work areas. Only the area occupied by the infrastructure will remain permanently modified. The presence of the station will have no effect on the permafrost. Given the general and specific mitigation measures to be implemented for the construction and operation phases, the risks of soil contamination are low. The intensity of the impact will be low, its scope will be limited because it will be restricted to a small area, and its duration will be long, as the generating station will be in operation for 50 years. The significance of the residual impact on the soil is therefore deemed to be minor.

6.6.2 Surface water

Present conditions

At 145 m from the generating station site, an intermittent stream and a permanent stream flow into the Rivière de Puvirnituq, which is more than 400 m from the site. This one is surrounded by a few wetlands, one of which is a small one that it encroaches upon. The presumed surface water flow in the sector is southeastward, towards the Rivière de Puvirnituq.

Anticipated construction-phase impacts and mitigation measures

Excavation and earthworks, the construction of the access road, as well as machinery transport and traffic during the work, are likely to alter water quality through the input and suspension of sediment and the risk of water contamination in the event of accidental petroleum product spills. Inadequate management of construction waste is also likely to alter the quality of surface water.

Suspended solids could be carried to the nearest water body as a result of erosion of soils left bare during excavation and earthworks. Machinery traffic and use could also locally alter drainage, increase erosion and lead to an increase in suspended solids in the aquatic environment.

The contribution of suspended solids will remain negligible during construction, given the limited amount of sediment on the platform and the distance of more than 100 m from the nearest watercourse.

The work required to build the platform over an area of 1.48 ha of natural terrain will have little impact on local drainage, given the configuration of the site during the construction work, the presence of a gentle slope near the work site and the type of soil.

The breakdown of a piece of construction equipment near an aquatic environment or the runoff from an accidental spill could lead to water contamination by hydrocarbons. However, the distance between the work area and the watercourses, including the Rivière de Puvirnituq, is sufficiently large that this risk is very low.

General mitigation measures

The mitigation measures provided for in Hydro-Québec's SECs will greatly reduce the impacts of construction work on surface water quality and drainage.

The contractor will apply the following clauses:

- Clause 6 – Accidental contaminant spills
- Clause 7 – Drainage
- Clause 15 – Plant and traffic

Anticipated operation-phase impacts and mitigation measures

Fuel storage and refueling activities at the generating station during the operational phase represent the main risk of contamination of surface water in the event of an accidental spill.

Surface water from the northern part of the platform will flow north and surface water from the southern part will flow south. To the south of the generating station site, a drainage ditch will channel water to the southwest to prevent it from accumulating near the station and then direct it to an adjacent wetland.

As noted in the previous section, the transportation, storage and management of petroleum products will be conducted in accordance with the requirements of applicable provincial and federal regulations. In addition, Hydro-Québec will implement safety measures and an emergency measures plan to prevent accidental spills and take the required action, if necessary (see Section 8).

Assessment of residual impact

There will be minor changes to the site drainage around the generating station during construction and operation. Sediment inputs to the water environment will be negligible since the soils are essentially rock and granular materials. In addition, the platform's slopes will be protected with riprap. The risk of surface water contamination by petroleum products and oils is low since current mitigation measures will allow for their proper management and thus prevent accidental spills. The water environments are far enough away from the generating station site that the risk of them being affected is low.

The intensity of the impact will be low, its scope will be limited because it will be restricted to a small area near the generating station, but its duration will be long, as the generating station will be in operation for 50 years. The significance of the residual impact on surface water is therefore considered minor.

6.7 Impacts on the biological environment and mitigation measures

6.7.1 Wetlands

Present conditions

Nine wetlands were identified within the limited study area in the vicinity of the proposed generating station. Five are open bogs, covered with prostrate shrub species (plateau) and herbaceous species (flatland). Three are marshes on the banks of dry ponds, and the last is a shrub swamp located in a small depression: it will be affected by the development of the generating station.

Anticipated construction-phase impacts and mitigation measures

A portion of the shrub swamp wetland (WL02) will be directly affected by the preparatory work and the installation of the work site, as well as by the grading, backfilling and earthworks. Thus, an area of 26.8 m² of this wetland will be destroyed (see Table 6-2).

The construction of a drainage ditch will also affect it indirectly (Map 5-2). Wetland WL02 is located in a small depression adjacent to the generating station platform. In order to avoid water accumulation near the foundations, even if there is no visible sign of water accumulation (hydrological indicator), a drainage ditch will be installed in the south direction, towards wetland WL03. In addition, the type of drainage, rated as "imperfect," and the presence of rock at a depth of only 8 cm suggest that water does not tend to accumulate significantly in this environment. However, it is considered that the drainage ditch will cause wetland drainage and that this work will result in a loss of 520 m² of wetland (see Table 6-2).

Table 6-2: Altered Area of Wetland WL02 by Type of Impact

Source of impact	Type of impact	Altered area (m²)	Impact on the environment	Main ecological function affected
Platform	Direct	26.8 [a]	Permanent loss of surface area	Biodiversity conservation: slight loss of habitat for wildlife
Drainage	Indirect	520	Changes in environmental integrity and composition	Water level regulation: slight loss of effectiveness of this function due to the development of the ditch, which will favor water drainage instead of retention

a. The 26.8 m² are included in the 520 m² of total area.

The wetlands observed provide diverse quality habitats for local wildlife and perform important ecological functions, including maintaining biodiversity, carbon sequestration, water regulation and retention. Due to their considerable size in the limited study area (more than one third), the direct loss expected is negligible.

General mitigation measures

During construction, wetlands in the vicinity of the substation will be marked to ensure that they are not affected by the work. The Contractor shall apply Clause 26 (Work in wetlands) of the SECs.

Anticipated operation-phase impacts and mitigation measures

In the operational phase, the loss of 520 m² of wetlands will remain.

Assessment of residual impact

Given the small area of wetland directly affected, the potential impact of the drainage ditch on WL02 and the standard mitigation measures applied during construction, the intensity of the impact is considered low. It will be limited in scope, as it will be confined to a small area, and its duration will be long, as it will be permanent. The significance of the residual (negative) impact is therefore considered minor.

6.7.2 Caribou

Present conditions

Caribou found in the Puvirnituq area belong to the Leaf River herd. The extended study area lies between the herd's calving grounds to the north and the wintering grounds to the south. These caribou are therefore likely to use the spring and fall migration corridors as well as the summer range and, consequently, the extended study area and the limited study area (see Section 5.5.3.1).

Anticipated construction-phase impacts and mitigation measures

Construction will result in the loss of approximately 1.66 ha, mostly covered by shrub tundra. This area represents a tiny portion of the Leaf River herd's summer range (approximately 250,000 km^2; Taillon et al., 2016). The shrub tundra itself is not a habitat of interest for caribou. During the summer, the species mainly uses environments rich in grasses and deciduous shrubs, which are not abundant in the shrub tundra present in the limited study area.

A small functional loss of habitat is also anticipated due to possible avoidance of the periphery of the work area. This loss could affect an area a few hundred metres or even a few kilometres away. The avoidance of human disturbance by migratory caribou is well documented in the scientific literature (reviewed in Plante, 2020). For example, roads, villages, power lines, mineral exploration sites, mines, and other types of industrial disturbances generate avoidance responses that, depending on the nature of the disturbance, can be particularly pronounced (Plante, 2020). Caribou do not use the habitats located on the periphery of a work zone, which will result in their loss of function. If this were the case during the construction period, which overlaps with the period of occupation of the study area by caribou (approximately from early July to mid-September), the species would no longer use certain habitats of interest (e.g., peat bogs).

No source of impact poses a risk to the survival of caribou. The risks of collision associated with transportation and traffic are very low given the slow speed of vehicles on the work site and the good visibility that drivers will have (absence of trees or other visual screens).

Anticipated operation-phase impacts and mitigation measures

The presence of the generating station and the movements of employees could disturb some caribou, which would then move away from the area. However, the generating station is located relatively close to the village and other existing disturbances (road, airport, dump, borrow pits and access road), which already reduces the likelihood of use of nearby habitats.

Assessment of residual impact

The survival of the caribou affected by the project is not at stake. Behavioral impacts (avoidance) are only expected during the construction period and, to a lesser extent, during the operation period, due to the presence of the generating station and employee movements. The scope of the impact will be limited, as the area associated with the functional loss of habitat, due to possible avoidance of the generating station sector, would be negligible given the numerous replacement habitats present in the summer range. During the construction period, the duration of the impact will be short, with any effects only being felt for about two and a half months (from early July to mid-September) each year that construction work is planned; it will be long for the operating phase, with a projected duration of 50 years. The significance of the residual impact on caribou is therefore minor.

6.7.3 Birds

Present conditions

Fifty-five species of birds are likely to be present in the extended study area. Few species are observed in quantity and diversity in the limited study area. The generating station will be located on a rocky plateau, which is not conducive to the species of interest present in the extended study area, particularly waterfowl and shorebirds.

Anticipated construction-phase impacts and mitigation measures

The main impacts during construction are related to the loss of habitat at the generating station site (1.66 ha, including 1.48 ha of shrub tundra, the rest being disturbed areas). Earthwork will begin in late July or early August, and vegetation will not be removed until after the nesting season for birds that may be present at the site. According to the Birds Canada nesting calendar request tool (Birds Canada, 2020), the critical period for potential nesting species in the limited study area is approximately May 25 to August 15.

The loss of habitat will force some species to seek new habitat, but the impact will be negligible considering the small area affected and the abundance of similar habitat in the vicinity. The various construction activities and transportation and traffic may also disturb the birds and encourage them to move temporarily. Nevertheless, those who use

the affected habitats during the construction period will be able to easily relocate nearby.

In addition, although no special-status bird species were identified as breeding in the limited study area, a pair of red-necked phalaropes was observed nearby during the field visit. A peregrine falcon was also seen flying over Puvirnituq. As there are no cliffs in the study areas, it does not appear that this species can reproduce locally. No short-eared owls were identified in the study areas (limited and expanded) during the bird surveys, but historical data indicate possible nesting in the expanded study area. Potential habitat for this species in the extended study area remains abundant.

Anticipated operation-phase impacts and mitigation measures

The presence of the generating station will make the loss of habitat permanent, but the birds will have available habitat nearby. No impact on bird populations is anticipated.

Assessment of residual impact

The removal of vegetation and the presence of the generating station will result in a loss of small area habitat for birds. In addition, none of the special-status bird species is likely to be disturbed during construction, provided that there is no encroachment into wetlands outside the generating station site, particularly where the red-necked phalarope nests. The scope of the impact will be limited, as the use of the environment by the different bird species will be altered only within the sector of the generating station. The duration of the impact is deemed to be short for bird species that currently nest in the limited study area, as they will be able to use the tundra environments after the construction is completed. The disturbance of birds during the construction phase is also considered to be short term. The significance of the residual impact on birds is therefore deemed to be minor.

6.8 Impacts on the human environment and mitigation measures

6.8.1 Air quality

Present conditions

Air quality is considered good in the Puvirnituq region, mainly because of its distance from major urban or industrialized areas. Oil-fired building heating and domestic water heating, as well as the generation of electricity from the thermal generating station (diesel generators), are the main sources of air pollutants that could locally affect air quality.

Anticipated construction-phase impacts and mitigation measures

The construction of the access road, excavation and blasting, grading, backfilling and earthworks, as well as transportation and traffic are likely to generate dust during the work.

Standard air quality mitigation measures, i.e., Clause 20 of Hydro-Québec's SECs, will be implemented to mitigate this impact. Other standard dust control measures will also be applied during the construction work.

Section 6.8.2 presents more specifically the impact of the project on GHGs during the construction period.

Anticipated operation-phase impacts and mitigation measures

An atmospheric dispersion study was conducted to assess the compliance of the emission of atmospheric contaminants by the planned generating station with the emission standards set out in Québec's *Clean Air Regulation* (RAA). Appendix H presents the detailed study results.

The contaminants targeted by the study are nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), total particulate matter (TPM) and fine particulate matter ($PM_{2.5}$). A dispersion study was conducted based on the requirements of the *Guide de la modélisation de la dispersion atmosphérique* (Richard Leduc, April 2005) published by the MELCC Direction du suivi de l'état de l'environnement, and Schedule H of the RAA. Section 52 of the RAA, concerning stationary internal combustion engines, is applicable to the engines of the Puvirnituq thermal generating station. This section specifies the maximum amounts of contaminant emissions per unit of energy supplied by the fuel.

A level-2 dispersion model (AERMOD) was used to estimate the maximum concentration of the target pollutants in the ambient air. The odor level around the generating station likely to be generated by the engines was also verified and compared with the MELCC criteria.

The generating station will be equipped with two 1.86 MW gensets and two 1.39 MW gensets for a total installed capacity of 6.50 MW. Gensets will be equipped with EPA Tier 2 or Canadian Federal Tier 2 certified engines. The stacks of the four gensets will be 12 m high, 0.356 m in diameter and will have an inverted cone at their outlet. The operation of the generating station involves variable use of the gensets depending on the power demand, which varies according to the time of year (summer and winter) and the time of day (day and night). The dispersion study considered an operating scenario based on generating station operating conditions, source (generating sets), maximum genset capacity and anticipated engine speed.

The dispersion study also took into account the sensitive receptors of interest, presented in Appendix F, namely two daycare centers, two schools, a seniors' residence, the medical clinic, the arena and the gymnasium.

Simulation results indicate that for all contaminants under consideration, all calculated ambient air concentrations at ground level are below the MELCC RAA standards in the modeling domain.

The calculated odor levels would exceed the criterion for the 98th annual percentile of the hourly maximum 4-minute average odor concentrations. The extent of the area of excess odor levels would be restricted to a distance of 50 m from the boundary of the built area around the generating station. The odor criterion (99.5th percentile) would be met.

At the sensitive receptors of interest, all results are well below the RAA standards and criteria and the MELCC odor criteria.

The emissions analysis shows that the proposed operating regime would meet the emission standards of the RAA.

Assessment of residual impact

During the construction stage, the intensity of the residual impact on air quality is deemed to be low, and its scope will be limited, since most of the work will take place at the site of the planned generating station. The duration of the impact will be short, as it will stem from certain construction activities. The residual impact of the project on air quality is considered to be of minor significance.

During the operation phase, the existing thermal generating station, located in the heart of the village of Puvirnituq, will be dismantled. Following the commissioning of the new thermal generating station, a significant improvement in air quality in the village is anticipated due to the installation of the latest generation of more efficient generators. Overall, during the operation period, the project's impact on air quality is deemed to be positive. Its intensity is considered moderate, its scope, local, and its duration, long. The significance of the (positive) residual impact on the air quality is considered moderate.

Section 6.8.2 presents the impact of the project on GHGs during the operational period in more detail.

6.8.2 Greenhouse gases and climate change

Present conditions

GHG emissions in the Puvirnituq region come mainly from oil-fired heating of buildings and domestic water, electricity production at the thermal generating station (diesel generators) and, to a lesser extent, vehicle traffic.

Anticipated construction-phase impacts and mitigation measures

Most of the GHG emissions to the atmosphere will come from the exhaust of land vehicles (on- and off-road) used in the construction of the new Puvirnituq generating station.

An estimate was established for the GHG emissions related the construction of the new Puvirnituq generating station. The consumption of fossil fuels (gasoline and diesel) was estimated based on the projected number of work hours for fuel-consuming equipment. It should be noted that the number of hours includes the total hours required to do the work, not the number of hours during which the vehicles and other equipment will be in operation. For this reason, the project's GHG emissions are overestimated.

Subsequently, for each type of equipment, consumption data were extracted from the manufacturers' technical specifications. In the absence of available consumption data, we matched the average hourly fuel consumption drawn from Figure 3 of the *2008 Canadian Vehicle Survey Update Report* with each type of equipment, depending on whether it is similar to a light-duty vehicle, a mid-sized truck or a heavy truck (see Table 6-3).

Table 6-3: Average Consumption by Type of Equipment

Type of equipment	Consumption (L/h) at a speed of 100 km/h [a]	Consumption (L/h) at a speed of 80 km/h
Light-duty vehicle	11.4	10
Mid-sized truck	23.0	19
Heavy truck	35.3	30

a. 2008 Canadian Vehicle Survey Update Report.

To calculate Project-related GHG emissions, emission factors from Part 2 of Annex 6 of Environment and Climate Change Canada's *National Inventory Report 1990-2016* (ECCC, 2018) and global warming potentials from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report were used.

For the entire construction of the new Puvirnituq generating station, fossil fuel consumption is estimated at 391,194 L of gasoline and diesel. The combustion of these volumes will emit approximately 1,032 t CO_2 eq. to the atmosphere over the life of the project (see Table 6-4). Table 6-5 shows the detailed GHG emissions for the project.

Table 6-4: Summary of Hours, Total Fuel Consumption and GHG Emissions for the New Puvirnituq Generating Station

Activity	Estimated hours	Total consumption (L)	GHG emissions (t CO_2 eq.)
Equipment (gasoline and diesel)	24,980	391,194	1,032

Table 6-5: Detailed Work Hours, Total Fuel Consumption and GHG Emissions for the New Puvirnituq Generating Station

Project stages	Sum of hours	Fuel consumption (L)	GHG emissions (t CO_2 eq.)
Exterior	***13,683.55***	***240,739.77***	***641.99***
Dump truck, 12-wheel	3,019.14	114,500.88	312.47
1.60 m^3 CAT 330CL hydraulic excavator on tracks	1,569.79	31,724.50	85.31
3/4 t 4x4 pickup truck	3,010.88	26,842.00	62.19
Concrete mixer 7.6 m^3	78.98	1,184.70	3.23
Hydraulic excavator on tracks 0.59 m^3 CAT 311D	319.85	2,845.98	7.65
Vibratory plate compactor, 13,500 lb. (28")	1,090.68	687.13	1.85
Crawler dozer CAT D4-C 58 kW 78 hp	922.98	7,984.57	21.47
Backhoe 1.00 m^3 CAT 416-D or Case 580	238.00	1,270.62	3.42
Tandem roller 5.8 t 142 cm CAT CB-434	770.83	6,858.74	18.44
76 to 115 mm Roc F7 hydr. drill without tip	569.17	12,981.59	34.91
Track loader 1.85 m^3 CAT 953-C	1,155.27	14,794.33	39.78
Pioneer SN3042 Primary Crusher	441.90	8,400.00	22.59
Pioneer M4840 Secondary Crusher	441.90	8,400.00	22.59
Mobile concrete plant and 250 kW generator	54.18	2,264.72	6.09

Table 6-5: Detailed Work Hours, Total Fuel Consumption and GHG Emissions for the New Puvirnituq Generating Station *(cont'd)*

Project stages	Sum of hours	Fuel consumption (L)	GHG emissions (t CO_2 eq.)
4.16 kV generating station	***8,130.04***	***105,705.49***	***273.32***
Telescopic aerial lift, gasoline-powered, 40'	1,777.50	24,760.58	66.58
Dump truck, 12-wheel	52.93	2,007.37	5.48
Hydraulic trackhoe excavator, 1.60 m^3 CAT 330CL	22.07	446.02	1.20
3/4 t 4x4 pickup truck	3,342.09	29,794.73	69.03
Concrete mixer 7.6 m^3	163.51	2,452.65	6.69
Hydraulic trackhoe excavator, 0.59 m^3 CAT 311D	4.40	39.15	0.11
Large vibratory plate compactor, 13,500 lb. (28")	309.16	194.77	0.52
Crawler dozer CAT D4-C 58 kW 78 hp	341.56	2,954.79	7.95
Tandem roller 5.8 t 142 cm CAT CB-434	319.49	2,842.78	7.64
Platform truck + crane 27.3 t Manitex 30124C	550.44	20,375.75	54.79
Concrete polisher 1,200 mm (gasoline)	94.63	167.97	0.43
Forklift 5,600 to 7,300 kg	535.25	6,987.69	18.79
Self-contained hydraulic crane, 36.3 t 4x4 Grove RT640E	535.25	9,263.68	24.91
Mobile concrete plant and 250 kW generator	81.76	3,417.57	9.19
Garage	***935.00***	***11,765.11***	***30.29***
Telescopic aerial lift, gasoline-powered, 40'	184.90	2,575.66	6.93
Dump truck, 12-wheel	5.00	189.63	0.52
Hydraulic trackhoe excavator, 1.60 m^3 CAT 330CL	2.50	50.52	0.14
3/4 t 4x4 pickup truck	411.15	3,665.40	8.49
Concrete mixer 7.6 m^3	19.69	295.35	0.81
Vibratory plate compactor, 13,500 lb. (28")	51.76	32.61	0.09
Crawler dozer CAT D4-C 58 kW 78 HP	56.26	486.70	1.31
Tandem roller 5.8 t 142 cm CAT CB-434	53.76	478.35	1.29
Truck platform + crane 27.3 t Manitex 30124C	66.50	2,461.64	6.62
Forklift 5,600 to 7,300 kg	36.82	480.69	1.29
Self-contained hydraulic crane, 36.3 t 4x4 Grove RT640E	36.82	637.25	1.71
Mobile concrete plant and 250 kW generator	9.84	411.31	1.11
12.5 kV step-up substation	***2,231.18***	***32,983.51***	***86.34***
3/4 mt 4x4 pickup truck	730.34	6,510.98	15.09
Concrete mixer 7.6 m^3	117.26	1,758.90	4.80
Vibratory plate compactor, 13,500 lb. (28")	147.44	92.89	0.25
Crawler dozer CAT D4-C 58 kW 78 HP	147.44	1,275.48	3.43
Tandem roller 5.8 t 142 cm CAT CB-434	147.44	1,311.90	3.53
Truck platform + crane 27.3 t Manitex 30124C	283.17	10,482.16	28.19
Forklift 5,600 to 7,300 kg	299.73	3,912.98	10.52
Self-contained hydraulic crane, 36.3 t 4x4 Grove RT640E	299.73	5,187.49	13.95
Mobile concrete plant and 250 kW generator	58.63	2,450.73	6.59
Grand total	**24,979.77**	**391,193.87**	**1,031.94**

Mitigation measures

Mitigation measures will be implemented to reduce GHG emissions from the emission sources listed in Table 6-4. The reusable excavated material will be used to restore the land around the generating station, which will reduce heavy trucking and, consequently, GHG emissions.

Anticipated operation-phase impacts and mitigation measures

The operation of the generating station will require servicing and maintenance activities that will sporadically demand the use of machinery and vehicles (lift trucks, snow remover, etc.). The emissions related to the consumption of fuel by the machinery cannot be quantified as this work is very variable. It is deemed negligible, however.

Table 6-6 presents estimates of the amount of fuel consumed during the operational phase. The GHG emission rate was calculated based on the actual measured value of the fuel delivered, i.e., 2,626 kg-CO_2/L eq.

It should be noted that it is anticipated that the new generating station will be designed to easily integrate a wind project and storage batteries. Space will be set aside to install telecommunications equipment capable of handling a wind-diesel pairing operation supported by battery storage. Additional space has been provided to add a fifth generator, which may be required in the very long term. The generating station will have solar panels to power these auxiliary services. The guaranteed power will ensure the reliability of the network for more than 30 years. The integration of renewable energy will optimize the cost of energy production for this self-sufficient network and should contribute to the reduction of GHG emissions over the entire life of the generating station.

In fact, starting in 2027, Hydro-Québec is aiming to integrate 46% to 62% of wind power into the system. The wind penetration scenario is the most conservative, and Hydro-Québec estimates that GHG reductions could be higher than calculated.

Table 6-6: Estimated Fuel Consumption and GHG Emissions for the New Puvirnituq Generating Station

Year	Fuel consumption (L)	GHG (t CO_2 eq.) [b]
2022	3,344,782	8,783
2023	3,430,989	9,010
2024	3,539,675	9,295
2025	3,632,211	9,538
2026	4,003,175	10,512
2027 [a]	2,219,602	5,829
2028	2,262,238	5,941
2029	2,279,776	5,987
2030	2,316,750	6,084
2031	2,344,281	6,156
2032	2,405,362	6,316
2033	2,419,424	6,353
2034	2,456,878	6,452
2035	2,482,094	6,518
2036	2,527,219	6,636
2037	2,543,504	6,679
2038	2,572,962	6,757
2039	2,604,579	6,840
2040	2,644,815	6,945
2041	2,656,530	6,976
2042	2,684,993	7,051
2043	2,705,788	7,105
2044	2,740,600	7,197
2045	2,766,134	7,264
2046	2,793,132	7,335
2047	2,798,404	7,349
2048	2,833,989	7,442
2049	2,836,383	7,448
2050	2,856,078	7,500

a. Start of integration of wind power into the grid.

b. Emission factor 2,626 kg/L CO_2 eq. (actual value measured on the delivered fuel).

Mitigation measures

Equipment will be maintained according to a plan based on manufacturers' recommendations and Hydro-Québec's expertise, without interrupting service.

Assessment of residual impact

During the construction phase, the intensity of the impact is deemed to be low and its scope limited, since most of the work will take place at the site of the planned generating station. The duration of the impact will be short, as it will stem from certain construction activities. The potential impact of the project on GHGs and climate change is considered minor.

The reduction of GHG emissions during the operational phase is considered a positive impact of low intensity. Its scope will be local and its duration long. The significance of the positive impact will therefore be minor.

6.8.3 Soundscape

Present conditions

The current generating station is located in the village to the east. Although the immediate environment of the generating station consists of industrial and commercial buildings, there are several noise-sensitive areas, mainly residential, to the south and west of the station. The closest residence to the generating station is approximately 100 m to the southwest. In 2012, sound surveys were conducted after the new generating unit No. 4 was commissioned to increase capacity.

During the day, the average sound levels measured around the generating station ranged from 50 dBA to 62 dBA. They vary mainly according to human activities in the village, especially vehicle traffic (motorcycles, cars, trucks). The noise from the generating station was barely audible or completely inaudible.

During the night, the average sound levels measured around the generating station ranged from 28 dBA to 41 dBA. With little or no human activity, the noise was due to noise emissions from the generating station.

Anticipated construction-phase impacts and mitigation measures

The construction of the new generating station will result in increased noise emissions in the village and may therefore cause nuisance. The most sensitive areas affected are the residences adjacent to the road leading from the unloading dock to the new generating station site. The loudest noise will be from truck traffic from the dock or borrow pits to the site of the new generating station. Given the distance between the site of the new generating station and the village, machinery work on the construction site (excavation, backfilling, etc.) will have a low impact.

Common and specific mitigation measures

These impacts will be reduced by implementing standard mitigation measures from Clause 2 (Noise) of Hydro-Québec's SECs (see Appendix B) as well as the following specific mitigation measures:

- Inform residents, especially those on streets near the wharf, of the period and times of the work before it begins.
- Set up a telephone line to inform the population of the progress of the work and deal with requests relating to specific problems.
- Plan work schedules taking into account the disturbance caused by noise. In principle, the work will be carried out from Monday to Friday between 7 a.m. and 7 p.m. Exceptionally, work could take place during the weekend.
- Educate workers, especially truckers, about noise emissions near residences (e.g., prohibit idling of unused vehicles and the use of the Jake brake on the work site and on nearby streets).
- Locate stationary equipment (such as compressors and generators) and other noisy construction equipment as far as possible from the nearest sensitive areas (residences).
- Use variable intensity reversing alarms (automatic adjustment according to ambient noise level) on construction equipment that is likely to reverse frequently.
- Establish a traffic pattern that takes into account the issue of noise from vehicles entering or leaving the work site; for example, avoid crossing or skirting residential areas whenever possible.

Anticipated operation-phase impacts and mitigation measures

In 1998, MELCC issued Instruction Note 98-01 on noise, which was revised in June 2006. It sets out the methods and criteria for judging the acceptability of noise emissions from stationary sources. A stationary sound source is bounded in space by the perimeter of the land it occupies and may consist of one or more elements, the sum of whose individual sounds constitutes the total contribution attributable to the source. The criteria of the original 1998 rating were renewed in 2006. However, the assessment methods have been modified by adding corrective terms for impact noise (KI), tonal noise (KT) and noise in special situations (KS). The assessment sound level (LAr) is the disturbance noise level plus applicable correction terms. In this case, we consider that the noise produced by the planned generating station during operation will not have characteristics that will require the application of a corrective term. This will have to be validated during the follow-up.

The MELCC defines noise criteria based on zoning categories established according to the uses permitted by the municipal zoning by-law and the residual noise. For example, on the property of a single or semi-detached dwelling built in a residential zone, the maximum level permitted is 40 dBA at night (from 7:00 p.m. to 7:00 a.m.). For a house built in an industrial zone, this maximum level is 50 dBA. Thus, for each sensitive area, the generating station's assessment sound level (LAr, 1 h) must not exceed the noise criterion, or the residual noise level if it is higher.

Noise surveys conducted in 2012 show that the residual noise level can be less than 40 dBA at night. Under the operating scenarios presented in Table 6-7, load variations between day and night result in negligible changes in the noise level produced by the generating station. Thus, compliance with the nighttime criteria implies compliance with the daytime criteria. The rest of the analysis will be limited to the night period. The nighttime noise limit, as per NI 98-01, is presented in Table 6-8.

Table 6-7: Operating Scenarios

	Load 2,026 (kW)	Group [a]	Electrical power 100% (ekW)	Mechanical power 100% (BkW)	Percentage of load (in %) (TMI for ref)
Winter day	2,190	1	1,526	1,603	0
		2	1,880	2,006	58
		3	1,880	2,006	58
		4.	1,526	1,603	0
Winter night	1,708	1	1,526	1,603	0
		2	1,880	2,006	4
		3	1,880	2,006	45
		4	1,526	1,603	0
Summer day	1,583	1	1,526	1,603	52
		2	1,880	2,006	0
		3	1,880	2,006	0
		4	1,526	1,603	52
Summer night	1,367	1	1,526	1,603	45
		2	1,880	2,006	0
		3	1,880	2,006	0
		4	1,526	1,603	45

a. Groups (assumption)

1: CAT C3516C 1,200 rpm EPA TIER 2, operating power: 1,387 kW (REF: TMI #1, TMI #3 for sound data only)

2: CAT C3516C 1,800 rpm EPA TIER 2, operating power: 1,861 kW (REF: TMI #2, TMI #4 for sound data only)

3: CAT C3516C 1,800 rpm EPA TIER 2, operating power: 1,861 kW (REF: TMI #2, TMI #4 for sound data only)

4: CAT C3516C 1,200 rpm EPA TIER 2, operating power: 1,387 kW (REF: TMI #1, TMI #3 for sound data only)

Table 6-8: Maximum Permitted Levels by Zoning Category

Noise-sensitive area		Maximum allowable level (dBA)	
Description	**MELCC Zone**	**Day (7 a.m. to 7 p.m.)**	**Night (7 p.m. to 7 a.m.)**
Residence built in a residential zone	I	45	40
Residence built in an industrial zone	IV	55	50
Building for commercial use	III	55	55
Building for industrial use	IV	70	70

Simulations were carried out using a numerical model developed with the specialized software SoundPLAN® version 8.1, and the noise level of the generating station was calculated according to the ISO 9613-2 method. By calculating the sound attenuation, it is possible to predict the noise level under meteorological conditions that are favorable to the propagation of sound from its emission sources to its receivers. These conditions consist of propagation either downwind or under a well-developed moderate temperature inversion at ground level, as commonly occurs at night. The method takes into account geometric divergence, atmospheric absorption, the effect of hard or porous soil, reflection from surfaces, the screening effect of buildings and terrain, and other factors such as the presence of vegetation.

Noise emissions from the generator building envelope that are transmitted to the outside through the walls of the engine compartments and through ventilation openings, from fuel combustion exhaust, from the ventilation of cooling air intake and exhaust and, lastly, from chillers were assessed.

The noise levels from the potential manufacturer's data for the new units do not exceed 128 dBA and 124 dBA for the exhaust outlet and the engine body at 100% load, respectively.

Specific mitigation measures

The noise study identified a set of specific mitigation measures that will be implemented to bring the new generating station into compliance with NI 98-01 once it is commissioned. These measures include:

- The use of a building envelope with enhanced sound performance through the incorporation of concrete for the engine compartments, whose walls will have a Sound Transmission Class (STC) rating of over 53.
- The use of efficient silencers at the exhaust outlet of new engines, at the air inlet and outlet of new engine compartments:
  - A silencer of the EliminX type from Silex, with a noise reduction of about 50 dBA, is recommended for the exhaust outlet of the engines.
  - Rectangular dissipative silencers are recommended for the air inlets (two per compartment) (their dynamic insertion losses (DIL) are shown in Table 6-9).

Table 6-9: Dynamic Insertion Losses of Air Inlet Silencers

Frequency (Hz)	63	125	250	500	1,000	2,000	4,000	8,000	Maximum regenerated power (dBA)
	Dynamic insertion loss (dB)								
Air inlet	6	13	22	41	46	48	40	26	82

Although several types of silencers can meet the criteria, preference should be given to products offering the best performance at 63 Hz and 125 Hz:

- a radiator emitting no more than 98 dBA of sound power
- acoustic lining (lagging) of the wall bushing at the base of the engine exhaust silencer
- acoustic sealing of all wall pipe penetrations

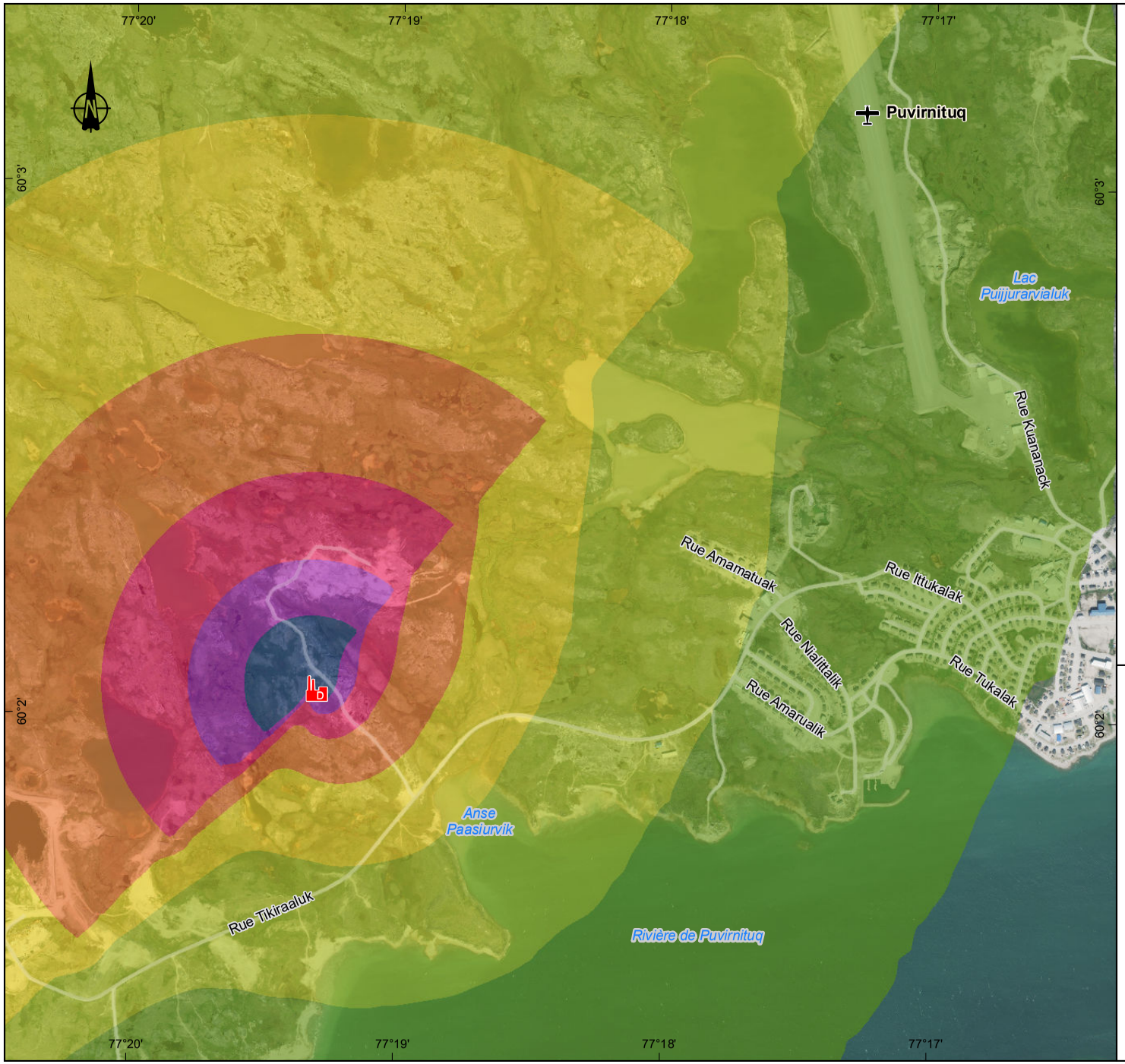
Noise levels were calculated for "Winter night" and "Summer night" situations, presented in Maps 6-1 and 6-2 respectively. The results show that the implementation of these mitigation measures meets the requirements of NI 98-01.

Sound monitoring is recommended after the generating station is commissioned.

Assessment of residual impact

During the construction phase, the intensity of the residual impact on the soundscape is considered low and its duration short, since the noisiest activities will be related to trucking from the wharf or borrow pits to the construction site. The residual impact is considered minor during the construction phase.

During the operation phase, the implementation of the specific planned mitigation measures will make it possible to maintain noise levels below those emitted by the existing generating station in the most noise-exposed sensitive areas. The residual impact on the soundscape will be positive, since the current situation will be improved and the noise level will remain below 40 dBA near residential areas.



Project component

Planned thermal generating station

Noise level at 1.5 m from the ground in dBA

60
55
50
45
40
35
30

New generating station in Puvirnituq

Expected Sound Levels from the Generating Station During Operation, at Night in Winter

Sources:

Orthoimage (Pléiades-1A), 50-cm resolution, Airbus, 2019
Adresses Québec, MERN Québec, January 1, 2020
Adresses Québec réseau+, MERN Québec, December 1, 2019
Project data, Hydro-Québec, February 2021

Mapping: SNC-Lavalin
File: 450419_eic6_1_slq_018_bruit_hiver_210727a.mxd

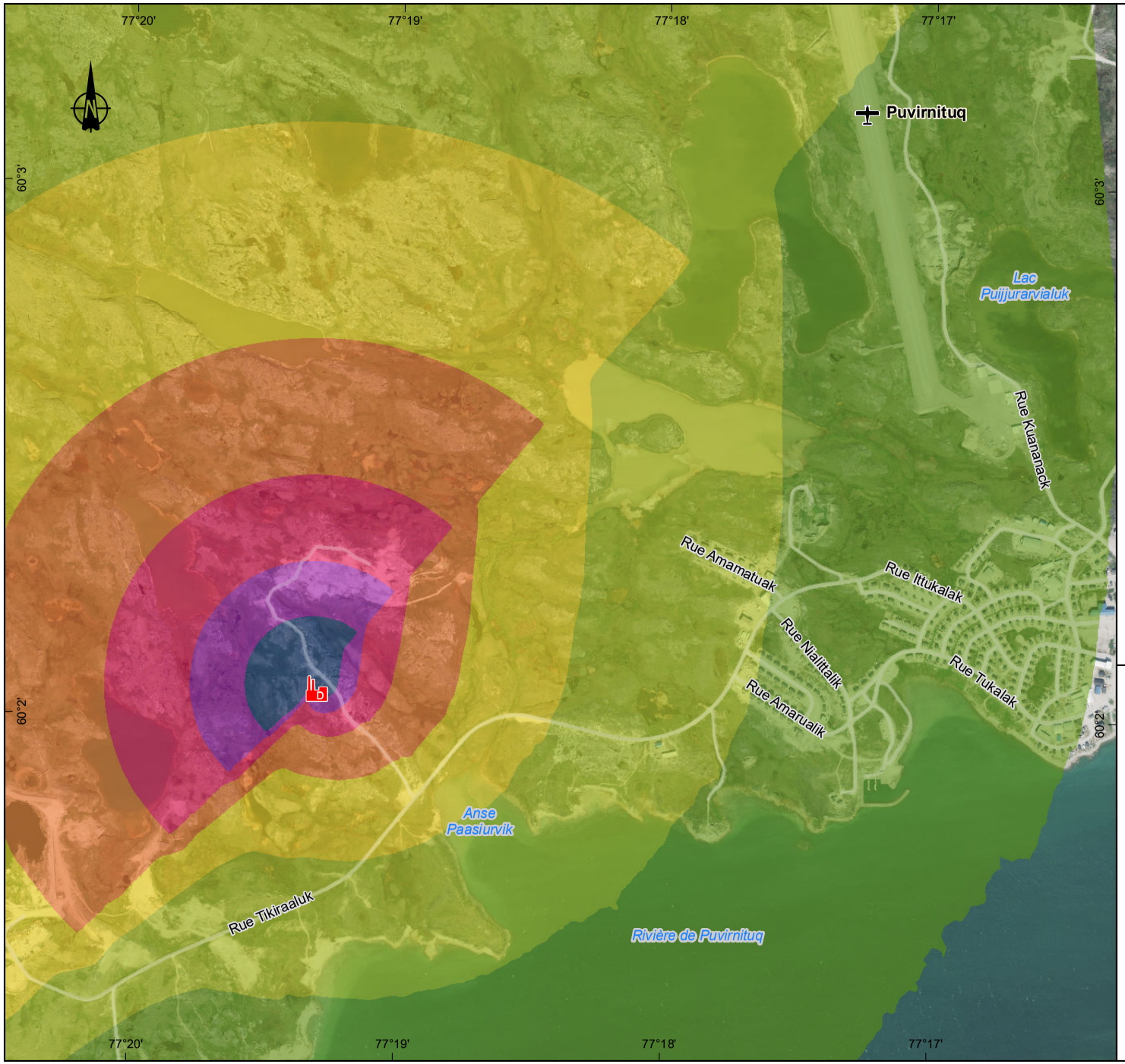
0 200 400 m

MTM, Zone 9, NAD83 (CSRS)

Map 6-1

September 2021

Hydro Québec



Project component

Planned thermal generating station

Noise level at 1.5 m from the ground in dBA

60
55
50
45
40
35
30

New generating station in Puvirnituq

Expected Sound Levels from the Generating Station During Operation, at Night in Summer

Sources:

Orthoimage (Pléiades-1A), 50-cm resolution, Airbus, 2019
Adresses Québec, MERN Québec, January 1, 2020
Adresses Québec réseau+, MERN Québec, December 1, 2019
Project data, Hydro-Québec, February 2021

Mapping: SNC-Lavalin
File: 450419_eic6_2_slq_017_bruit_ete_210727a.mxd

0 200 400 m

MTM, Zone 9, NAD83 (CSRS)

Map 6-2

September 2021

Hydro Québec

6.8.4 Infrastructure and services

Present conditions

As mentioned in Section 5.5.5.1, there is one airport in the extended study area, located north of the village (see Map A, pocket insert). There are no roads linking Puvirnituq to other Nunavik communities. The village is served by a local network of paved roads that allow for movement within the community only. There is also a commercial wharf, a community wharf and a boat launch, as well as the existing thermal generating station and a pipeline that transports fuel from the village's supply boat to the fuel depot next to the generating station (see Map A, pocket insert). The village also has a northern landfill site (NLS) in addition to sewage treatment ponds.

Anticipated construction-phase impacts and mitigation measures

The transport and traffic generated by construction activities may disrupt local traffic and contribute to the deterioration of roads used by the local population and land users. The degree of disturbance will depend primarily on the location of the borrow pits to be mined by the project and the route of the trucks (approximately 2,700 10-wheel truckloads over a period of approximately 14 weeks) required to transport the material to the generating station site. The existing borrow pits are located north, northeast and west of the village of Puvirnituq. Operating the northern and northeastern ones would require trucks to travel greater distances and through the village. The transport of equipment and construction materials from the Puvirnituq dock will also contribute, to a lesser degree, to the disturbance of local traffic.

Residents and land users will feel this traffic disruption, which could temporarily and periodically interfere with certain public services (police, firefighters, drinking water supply, wastewater transport, waste material transport, etc.). The application of Clause 15 of the SECs will mitigate this impact and guarantee the maintenance and protection of roadways for the duration of the work.

The construction of the new generating station will employ 19 to 30 workers between July 2023 and December 2025. These outside workers, who will be present during the construction phase, will be housed in existing camps in the village or in a camp set up by the contractor. Their presence will not affect the community's housing infrastructure, whether permanent or temporary (e.g., hotel accommodation).

However, various products and services needed by workers could be sourced locally. Workers in the camp will have access to health services, drinking water, fuel for vehicles and machinery, and energy sources for construction throughout the duration of the work. This could affect the availability of these products and services to the community of Puvirnituq.

According to the agreement reached with the community, residual materials generated by the construction work (approximately 200 m^3 of wood, wool, gypsum, metal, etc.) could be sent to the Puvirnituq northern landfill site (NLS). Residual hazardous materials will be sent to the south of the province for treatment.

General mitigation measure

The application of Clause 15 of the SECs will mitigate the impact of the construction of the generating station on traffic and guarantee the maintenance and protection of roadways for the duration of the work.

Specific mitigation measures

The following specific mitigation measures will be applied:

- Inform the municipal council of the work schedule and the number of workers expected in the community.
- Establish a plan for transporting equipment and materials, in collaboration with the municipal council.
- Ensure that signage is adequate (Inuit-friendly language and visual references) and that vehicles are clearly visible.
- If necessary, use signalers or a safety escort during maneuvers by trucks or oversize loads.
- Ensure that external contractors have access to and are aware of the code of conduct.

Anticipated operation-phase impacts and mitigation measures

Apart from the supply of the generating station by tanker trucks, there will be no significant increase in traffic during the operation phase. During this period, waste materials will be managed in the same manner as at the current generating station. The municipality of Puvirnituq will take charge of domestic waste and send it to the village's NLS, while residual hazardous materials (used oil, empty aerosols, etc.) will be sorted and stored on the generating station site before being shipped to recovery centers in southern Québec for processing. The capacity of Puvirnituq's other infrastructures and services (roads, housing, landfill site, etc.) will be sufficient to meet future needs, given the nature and scope of activities at the generating station, the number of employees involved (two permanent employees) and the end of operations at the current thermal generating station. No impact is expected on Puvirnituq's infrastructures and services during the generating station's operation phase.

Assessment of residual impact

During the construction phase, the impacts are mainly related to increased truck traffic, depending on the location of the borrow pits. There is a possibility that this increased traffic may temporarily and periodically affect the local road network. Thus, the

intensity of the impact on the community's infrastructure and services is considered low. The scope of the impact will be local and its duration moderate, as it will be limited to the construction phase. The significance of the impact is therefore minor.

Since no impact is expected on the infrastructure and services of the community of Puvirnituq during the operation phase, there will be no residual impact during this period.

6.8.5 Land use

Present conditions

The planned site for the new generating station is located about 2.5 km from the center of Puvirnituq, between the access road to the treatment ponds and a surface mineral extraction site. The proposed site for the generating station is in a potential development sector specified in the Puvirnituq zoning plan (KRG, 2016). However, Puvirnituq is planning an expansion to the east of the existing village, where potential development areas have also been identified (see Map A, pocket insert). In addition, the Puvirnituq municipal council accepted the choice of site for the future generating station and, on June 19, 2020, sent Hydro-Québec a resolution (resolution No. 20-06-38) authorizing it to carry out the field surveys and, on May 5, 2021, a development permit (resolution No. 21-05-50).

The limited study area is not suitable for fishing due to the lack of water bodies. Some residents do, however, pick berries. In addition, some land users mentioned that they hunt waterfowl in the limited study area east of the future generating station site (see Map A, pocket insert). Caribou are also hunted in this area. A gathering place near the existing road, with picnic tables and a fire pit, was also identified.

Anticipated construction-phase impacts and mitigation measures

An increase in truck traffic in and around the village is expected for the transportation of equipment and materials from the dock and borrow pits to the construction site. It may interfere with access to some land use sites on an ad hoc basis, but will not prevent access.

In addition to the increase in traffic, construction of the generating station will disrupt caribou hunting by some users, since the animals will avoid the periphery of the work area. As well, various construction activities, transportation and traffic could disturb geese and cause them to move, temporarily disrupting their hunting.

The construction work will prevent any gatherings on the current site.

Specific mitigation measures

The following specific mitigation measures will be applied:

- Inform the municipal council of the work schedule and the number of workers expected in the community.
- Establish a plan for transporting equipment and materials, in collaboration with the municipal council.
- Prepare a community-selected gathering place prior to the start of construction.[1]

Anticipated operation-phase impacts and mitigation measures

Since the site is of little interest for traditional fishing and gathering activities, and of limited interest for hunting, the presence of the generating station will not change the current land use in the limited study area. Hunting will take place in the vicinity of the future generating station, since game should continue to frequent the area. The current gathering place will be moved to a site chosen by the community. After an adjustment period, users should be able to continue their current activities.

Ongoing activities—primarily vehicle and truck traffic to the site to allow for the operation and maintenance of the generating station and its fuel supply—will be on a small scale and limited to the village and its immediate surroundings. These activities will be almost identical to those associated with the existing generating station, which will be dismantled.

Assessment of residual impact

Although the site of the future generating station is used by members of the community for some hunting and gathering activities, it was chosen with the agreement of the local authorities, in line with the municipal development plan. In addition, the project will not affect access to or use of other sites.

The intensity of the impact is deemed to be low in the construction phase, as activities will have little to no effect on the community's access to and use of the land. The scope of the impact will be local, as it will be felt by a limited portion of the population and in a small area, and its duration will be short, as the impact will occur only during the construction phase. The significance of the impact during the construction phase is therefore minor.

The assembly place, currently at the site of the future generating station, will be moved to another site chosen by the community. Day-to-day operations will be the same as at the existing generating station. The intensity of the impact is therefore considered low.

[1] The municipal council of Puvirnituq adopted resolution 21-05-51 on May 5, 2021. The purpose of this resolution is to authorize the development by Hydro-Québec of a new assembly site to be located approximately 1 km west of the village of Puvirnituq.

Its scope will be limited to the site of the generating station, and its duration will be medium, since it will be felt for a limited period once the generating station is in operation, i.e., only during the adjustment period for current land users. The significance of the residual impact is therefore minor.

6.8.6 Economic spinoffs

Present conditions

The local economy in Nunavik is characterized by local markets at the community level, a high cost of living and doing business, lower consumer purchasing power and a low level of education in the active population. Employment in Puvirnituq is primarily in the fields of education, social, community and government services, and sales and service. According to the latest available statistics, the unemployment rate in Puvirnituq is 11.6%, which is lower than the rate for all Nunavik communities (15.4%).

Anticipated construction-phase impacts and mitigation measures

The construction of the new generating station will employ 19 to 30 workers between July 2023 and December 2025. Most of these workers will come from outside the village of Puvirnituq, but local workers will be hired, based on their availability. The presence of workers from outside the community may generate indirect spinoffs related to the purchase of goods and services in the community. Furthermore, local suppliers hired for goods and services during the construction phase will boost local economic spinoffs. They will be required primarily for the operation of heavy machinery and for the transport and supply of granular materials. At this stage of the project, it is difficult to estimate the number of local workers and the percentage of local economic benefits.

Hydro-Québec will apply its policy regarding relations with Indigenous communities (*Nos relations avec les autochtones*, 2019), which promotes job training and hiring of Indigenous people.

Specific mitigation measures

The following enhancement measures will be applied:

- Establish incentives for hiring Inuit workers and using subcontractors based in the community of Puvirnituq.
- Give preference to local goods and services providers.
- Establish incentives for hiring local Inuit labor. Hydro-Québec pays an amount for each Inuit worker hired (certified tradesperson, janitor, cook and others).
- Establish incentives for the use of subcontractors located in Puvirnituq.

Anticipated operation-phase impacts and mitigation measures

The operation phase of the new generating station will not generate additional jobs. The operation will be carried out by the two employees who currently operate the existing generating station and who are residents of Puvirnituq. Maintenance of the site will be carried out by specialized employees from outside the community, based on pre-established schedules or in response to outages or breakdowns. Once construction of the generating station has been completed, certain services will be required to maintain the site, including snow removal on the access road and the grounds around the station and fuel supply. As mentioned above, the transportation of diesel fuel to the generating station will be provided by Halutik Enterprises using tanker trucks.

Assessment of residual impact

Construction of the generating station will have a positive impact in terms of economic spinoffs generated in the community of Puvirnituq. The project is expected to generate a few local jobs for two and a half years, as well as contracts for local businesses, and indirect benefits for other businesses and services in the community. For the construction phase, the intensity of the impact is considered low to medium, its scope local and its duration medium. The significance of the positive residual impact is low to medium.

During the operation phase, existing jobs and contracts for local businesses will be maintained. No significant changes are expected from the current situation.

6.8.7 Health, safety and quality of life

Present conditions

Communities such as Puvirnituq face a number of quality-of-life issues, including food insecurity, lack of housing, high cost of living and a high rate of violence. This is reflected in the Community Well-Being (CWB) Index for 2016, as shown in Section 5.5.8. The CWB in Puvirnituq is similar to that of Nunavik.

Anticipated construction-phase impacts and mitigation measures

Transporting equipment and materials needed to build the new generating station will increase truck traffic in the community. This also includes transporting generating sets by truck from the port to the generating station, as well as various materials and equipment required for their installation. The temporary increase in transport on village roads poses a greater risk of accidents for residents and road users and may cause some noise and dust-related inconveniences. Depending on the route taken between the Puvirnituq wharf or the borrow pits and the work site, the trucks will have to travel at times on residential roads or near high-risk sectors (schools, daycare services, playgrounds, etc.).

Construction of the generating station will require the hiring of approximately 19 to 30 workers, mostly from outside the village of Puvirnituq. This presence will be spread out over a period of almost two and a half years. The presence of outside workers could lead to additional pressure on health services in the Puvirnituq community, as well as negative social impacts, particularly regarding alcohol and drug use or smuggling. However, the village of Puvirnituq has a municipal by-law regarding the consumption and sale of alcohol that outside workers will be required to comply with while in Puvirnituq. Their presence may also raise fears based on past negative experiences related to the presence of outside workers in the community (sexual abuse, physical or verbal abuse, etc.).

Specific mitigation measures

The following specific mitigation measures will be applied:

- Inform the municipal council of the work schedule and the number of workers expected in the community.
- Establish a plan for transporting equipment and materials, in collaboration with the municipal council. The plan will take into account the location of the most sensitive areas such as schools, playgrounds and childcare services, as well as school attendance periods and routes taken by school students.
- Implement appropriate road signs to improve user safety.
- If necessary, use signalers or a safety escort during maneuvers by trucks. Ensure that vehicles are clearly visible.
- Ensure the maintenance and cleaning of public roads used by heavy vehicles and use certified dust suppressants as needed.
- Educate workers from outside the community about the issues tied to their presence, provide them with a code of conduct and ensure that they read it.
- Ensure that external contractors read the code of conduct.
- Inform workers about the village of Inukjuak's alcohol regulations.
- Encourage workers to avoid alcohol or drug use during their construction stay.
- Develop a protocol to follow in the event of a worker's worsening health problem or a serious accident.

Anticipated operation-phase impacts and mitigation measures

Activities that have an impact on health, safety and quality of life will change little, since the proposed generating station will replace the existing generating station.

Other than truck traffic for the supply of diesel to the generating station, no other potential impacts on the health and safety of Puvirnituq residents are anticipated during the operation phase. Maintenance of the site will be carried out by specialized employees from outside the community, based on pre-established maintenance schedules or in response to outages or breakdowns. These stays will be of short duration and will involve very few employees.

As described in more detail in Section 8, Hydro-Québec will also implement safety measures and an emergency measures plan for the operation phase.

No negative impacts on the health and safety of Puvirnituq residents are anticipated during the operation phase. The distance of the new generating station from the village will help reduce the current nuisances (noise, air pollution) and health and safety risks of the existing generating station at the end of its life.

Assessment of residual impact

Given the mitigation measures put in place, the effects on health, safety and quality of life will be mainly related to the increase in traffic during the construction phase. These are temporary and limited effects. Thus, the intensity of the impact of construction activities on the health, safety and quality of life of Puvirnituq residents is considered low, its scope local and its duration medium. The significance of the residual impact is minor.

In the operation phase, the situation will be comparable to the current one. Thus, no residual negative impact on the health and safety of Puvirnituq residents is anticipated.

6.8.8 Archaeology

Present conditions

To date, no archaeological sites have been identified directly on the site of the new generating station. However, this is an area with a potential for archaeological discoveries that is rated as "medium" and therefore of interest.

Anticipated construction-phase impacts and mitigation measures

The potential impacts on archaeological heritage are mainly related to grading, excavation, blasting and earthworks. These activities could damage or destroy known or unknown archaeological remains.

Hydro-Québec will perform a systematic archaeological inventory (visual inspections and surveys) prior to beginning construction work to validate the presence or absence of archaeological sites in the target area. This work is indispensable to ensure the absence of archaeological remains in the construction area or to document existing remains.

General mitigation measures

Clause 19.2 of the SECs states that if archaeological objects, structures or remains are discovered accidentally on the work site (e.g., old foundations, flooring, sections of wall, bones, glass bottles, concentrations of ceramics, etc.) in the absence of an archaeologist, the project manager must stop work in the immediate area of the discovery, set up a safety perimeter and record the discovery as best he or she can (photos, GPS coordinates, description of the place and context of the discovery). The project manager must immediately inform the Hydro-Québec archaeologist responsible for the project, who will assess the heritage value of the artifacts and determine what mitigation measures, if any, should be applied before work resumes. The contractor must avoid any action likely to compromise the integrity of the site or the remains discovered. He or she must also cooperate with the Hydro-Québec archaeologist or their representative and give them free access to the work site at all times so that they can carry out the necessary verifications.

Specific mitigation measures

The following specific mitigation measures will be applied:

- If archaeological remains are found at the generating station site, salvage excavation will be considered.
- If archaeological remains are found near the generating station site, markers will indicate their presence and their vulnerability to traffic and activities outside the site.

Anticipated operation-phase impacts

No impact on archaeological remains is anticipated during the operation phase.

Assessment of residual impact

In the event that archaeological remains are discovered, recording them will help safeguard the contents of the sites uncovered. This process involves, with the prior agreement of the Inuit community, the Hydro-Québec archaeologist and the Ministère de la Culture et des Communications du Québec, the controlled destruction of the archaeological site. Due to the planned mitigation measures, i.e., the safeguarding of artifacts, the intensity of the impact is considered low. Its scope will be limited, as the area of archaeological potential affected by the work remains limited. Its duration will be long, as the area will be permanently modified. The significance of the residual impact on this component is considered minor, but could be different depending on the heritage value attributed to the archaeological sites or objects uncovered and the interest shown by the Inuit community of Puvirnituq.

6.8.9 Landscape

Present conditions

The site of the future generating station is part of a relatively homogeneous landscape composed mainly of shrubby tundra, wetlands and water bodies. The topography is not very pronounced, which generally provides open and deep views of the area.

Anticipated construction-phase impacts

The stripping, excavation and grading of surfaces required for the installation of infrastructure and the construction of the access road will result in landscape disturbance within the limited study area. The presence of trucks and machinery will also contribute. The construction of the generating station, buildings and associated infrastructure will gradually change the landscape of the limited study area. During this period, the work will be visible mainly to mobile observers traveling on the access road leading to the NLS and the lagoons, as well as to land users who frequent this sector for hunting, fishing, trapping and berry picking, as well as for snowmobile and ATV traffic. The nearest residents, who are located in the western residential sector of the village of Puvirnituq, are likely to have a permanent but distant view of the work site.

Although no mitigation measures are planned during the construction period, the intensity of the impact will be low, given that the construction site will be far from the village and that few permanent or regular fixed observers are likely to see it. The scope of the impact will be limited, and the duration will be medium. The significance of the impact is minor.

Anticipated operation-phase impacts

The new thermal generating station will be built outside the village, in an area where the landscape is already disturbed by the presence of wastewater treatment ponds, the NLS, the access road to these infrastructures, several extraction sites as well as other undefined disturbed environments. It will include a building housing the generating sets and smaller associated buildings. The generating station and the adjacent distribution substation will be built on a site crossed by an existing access road, connecting an old sand pit to the access road that leads to the treatment ponds. The implementation of these infrastructures is therefore part of an already disturbed landscape, which offers a medium blending capacity.

Although the project area does not include any sites or viewpoints of recognized aesthetic interest, the higher points offer an open and deep view of the territory and the Rivière de Puvirnituq. The observers most likely to have direct visual access to the new generating station are users of the access road that leads to the NLS and the treatment ponds. These are mobile and occasional observers, however. Stationary observers from the residential sector west of the village of Puvirnituq could have a permanent but

distant view (more than 1.3 km away) of the new thermal generating station. The flat topography and lack of forest cover provide open and direct views from this area. In addition, residents who use the territory for hunting, fishing, trapping and berry picking, as well as for snowmobile and ATV traffic near the future thermal generating station, are mobile observers likely to see the proposed generating station occasionally, but year-round. Since the facilities will be barely visible to the main observers in the area, the degree of landscape absorption is high.

Assessment of residual impact

Based on the medium blending and high absorption levels described above, the intensity of the impact on the landscape is considered low. The scope of the impact (degree of perception) is also considered low, given that the infrastructures will only be occasionally perceptible to mobile observers, and will be barely perceptible from the village of Puvirnituq, which is quite far from the generating station site. The duration of the impact will be long since it will occur throughout the life of the facility. The significance of the disturbance to the landscape is deemed to be minor. No specific mitigation measures are planned for the operation phase.

6.9 Cumulative impacts

The new thermal generating station project in Puvirnituq is intended to replace an existing thermal generating station that has reached the end of its useful life. The generating station, while in operation, will have a positive effect on some impacts by moving a source of air pollution and noise from the heart of the village to a site nearly 3 km away. In addition, the project foresees the installation of the latest generation of more efficient generating sets, which will lead to a reduction in GHG emissions compared to the current situation.

With its design that incorporates best practices, compliance with environmental standards, optimization of its location to avoid sensitive environments and the implementation of mitigation measures during the construction and operation phases, the new Puvirnituq thermal generating station project will have no residual negative impact, of major or moderate significance, on the valued environmental components targeted in this study.

Given that the project's residual (negative) impacts are all deemed to be of minor residual significance, no cumulative effect is anticipated. In fact, it is believed that the project's impacts, all of minor significance, will have no significant cumulative effect on the potential residual impacts of other past, current and future projects, activities and events.

7 Environmental overview

The project will result in impacts on the environment. To reduce these impacts as much as possible, Hydro-Québec will apply various mitigation measures, including several that it routinely implements in its projects.

7.1 Biophysical environment

The significance of anticipated residual adverse impacts on each valued component of the biophysical environment is assessed as minor. The valued components selected for the impact assessment are the soil, surface water, wetlands, and caribou and bird populations.

Construction activities for the new generating station, including earthwork, blasting, foundation and access road construction, will have a minor impact on the surface soil composition and profile. Granular material will be obtained from existing borrow pits and a thin layer of organic soil will be stripped and retained in the work areas for site restoration. At the end of the work, the disturbed soil in the work areas will be restored without any impact on permafrost. The only area permanently changed is the area occupied by the new generating station's infrastructures. The risk of soil contamination during the construction and operation phases remains low.

Surface water on the site flows through intermittent and permanent watercourses located 145 m away and at the edge of the surrounding wetlands. These streams flow into the Rivière de Puvirnituq 400 m from the site of the new generating station. The input and suspension of sediments that could alter the quality of surface water during construction activities, including excavation, earthwork and the construction of the access road, as well as the circulation of heavy machinery, will remain negligible, especially since the distance between the platform and the watercourse will remain greater than 100 m and the soil will be composed mainly of rock and granular materials. The slope of the new site platform will be protected with riprap, which will reduce the input of suspended sediments to surface waters. The risk of water contamination from improper waste management or accidental spills remains low.

Of the nine wetlands identified, only one will be affected by the construction of the new generating station. Site preparation and installation work, as well as backfilling and earthmoving activities, will result in the direct loss of 26.8 m^2 of a shrub swamp wetland. A larger area of this wetland will be indirectly affected by the construction of a drainage ditch, which is required to prevent the accumulation of water near the facility foundations. This will result in partial drainage for a total loss of 520 m^2. The loss of wetlands at this location is negligible.

The development of the new generating station site will result in the loss of 1.66 ha of shrub tundra, a tiny portion of the summer range of the Leaf River caribou herd that frequents the Puvirnituq sector. First, at most, a few transient individuals are likely to use the extended and limited study areas. The site itself does not constitute a habitat of interest for caribou. Construction and operation activities will result in only a slight functional loss of habitat due to avoidance of the work area periphery. In addition, the site is close to pre-existing disturbances, which already reduce the likelihood of habitat use in this area. Project activities do not pose a risk of impact to the survival of the species.

Although the activities associated with the construction of the new generating station will result in the loss of 1.66 ha of habitat, it is located in an area that is not conducive to bird species of interest, such as waterfowl or shorebirds. They are not very abundant or diversified.

General mitigation measures

During construction of the new thermal generating station, the following general mitigation measures, described in detail in Hydro-Québec's *Standard Environmental Clauses* (SECs) (see Appendix B), will be applied to reduce impacts on the biophysical environment:

- Clause 6 – Accidental contaminant spills
- Clause 7 – Drainage
- Clause 10 – Excavation and earthwork
- Clause 15 – Plant and traffic
- Clause 16 – Hazardous materials
- Clause 17 – Waste materials
- Clause 21 – Site restoration
- Clause 23 – Blasting
- Clause 26 – Work in wetlands

Specific mitigation measures

Specific mitigation measures were also planned for certain affected components.

Soil and surface water

- Storage and management of fuel and used oil in compliance with regulations.
- Shipping and processing of used oil and waste materials to accredited recovery centers.
- Establishment of safety measures and an emergency response plan in the event of an accidental spill.

7.2 Human environment

The significance of the residual impacts on the valued components of the human environment during construction is minor, except for the impact on economic spinoffs, which is considered to be of low to medium significance (positive impact). In the operation phase, the impact on air quality will be positive and of moderate significance. The impact on greenhouse gases and climate change as well as the soundscape will also be positive, but of minor significance.

The atmospheric dispersion study made it possible to assess the compliance of air contaminant emissions from the future generating station with the emission standards of the Québec *Clean Air Regulation* (RAA), taking into account the sensitive receptors of interest. Calculated ambient air concentrations at ground level for all contaminants studied (nitrogen dioxide, sulphur dioxide, carbon monoxide, total particulate matter and fine particulate matter) are all below the RAA standards. The same is true for the odor levels, which are also calculated. The analysis demonstrates that the emission standards of the RAA will be met under the proposed operating regime.

During the construction phase, most of the GHG emissions to the atmosphere will come from the exhaust of land vehicles (on- and off-road). For this entire phase, fuel consumption is estimated at 391,194 L of gasoline and diesel, equivalent to a total of up to 1,032 t CO_2 eq. to the atmosphere over the entire project period. In the operation phase, in 2026, the generating station will consume 4,003,175 L of fuel, which corresponds to 10,512 (t CO_2 eq.) As of 2027, Hydro-Québec will integrate a wind farm, which will significantly reduce GHGs, as the new generating station will consume 2,219,602 L of fuel, or 5,829 t CO_2 eq., in the first year. The integration of wind energy into the grid will be in the range of 46–62%.

The current generating station is located inside the village. The noise-sensitive areas in its immediate vicinity are mainly residential to the south and west. Average sound levels measured in 2012 around the generating station ranged from 50 dBa to 62 dBA during the day and 28 dBA to 41 dBA at night. The construction of the new generating station will result in a temporary increase in noise emissions in the village. The most

sensitive areas affected are the residences adjacent to the road leading from the unloading dock to the selected site. The noisiest work will be related to truck traffic from the wharf and borrow pits to the new generating station site. Due to the distance from the village, the impact of machinery on the construction site will be low. In the operation phase, the residual impact on the soundscape will be positive, and the sound level will remain below the 40-dBA threshold near residential areas, which is an improvement over the current situation.

The village of Puvirnituq is served by a local network of roads, some of which are paved. The transport and traffic generated by the construction activity may disrupt local traffic and contribute to the deterioration of roads used by residents and other land users. Its intensity will depend on the location of the borrow pits and the route taken by the trucks, which will have to carry out a total of approximately 2,700 loads over a 14-week period. No impact is expected on Puvirnituq's infrastructures and services during the operation phase of the generating station.

The planned site for construction of the new generating station is nearly 2 km from the center of the village. The Puvirnituq municipal council, according to its development plan, issued a development permit to Hydro-Québec for this site. The project will not affect access to other sites or their use for berry-picking or hunting by residents. The current gathering place near the future generating station will be relocated and can continue to be used by community members during the operation phase.

The construction of the new generating station will employ 19–30 workers over a two-and-a-half-year period. Most of these workers will come from outside the village of Puvirnituq. A few local workers will be hired according to their availability and trained in accordance with Hydro-Québec's policy regarding relations with Indigenous communities (*Nos relations avec les autochtones*). The presence of outside workers and the hiring of local suppliers of goods and services could generate direct and indirect economic benefits locally. Although the operation phase of the generating station will not create any additional jobs, certain services will be maintained, including snow removal from the access road and the land adjacent to the station, as well as fuel supply.

To reach the jobsite, the trucks will have to travel at times on residential roads or near high-risk sectors (schools, daycare services, playgrounds, etc.), which will temporarily create a risk of accident for residents and road users. These activities will be temporary and of limited duration. During the operation phase, the situation is comparable to the current one and no residual negative impact on the health and safety of Puvirnituq residents is anticipated. The distance between the new generating station and the village will help to reduce the current nuisances (noise, air pollution) and health and safety risks from the existing generating station, which is now at the end of its life.

No archaeological sites have been identified on the site of the new generating station, although the area is considered to have "moderate" archaeological potential. Hydro-Québec will perform a systematic archaeological inventory (visual inspections and surveys) prior to beginning construction work to validate the presence or absence of archaeological sites in the target area. In the event of a discovery, the archaeological remains will be recorded, and the artifacts, preserved.

The site of the future generating station is part of a relatively homogeneous landscape, mainly composed of shrubby tundra, wetlands and water bodies. Due to the medium insertion and high absorption levels, the intensity of the impact on the landscape is considered low. The infrastructures will be visible only occasionally to mobile observers, and very little from the village of Puvirnituq because of the distance from the generating station. No specific mitigation measures are anticipated during the operation phase.

General mitigation measures

In order to reduce the impacts on the human environment during construction of the new thermal generating station, the following general mitigation measures, described in detail in Hydro-Québec's SECs (see Appendix B), are planned:

- Clause 2 – Noise
- Clause 15 – Plant and traffic
- Clause 19 – Heritage and archaeology
- Clause 20 – Air quality

Specific mitigation measures

The following specific mitigation measures will be applied during the construction of the new thermal generating station.

Greenhouse gases and climate change

- Reduce heavy trucking by reusing the excavated materials to restore the land around the generating station.
- Maintain equipment according to a plan that complies with manufacturers' recommendations.

Soundscape

- Inform residents, especially those on streets near the wharf, of the construction period and work schedule before the work begins.
- Set up a telephone line to inform the population of the progress of the work and deal with requests relating to specific problems.
- Plan work schedules taking into account the disturbance caused by noise. In principle, the work will be carried out from Monday to Friday between 7 a.m. and 7 p.m. Exceptionally, however, work could take place during the weekend.
- Educate workers, especially truckers, about noise emissions near residences (e.g., prohibit idling of unused vehicles and the use of the Jake brake on the work site and on nearby streets).
- Locate stationary equipment (such as compressors and generators) and other noisy construction equipment as far as possible from the nearest sensitive areas (residences).
- Use variable intensity reversing alarms (automatic adjustment according to ambient noise level) on construction equipment that is likely to reverse frequently.
- Establish a traffic pattern that takes into account the issue of noise from vehicles entering or leaving the work site (e.g., avoid crossing or skirting residential areas whenever possible).

For the new generating station, the following specific mitigation measures, identified during the noise study, will be implemented in accordance with NI 98-01:

- Use a building envelope with enhanced sound performance through the incorporation of concrete for the engine compartments, the walls of which will have a Sound Transmission Class (STC) rating of over 53.
- Use efficient silencers at the exhaust outlet of new engines, at the air inlet and outlet of new engine compartments.
- Carry out sound monitoring after the commissioning of the generating station.

Infrastructure and services

- Inform the municipal council of the work schedule and the number of workers expected in the community.
- Establish a plan for transporting equipment and materials, in collaboration with the municipal council.
- Ensure that signage is adequate (Inuit-friendly language and visual references) and that vehicles are clearly visible.
- If necessary, use signalers or a safety escort during manoeuvers by trucks or oversize loads.
- Ensure that external contractors have access to and are aware of the code of conduct.

Land use

- Inform the municipal council of the work schedule and the number of workers expected in the community.
- Establish a plan for transporting equipment and materials, in collaboration with the municipal council.
- Provide a community-selected assembly site prior to the start of construction.

Economic spinoffs

- Establish incentives for hiring Inuit workers and using subcontractors based in the community of Puvirnituq.
- Give preference to local goods and services providers.
- Establish incentives for hiring local Inuit labor. Hydro-Québec pays an amount for each Inuit worker hired (tradesperson, janitor, cook and others).
- Establish incentives for the use of subcontractors located in Puvirnituq.

Health, safety and quality of life

- Inform the municipal council of the work schedule and the number of workers expected in the community.
- Establish a plan for transporting equipment and materials, in collaboration with the municipal council. This plan will take into account the location of the most sensitive areas such as schools, playgrounds and daycare facilities. In particular, the periods of school attendance and the routes taken by schoolchildren will be taken into account.
- Ensure adequate signage (Inuit-friendly language and visual references).
- If necessary, use signalers or a safety escort during manoeuvers by trucks. Ensure that vehicles are clearly visible and traveling at the permitted speeds.
- Ensure the maintenance and cleaning of public roads used by heavy vehicles and use certified dust suppressants as needed.
- Educate workers from outside the community about the issues tied to their presence, provide them with a code of conduct and ensure that they read it.
- Ensure that workers do not engage in resource extraction activities on the land unless invited by a community member or with the agreement of local authorities.
- Ensure that contractors comply with Hydro-Québec's *Supplier Code of Conduct*, which stipulates, among other things, that suppliers undertake to promote an alcohol and drug-free work environment.
- Inform workers about the village of Puvirnituq's alcohol regulations.
- Encourage workers to avoid alcohol or drug use during their stay.
- Develop a protocol to follow in the event of a worker's worsening health problem or a serious accident.
- Establish safety measures and an emergency response plan.

Archaeology

- Perform a systematic archaeological inventory (visual inspections and surveys) prior to beginning construction work to validate the presence or absence of archaeological sites in the target area.
- If archaeological remains are found at the generating station site, salvage excavation will be considered.
- If archaeological remains are found near the generating station site, mark the remains to indicate their presence and their "vulnerability" to traffic and activities outside the site.

7.3 Summary of impacts and mitigation measures

The impacts of the new thermal generating station project will be felt mainly during the construction phase. Since the work is limited, small-scale and carried out over a short period of time, and given the mitigation measures in place, the project's impacts will be minor. During the operation phase, Hydro-Québec will continue the activities already under way, so the project should not exacerbate the current negative impacts. The replacement of the existing generating station will have a positive impact on the community of Puvirnituq by displacing this source of pollution (noise and air), currently located in the heart of the village. The community will then be equipped with a modern, less polluting and more efficient generating station that will secure the village's energy supply. The project will also lay the groundwork for a second phase of development, wind power supply that would reduce the use of fossil fuels and the associated greenhouse gas emissions.

Table 7-1 identifies potentially affected components of the biophysical and human environments, potential sources of impact, the project's environmental impacts, mitigation measures and residual impacts.

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Biophysical environment				
Soils	Development of the access road Excavation and blasting Leveling, backfilling and earthwork Construction of the generating station Waste management Transport and traffic Operation of the generating station and fuel management Servicing and maintenance of generating station	Change in the soil surface and profile at platform location Erosion of bare soil Risk of soil contamination in the event of accidental petroleum product spills Risk of soil contamination due to inadequate waste management	SEC: 6, 10, 15, 16, 17, 21, 23 Store and manage fuel in accordance with regulations Ship and process used oil and waste materials at accredited recovery centers Implement safety measures and an emergency response plan for accidental spills	Construction Intensity: low Scope: limited Duration: long **Significance: minor** Operation Intensity: low Scope: limited Duration: long **Significance: minor**
Wetlands	Excavation and blasting Leveling, backfilling and earthwork	Loss of 520 m² of shrub swamp wetlands	SEC: 26	Construction Intensity: low Scope: limited Duration: long **Significance: minor** Operation Intensity: low Scope: limited Duration: long **Significance: minor**
Caribou	Development of the access road Excavation and blasting Leveling, backfilling and earthwork Construction of the generating station Transport and traffic Operation of the generating station and fuel management	Negligible loss of habitat of approximately 1.66 ha, mainly consisting of shrub tundra. Low functional loss of habitat, due to possible avoidance of the periphery of the jobsite.	None	Construction Intensity: low Scope: limited Duration: short **Significance: minor** Operation Intensity: low Scope: limited Duration: long **Significance: minor**

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station *(cont'd)*

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Biophysical environment *(cont'd)*				
Birds	Development of the access road Excavation and blasting Leveling, backfilling and earthwork Construction of the generating station Transport and traffic	Negligible loss of habitat of approximately 1.66 ha, mainly consisting of shrub tundra.	None	Construction Intensity: low Scope: limited Duration: short **Significance: minor** Operation Intensity: low Scope: limited Duration: short **Significance: minor**
Human environment				
Air quality	Development of the access road Excavation and blasting Leveling, backfilling and earthwork Transport and traffic Operation of the generating station and fuel management Servicing and maintenance of generating station	Increase in dust during construction work Emissions of air contaminants during operation of the generating station Improvement in air quality in the village of Puvirnituq after dismantling of the existing generating station	SEC: 20	Construction Intensity: low Scope: limited Duration: short **Significance: minor** Operation (positive impact) Intensity: medium Scope: local Duration: long **Significance: moderate**
Greenhouse gases and climate change	Excavation and blasting Leveling, backfilling and earthwork Operation of the generating station and fuel management	GHG emissions during construction work Reduction of GHGs during operation of the generating station	Reduce heavy trucking by reusing excavated materials to restore the land around the generating station. Maintain equipment during operation in accordance with manufacturers' recommendations.	Construction Intensity: low Scope: limited Duration: short **Significance: minor** Operation (positive impact) Intensity: low Scope: local Duration: long **Significance: minor**

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station *(cont'd)*

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Human environment *(cont'd)*				
Soundscape	Development of the access road Excavation and blasting Leveling, backfilling and earthwork Construction of the generating station Waste management Transport and traffic	Increased ambient noise during construction (construction equipment, heavy vehicles and noisy equipment) and operation of the generating station	SEC: 2 Inform residents, especially those on streets near the wharf, before the work begins, of the work period and work schedule. Set up a telephone line to inform the population of the progress of the work and deal with requests relating to specific problems. Plan work schedules taking into account the disturbance caused by noise. In principle, the work will be carried out from Monday to Friday between 7 a.m. and 7 p.m. Exceptionally, however, work could take place during the weekend. Educate workers, especially truckers, about noise emissions near residences (e.g., prohibit idling of unused vehicles and the use of the Jake brake on the jobsite and on nearby streets). Locate stationary equipment (such as compressors and generators) and other noisy construction equipment as far as possible from the nearest sensitive areas (residences). Use variable intensity reversing alarms (automatic adjustment according to ambient noise level) on construction equipment that is likely to reverse frequently.	<u>Construction</u> Intensity: low Scope: n/a Duration: short **Significance: minor** <u>Operation</u> (positive impact) Intensity: n/a Scope: n/a Duration: n/a **Significance: minor**

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station *(cont'd)*

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Human environment *(cont'd)*				
Soundscape *(cont'd)*			Establish a traffic pattern that takes into account the issue of noise from vehicles entering or leaving the work site (e.g., avoid crossing or skirting residential areas whenever possible). Use a building envelope with enhanced sound performance through the incorporation of concrete for the engine compartments, whose walls will have a Sound Transmission Class (STC) rating of over 53. Use efficient silencers at the exhaust outlet of new engines, at the air inlet and outlet of new engine compartments.	
Infrastructure and services	Waste management Transport and traffic Housing and worker presence	Temporary traffic disruption on local roads Deterioration of local road conditions Temporary and limited interference with certain public services	SEC: 15 Inform the municipal council of the work schedule and the number of workers expected in the community Establish a plan for transporting equipment and materials, in collaboration with the municipal council. Ensure that signage is adequate (Inuit-friendly language and visual references) and that vehicles are clearly visible. If necessary, use signalers or a safety escort during manoeuvers by trucks or oversize loads. Ensure that external contractors have access to and are aware of the code of conduct.	Construction Intensity: low Scope: local Duration: medium **Significance: minor** Operation Intensity: n/a Scope: n/a Duration: n/a **Significance: none**

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station *(cont'd)*

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Human environment *(cont'd)*				
Land use	Development of the access road Construction of the generating station Waste management Transport and traffic Housing and worker presence	Temporary and localized potential disturbance of certain hunting and berry-picking activities Relocation of a community assembly site	Inform the municipal council of the work schedule and the number of workers expected in the community Establish a plan for transporting equipment and materials, in collaboration with the municipal council. Provide a community-selected gathering place prior to the start of construction.	Construction Intensity: low Scope: local Duration: short **Significance: minor** Operation Intensity: low Scope: limited Duration: medium **Significance: minor**
Economic spinoffs	Employment and purchase of goods and services	Hiring of local workers and use of local suppliers during construction work Indirect economic spinoffs associated with the purchase of goods and services in the community	Establish incentives for hiring Inuit workers and subcontractors in the community of Puvirnituq. Give preference to local goods and services providers. Establish incentives for hiring local Inuit labor. Establish incentives for hiring subcontractors based in Puvirnituq.	Construction (positive impact) Intensity: low to medium Scope: local Duration: medium **Significance: low to medium** Operation Intensity: n/a Scope: n/a Duration: n/a **Significance: none**
Health, safety and quality of life	Waste management Transport and traffic Housing and worker presence Operation of the generating station and fuel management	Temporary increase in traffic in the village of Puvirnituq Increased risk of accidents with local road users Noise and dust-related inconveniences due to trucking Additional pressure on health services due to the presence of outside workers Negative social impacts caused by the presence of outside workers	Inform the municipal council of the work schedule and the number of workers expected in the community. Establish a plan for transporting equipment and materials, in collaboration with the municipal council. This plan will take into account the location of the most sensitive areas such as schools, playgrounds and daycare. In particular, the periods of school attendance and the routes taken by schoolchildren will be taken into account.	Construction Intensity: low Scope: local Duration: medium **Significance: minor** Operation Intensity: n/a Scope: n/a Duration: n/a **Significance: none**

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station *(cont'd)*

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Human environment *(cont'd)*				
Health, safety and quality of life *(cont'd)*			Ensure adequate signage (Inuit-friendly language and visual references). If necessary, use signalers or a safety escort during manoeuvers by trucks. Ensure that vehicles are clearly visible and traveling at the permitted speeds. Ensure the maintenance and cleaning of public roads used by heavy vehicles and use certified dust suppressants as needed. Educate workers from outside the community about the issues tied to their presence, provide them with a code of conduct and ensure that they read it. Ensure that workers do not engage in resource extraction activities on the land unless invited by a community member or with the agreement of local authorities. Ensure that contractors comply with Hydro-Québec's Supplier Code of Conduct, which stipulates, among other things, that they undertake to promote an alcohol and drug-free work environment. Inform workers about the village of Puvirnituq's alcohol regulations. Encourage workers to avoid alcohol or drug use during their stay. Develop a protocol to follow in the event of a worker's worsening health problem or a serious accident.	

Table 7-1: Summary of Residual Impacts Related to the Implementation of the New Thermal Generating Station *(cont'd)*

Environmental component	Main sources of impact	Description of residual impact	Mitigation measures	Assessment of residual impact
Human environment *(cont'd)*				
Archaeology	Development of the access road Excavation and blasting Leveling, backfilling and earthwork	If archaeological remains are found during the surveys, they will be recorded, and the artifacts, preserved.	SEC: 19 Perform a systematic archaeological inventory (visual inspections and surveys) prior to beginning construction work to validate the presence or absence of archaeological sites in the target area. If archaeological remains are found at the generating station site, salvage excavation will be considered. If archaeological remains are found near the generating station site, mark the remains to indicate their presence and their vulnerability to traffic and activities outside the site.	Construction Intensity: low Scope: limited Duration: long **Significance: minor** Operation Intensity: n/a Scope: n/a Duration: n/a **Significance: none**
Landscape	Presence of infrastructures	Change to landscape		Construction Intensity: low Scope: low Duration: long **Significance: minor** Operation Intensity: low Scope: low Duration: short **Significance: minor**

8 Technological accident risk management

8.1 Construction phase – Risk analysis

During construction, the hazards will mainly be spills or fires involving hydrocarbons at the jobsite.

Specifically, the following accidental events could occur:

- fuel leakage during the refueling of rolling stock and construction machinery
- hydraulic oil leaks from rolling stock and construction machinery
- spill or fire from temporary fuel tanks at the jobsite
- spill or fire at residual hazardous material storage sites at the jobsite

8.2 Construction phase – Safety equipment and measures

Various pieces of equipment will be available to respond to any accidental event that occurs during construction:

- emergency response kits located at strategic points at the jobsite to respond quickly to any spills
- portable fire extinguishers to control small fires

Although not intended for this purpose, machinery available at the jobsite may be used to limit the extent of a major spill by constructing trenches or embankments. The use, maintenance and refueling of machinery at the jobsite will be subject to the following measures:

- Refueling will have to be conducted under continuous supervision and at dedicated locations.
- If fuel tanks are present at the jobsite, they will have to be double-walled or have a retaining basin.
- Transportation of fuel and other hazardous substances shall be in accordance with the *Transportation of Dangerous Goods Regulations*.
- A temporary storage area for consolidation (e.g., filling drums) will be provided to allow contractors to finalize packaging and labeling prior to shipment to authorized sites.
- The temporary area will be set up to meet the requirements of the *Regulation respecting hazardous materials*.

The requirements mentioned in this section will be specified in the environmental specifications that all contractors will be contractually bound to follow. A Hydro-Québec environmental supervisor will ensure their application during the construction phase.

8.3 Construction phase – Emergency measures plan

A specific emergency plan will be developed to address emergency situations during the construction phase. As is the case on most construction sites, the construction contractor will be contractually obliged to put in place its own emergency measures plan, adapted to the hazards inherent to its work. Hydro-Québec will ensure this emergency plan is compliant.

The emergency response measures will allow for the rapid and effective deployment of personnel and equipment required to limit the consequences of an emergency. In the event of a spill, the contaminated material and soil will be recovered and disposed of in accordance with the regulations in effect.

A preliminary version of the emergency measures plan that will be required of the contractor is included in Appendix G.3. The final version will be filed with the MELCC and other authorities before construction begins.

8.4 Operation phase – Risk analysis

8.4.1 Objective

The purpose of analyzing the technological risks of the new Puvirnituq generating station during the operation phase is to determine accidental events that may occur, assess the potential consequences and determine the project's acceptability in terms of technological risks. It also serves to verify and optimize, if necessary, the protection measures put in place to avoid such potential accidents or reduce their frequency and consequences.

8.4.2 Scope of analysis

The risks covered by this analysis are major accidental events that could have consequences off-site and damage the human or biophysical environment. This analysis does not cover:

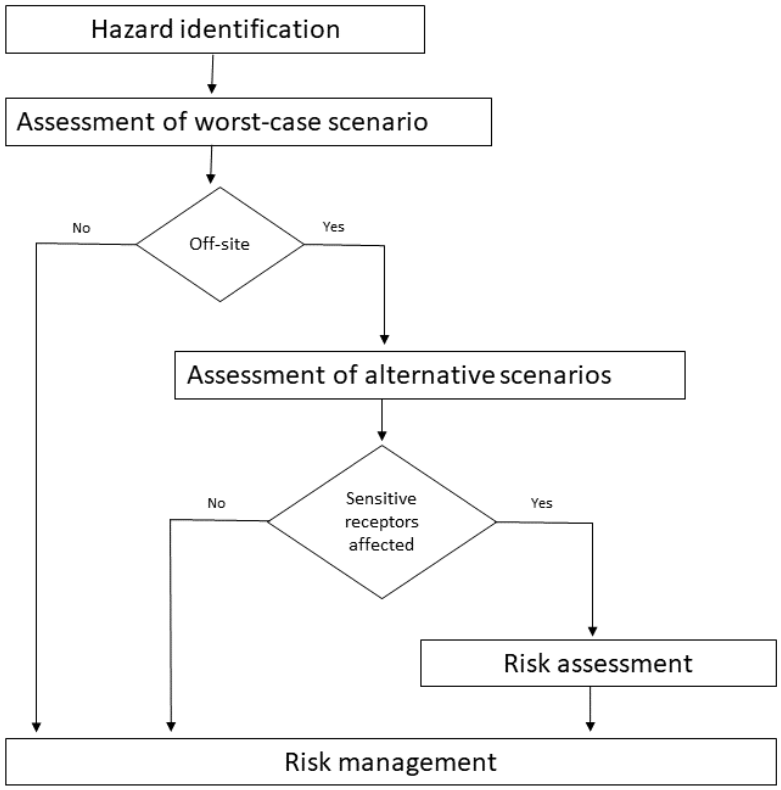
- Risks related to industrial accidents
- Risks to the health of workers in the normal course of activities (occupational diseases)

8.4.3 General procedure

The general approach to analyzing the project's risks meets the requirements of the technological risk analysis guide of the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MENV, 2002), which is included in its directive for conducting the environmental and social impact assessment of the project.

As Figure 8-1 shows, the first stage is to determine the dangers: hazardous substances and activities involved in the project, sensitive elements near the construction site, sources of external risk, and history of past accidents for similar facilities. Then the potential consequences are assessed based on worst-case scenarios. If the assessment of these worst-case scenarios shows that the consequences will remain within the site, the next part of the analysis focuses on risk management measures. Otherwise, the analysis continues with the assessment of alternative scenarios. If the assessed accident scenarios show that the population may be affected, an additional assessment of their frequency and associated risks may also be performed. Lastly, the security measures in place are identified and optimized to eliminate or reduce the risks, and a risk management plan is established, including an emergency measures plan, to manage the residual risks that cannot be eliminated.

Figure 8-1: Technological Risk Analysis Procedure



8.4.4 Safety characteristics of the project

The intrinsic characteristics of the project make the risks for the human and biophysical environment low. In addition, the following features will help to further reduce them:

- Relatively low quantity of diesel stored on the site
- Double-walled outdoor diesel tanks
- Retention and storage of spills from other equipment and tanks located inside the main building

8.4.5 Determination of sensitive elements in the environment

Sensitive elements in the environment are those that, due to their proximity, could be affected by a major accident at the site of the generating station. Table 8-1 lists the main environmental sensitivities present in the extended study area, and Map A (pocket insert) shows their location.

Table 8-1: Main Sensitive Elements in the Extended Study Area

Category	Description	Distance from generating station site
Human environment	Village of Puvirnituq	First residences more than 1,300 m to the east
	• Social Services Center	1,500 m northeast
	• Sailivik Elders Home	1,580 m to the east
	• Arqsuivik facility (childcare)	1,630 m to the east
	• Sarliatauvik Childcare Centre	2,390 m to the east
	• Inuulitsivik Health Center	2,600 m to the east
	• Iguarsivik school	2,800 m to the east
	• Ikaarvik school	2,800 m to the east
Infrastructure	Airport	2,200 m northeast
	Public road (Rue Tikiraaluk)	450 metres southeast
	Drinking water intake (Rivière de Puvirnituq)	6,200 m northeast
Other industrial components	Industrial land	1,100 m to the east
	Existing thermal generating station and fuel depot	3,000 m to the east
Environmental components	Anse Paasiurvik (mouth of the Rivière de Puvirnituq in Baie d'Hudson (Hudson Bay))	450 m southeast
	Small unnamed lakes	460 m to the west and northwest
	Perennial watercourse	150 m to the west

With regard to the human environment, since the new generating station is located outside the village of Puvirnituq, the nearest residences and public services are currently located more than 1.3 km east or northeast of the construction site. The sensitive elements of the biophysical environment (aquatic environment), i.e., Anse Paasiurvik (Rivière de Puvirnituq) 440 m southeast of the site, two small unnamed lakes about 460 m to the west and northwest and a permanent stream to the west, about 150 m from the generating station site, are all outside the limited study area (see Map A, pocket insert).

8.4.6 Determination of external risks

External risks are natural or anthropogenic events with no connection to this project that are likely to interfere with the operation of the generating station or the integrity of the facilities.

Earthquakes

Most of the world's earthquakes occur near the boundaries of tectonic plates. Eastern Canada (Ontario, Québec and the Maritime Provinces) has no such boundaries. Located in a stable continental region of the North American tectonic plate, where seismic activity is relatively low (Landry, 2013), this part of the country has five areas with relatively more seismic activity:

- Western Québec
- Charlevoix-Kamouraska area
- Bas-Saint-Laurent
- Northern part of the Appalaches (Appalachian Mountains)
- Southeast continental margin

According to Natural Resources Canada statistics (2018), approximately 450 earthquakes occur here each year. Most are too faint or too distant to be noticed, but about 25 are experienced by residents each year. Over a 10-year period, approximately three earthquakes are likely to cause damage to buildings. Generally, they have a magnitude greater than 5.

As the construction area is not in any of these zones, the seismic risk can be deemed to be very low. The buildings and facilities will be built in compliance with the *National Building Code of Canada* (NBC), which sets standards for every seismic zone to ensure resistance to seismic loads.

Extreme weather conditions

Extreme weather conditions may take the form of heavy rain and violent wind. In winter, these conditions may take the form of heavy snowfall, violent wind, glaze ice or very low temperatures. The consequences of these extraordinary weather conditions

may be direct or indirect. For example, wind, precipitation, snow and ice may lead to loads that can directly affect the integrity of the buildings or equipment.

The NBC (2015) defines local weather data as the hourly wind pressure, maximum depth of precipitation, maximum load due to combined snow and rain, which will be taken into consideration in the design of the generating station buildings and equipment. They will be built in compliance with the codes and regulations in effect so they are able to resist extreme weather conditions.

Flooding

Flooding usually occurs upstream of sills (raising of the watercourse or narrowing of the banks) that hinder the flow of the water. The formation of ice jams can also contribute to flooding by obstructing the flow of the water, especially at narrow points in the watercourse.

There are no major watercourses in the vicinity of the construction site, which is also elevated above the water level of Anse Paasiurvik, the only water feature in the vicinity. There is therefore no risk of flooding on the project site.

Ground instability

The construction of the buildings and equipment will be adapted to the characteristics of the terrain (primarily rock) and the presence of permafrost to prevent instability due to climate change or heat released into the soil through the operation of the generating station.

Air transport

The Puvirnituq airport, which is used only by small and medium-sized aircraft, is located about 2.2 km northeast of the site of the new generating station. Due to its location outside the approach and take-off zone, where the risk of aircraft accidents is higher, and due to the low level of airport traffic, the new generating station will be exposed to a low risk of aircraft accidents.

Octant performed preliminary validations to determine the risk at the selected location. The height of the generating station buildings and smokestacks will be low. Transport Canada will be consulted to verify whether marking is required due to the proximity of the airport (Standard 621 – Obstruction Marking and Lighting – Canadian Aviation Regulations). Once the detailed engineering is completed or during its execution, the required validations with Transport Canada and NAV CANADA will be performed.

Industrial and commercial activities

The site of the generating station is in a place without significant industrial or commercial activities that may represent an external risk.

8.4.7 Hazardous substances present at the generating station and type of storage

This section describes the hazardous substances that could have negative consequences for the human and biophysical environments in the event of an accidental spill, as well as the equipment in which they are stored. At the new generating station site, diesel fuel will be stored in outdoor tanks adjacent to the generating station building and other hazardous substances in the HM/RHM storage room. Three HMRC shelters will also be used to store drums in transition between the port and the generating station. Table 8-2 summarizes the information about these substances, the safety data sheets for which can be found in Appendix G.1.

Table 8-2: Presentation of the Main Hazardous Substances

Name	Storage	Maximum quantity on site [a]
Diesel	2 outdoor tanks	2 x 75 m^3
	2 indoor day tanks	2 x 50 m^3
Lubricating oil for generating sets	1 indoor tank and 66 drums[b]	2.5 m^3 (tank) 13.53 m^3 (66 drums of 205 L)
Coolant and antifreeze (ethylene glycol) for generating sets	1 indoor tank and 7 drums[b]	2.0 m^3 (tank) 1.43 m^3 (7 drums of 205 L)
Insulating oil for transformers	2 oil transformers	10 m^3 (5,000 L per transformer)
Used oil	1 indoor tank and 66 drums[b]	2.5 m^3 (tank) 13.53 m^3 (66 drums of 205 L)
Waste oil	1 indoor tank and 4 drums[b]	2.5 m^3 (tank) 0.82 m^3 (4 drums of 205 L)
Coolant and antifreeze	Drums	Undetermined

a. These data are approximate. The number of drums will vary depending on the frequency and actual use of the generating station.

b. The tank and drums are not normally all full at the same time.

Diesel

The station's generating sets and the emergency generator will run on Arctic Fuel diesel, a low-volatility product of petroleum distillation classified as a Class II fuel. Its flash point ranges from 40ºC to 90ºC, which means it emits no vapor at room temperature. As its relative density ranges from 0.78 g/ml to 0.88 g/ml, it is lighter than water, in which it is considered to be very slightly soluble.

The diesel will be stored in two CAN/ULC-S653 compliant sump tanks with an individual capacity of 75 m^3 and a capacity of at least 110% of the design volume. The storage capacity will be sufficient to supply the generating station for a minimum period of 8.5 days. Diesel will also be held in day tanks, located inside the generating station and used for the daily supply of the generating sets. The expected diesel consumption is approximately 4,015 m^3/year, or an average of 11 kL/day.

Lubricating oil

Oil will be used for the lubrication system of the generating sets. Made from heavy petroleum fractions, oil is a combustible liquid but not very volatile (flash point >200ºC). With a relative density of about 0.88 g/ml, oil is lighter than water, in which it is very slightly soluble.

The lubricating oil, which must be replaced periodically, will be delivered to the generating station in drums and then transferred to a tank with a capacity of 3 m^3. Its capacity will be sufficient to allow for a minimum of six oil changes without refills from the drums. This tank will be stored in the generating station.

Coolant and antifreeze

The generating units will be equipped with a cooling system that uses an industrial-use liquid (ethylene glycol) as a coolant and antifreeze. Ethylene glycol is a viscous liquid, slightly volatile (flash point around 116ºC) and completely miscible with water.

Delivered to the generating station in drums, the liquid will be transferred to a tank with a capacity of 2 m^3, stored in the powerhouse.

Insulating oil

Oil is used in transformers as a coolant and dielectric insulator. The general features of insulating oil are similar to those of lubricating oil: it has a high flash point and is not water-soluble.

The insulating oil will be in two power transformers containing approximately 5,000 L each.

Residual hazardous materials

The operation of the generating station will generate used oil, either from the lubricating oil in the generating sets, which must be replaced periodically, or from waste oil, mixed with water, which may accumulate in the sumps inside the station building. Spent coolant will also be generated as it is periodically replaced in the cooling system.

This waste material will be temporarily stored in drums at the station for disposal in accordance with applicable regulations.

Other

Other substances will be present, such as cleaning products, degreasers and solvents. These substances will be used and stored in small quantities so that they do not pose a significant risk.

8.4.8 Transport of hazardous substances

The modes of transport and delivery frequencies for hazardous substances are summarized in Table 8-3. These data are estimates and may vary somewhat during the operation phase.

The diesel used as fuel will be transported to the generating station in tank trucks that will be supplied from the fuel depot at the village of Puvirnituq. The distance between this depot and the site of the generating station is approximately 3 km. Lubricating oil, coolant, antifreeze and other substances will be delivered in drums or cans via containers brought to Puvirnituq by sea and then transported by truck from the dock to the generating station. Residual hazardous materials will be drummed up and transported to the dock by truck for shipment by boat to authorized centers.

The volume of dangerous goods transported will change little, since the new generating station will replace the existing one.

Table 8-3: Transportation of Hazardous Substances

Substance	Mode of transport	Delivery frequency
Diesel	Tank truck	364 times/year (7 times/week on average)
Lubricating oil	Drums transported by truck	Once a year
Coolant and antifreeze (ethylene glycol)	Drums transported by truck	Once a year
Residual hazardous materials	Drums transported by truck	Once a year

8.4.9 Accident history

The history of accidents that have occurred at similar facilities can be used to better define the nature of the problems that may occur and thus establish and analyze accident scenarios. It can also be used to improve the design of the generating station and its equipment, to determine the safety equipment required, and to better define the risk management plan.

Table 8-4 summarizes the incidents that have occurred at the existing generating station in the village of Puvirnituq. Equipment failure and human error were the causes of these incidents involving diesel, oil or antifreeze. Of these incidents, only one can be considered significant, with a 1,165 L diesel spill. In all cases, the extent was restricted to the generating station site. Other small, inconsequential incidents are not summarized in this table (<25 L).

Table 8-4: Major Spills (Greater than or Equal to 100 L) at the Existing Puvirnituq Thermal Generating Station in the Last 10 Years

Date	Substance	Quantity (L)	Equipment involved	Cause
July 2019	Lubricating oil	100	Distribution station, tank and piping	Equipment breakdown
March 2015	Diesel	1,165	Undetermined	Other

Table 8-5 shows the main diesel spills that have occurred at other thermal generating stations in Hydro-Québec's off-grid systems since 2010. Two incidents in Ivujivik and Inukjuak in 2015 can be considered very significant. Part of the release reached a stream and Baie d'Hudson (Hudson Bay). In the Inukjuak incident, the spilled diesel remained in a very small area in the immediate vicinity of the generating station and did not reach any bodies of water. Other inconsequential incidents (<100 L) are not summarized in this table. The major spill that occurred at the Iles-de-la-Madeleine thermal generating station in 2014 is not included in this history because it involved the pipeline, a type of equipment that will not be found at the Puvirnituq generating station.

Table 8-5: Main Diesel Spills (≥100 L) at Other Self-Supplied Thermal Generating Stations in Northern Québec Since 2010

Year	Generating station	Quantity (L)	Cause
2015	Inukjuak	13,500	Incorrect switching operation during modernization work
2015	Ivujivik	14,200	Equipment breakdown
2013	Salluit	1,000	Equipment breakdown
2012	La Romaine	100	Human error
2012	Kuujjuaq	113	Human error
2010	Inukjuak	400	Equipment breakdown

8.4.10 Identification of potential accidental events

The potential accidental events at the new station are essentially a loss of containment or a hazardous substance spill (diesel, various oils, coolant and antifreeze) which could be caused by the following:

- equipment failure (design or construction error, wear or corrosion, activities outside of boundaries)
- human error (incorrect procedure, incorrect switching operation)
- external risks (earthquake, extreme weather conditions, aircraft accidents, malicious acts)

This loss of containment or spill could result in any of the following:

- soil, groundwater or surface water contamination
- fire in the event the spilled liquid ignites
- explosion in the event of the formation of flammable vapor and ignition in a confined environment (inside a building) transformer fire and/or explosion

A spill without ignition is the most likely event. The probability of ignition of a liquid spill or vapor release is relatively low because these substances have low volatility and high flash points. This is especially true for lubricating oil, coolant, and insulating oil in transformers, which are used at high temperatures, or if the spilled liquid touches a very hot surface.

The main protective measures to control these accidental events primarily involve various retention systems to catch potential spills and a fire protection system.

8.4.10.1 Spills

Table 8-6 shows the various equipment and activities that could result in a spill. It also indicates the main measures planned to prevent or protect against a spill, several of which are retention systems.

Table 8-6: Sources of Potential Spills and Main Safety Measures

Equipment or activity at source of spill	Preventive or protective measures
Diesel	
Main outdoor tanks	• Double-walled tanks • Manual isolation gate at each tank, accessible from the walkway • Monitoring of level variation with alarm • Emptying of tanks with piping entering from above • Bollards

Table 8-6: Sources of Potential Spills and Main Safety Measures *(cont'd)*

Equipment or activity at source of spill	Preventive or protective measures
Diesel *(cont'd)*	
Overfilling of tanks (unloading from tank truck to main tanks)	• Filling enclosure • Level indicator with high-level alarm • Constant presence of an operator during unloading
Flexible hose (unloading from tank truck to main tanks)	• Manual shutoff valve on the tank truck • Constant presence of an operator during unloading • Regular inspection and replacement of flexible hoses • Recovery kit nearby
Pipelines between the main tanks and the day tank	• High-level pipelines (above the maximum level in the tanks) to the interior, as the tanks cannot be emptied by gravity • Corrosion protection • Impervious floor with sumps and detection probes (inside)
Indoor day tank	• Double-bottom tank • Impervious floor with sumps and detection probes
Overfilling of the indoor day tank	• Level indicators (magnetic level indicator and analog level probe) • Impervious floor with sumps and detection probes
Circuit between the day tank and the generating sets	• Impervious floor with sumps and detection probes
Lubricating oil	
Indoor tank	• Impervious floor with sumps and detection probes
Tank overfill (transfer from drums to tank)	• Visual level indicator and high-level switch connected to the pump • Push button to stop pumping • Continuous monitoring • Impervious floor with sumps and detection probes
Filling of generating sets from the tank	• Push button to stop pumping • Continuous monitoring • Regular inspection and replacement of flexible hoses • Impervious floor with sumps and detection probes
Storage, handling and unloading of drums	• Impervious floor with sumps and detection probes (indoor storage)
Coolant and antifreeze	
Indoor tank	• Impervious floor with sumps and detection probes
Overfilling (transfer from drums to tank)	• Visual level indicator and high-level switch • Push button to stop pumping • Continuous monitoring • Impervious floor with sumps and detection probes

Table 8-6: Sources of Potential Spills and Main Safety Measures *(cont'd)*

Equipment or activity at source of spill	Preventive or protective measures
Coolant and antifreeze *(cont'd)*	
Circuit	• Welded piping • Impervious floor with sumps and detection probes (indoor circuit)
Filling of the circuit from the tank or drums	• Push button to stop pumping (manual hold) • Continuous monitoring • Impervious floor with sumps and detection probes
Drainage from tank to drums or drainage from circuit directly to drums	• Push button to stop pumping • Manual valve • Continuous monitoring • Impervious floor with sumps and detection probes
Storage, handling, loading/unloading of drums	• Impervious floor with sumps and detection probes (indoor storage)
Used oil	
Indoor tank	• Impervious floor with sumps and detection probes
Tank overfill (emptying of generating sets to the tank)	• Visual level indicator and high-level switch • Push button to stop pumping • Continuous monitoring • Impervious floor with sumps and detection probes
Emptying of the tank to the drums or emptying of generating sets directly to the drums	• Push button to stop pumping • Manual valve • Continuous monitoring • Regular inspection and replacement of flexible hoses • Impervious floor with sumps and detection probes
Storage, handling and loading of drums	• Impervious floor with sumps and detection probes (indoor storage)
Waste oil	
Indoor tank	• Double-bottom tank • Impervious floor with sumps and detection probes
Tank overfill (emptying of sumps to the tank)	• Level detection probe • Impervious floor with sumps and detection probes
Emptying of tank to the drums	• Push button to stop pumping • Manual valve • Continuous monitoring • Regular inspection and replacement of flexible hoses • Impervious floor with sumps and detection probes
Storage, handling and loading of drums	• Impervious floor with sumps and detection probes (indoor storage)

Table 8-6: Sources of Potential Spills and Main Safety Measures *(cont'd)*

Equipment or activity at source of spill	Preventive or protective measures
Insulating oil	
Transformers	• Contained storage area under the transformer with a firewall
Other	
Oil or fuel leakage from machinery or vehicles outside	• Recovery kits

Fires

Some of the spills described in the previous section could create a fire if ignited, especially for combustible liquids used at high temperatures or if the spilled liquid touches a very hot surface.

Fire protection for the new Puvirnituq generating station will be provided primarily by an active (automated) protection system to safeguard the following rooms:

- generating set compartments
- indoor tank room
- pump room

The active protection system has not yet been selected as the detailed engineering is not yet finalized. In addition to the fire panel and associated detection accessories, three active protection systems are currently under consideration: Novec 1230 (gaseous extinguishing agent), Monarch (dry chemical) and GreenEx (aerosol). The signals from the fire panel (alarm, supervision, failure) will be retransmitted to Lac-Robertson generating station via the ParaVox system or via the control signals.

Fire protection will also be provided through strategically located portable fire extinguishers and various passive measures (equipment separation, fire retardant materials, etc.).

8.4.11 Assessment of the consequences of accidental events

The methodology guides for technological risk analysis (MENV, 2002; CRAIM, 2017), which include lists of hazardous materials and their threshold quantities, will be used to determine whether accident scenarios should be assessed for these substances. These guides also indicate that the substances should be considered if they may have off-site consequences. Note that diesel is not mentioned.

Therefore, a standard scenario for determining the potential for off-site consequences must be assessed. This scenario is as follows: evaluation of an emission of the largest quantity of a hazardous substance contained in the largest container, with the greatest distance of impact, based on passive protective measures.

For diesel, double-walled tanks are considered a passive protective measure. In the event of a leak from the tanks, the diesel would remain contained by the second wall so that there would be no consequences outside the site boundaries.

For other hazardous substances, the planned passive protection measures also ensure that there will be no off-site consequences in the event of an accidental spill: impervious floor with sumps or double-bottom indoor tanks and contained storage areas under the oil transformers.

As per the general approach explained in section 8.1.3, the remainder of the analysis in the following sections is limited to risk management, since potential accidents cannot have off-site consequences.

8.5 Operation phase – Accident prevention measures and facility safety

To ensure the safety of people and places during operation of the generating station, applicable laws, regulations and codes will be followed in the design of equipment and construction of facilities. In addition, protective equipment and a risk management program will be in place to eliminate or reduce the risk of accidents.

8.5.1 Safety equipment and measures

A number of safety equipment items and measures have been provided to eliminate or reduce the risk of accidents. Most of these have already been detailed in section 8.1.10, and this section will simply recall the main ones:

- fenced site and controlled access
- design and construction that takes into account northern conditions and the presence of permafrost
- double-walled outdoor diesel tanks
- indoor equipment and tanks located in rooms with impermeable floors and sumps
- automated fire protection system to protect the genset compartments, indoor tank room and pump room
- response equipment for spills (recovery kits) and small fires (portable extinguishers)

8.5.2 Risk management program

To ensure the safety of the public, the environment and workers during operation activities, a program will be implemented to manage risks that cannot be eliminated with the planned means of protection. Based on practices already in place at other Hydro-Québec thermal generating stations, this program will include the following elements:

1. Monitoring during construction and operation of the generating station
2. Commissioning and start-up procedures
3. Safe operating procedures, including continuous monitoring of activities
4. Regular equipment inspection, maintenance and replacement programs
5. Documenting and updating information on:
    a. dangers associated with operating activities and hazardous substances inventories (quantities stored, delivered or shipped off-site)
    b. equipment design and changes
    c. operating procedures, normal operating conditions and safety systems in place
    d. electrical systems, instrumentation, etc.
6. visual identification of stored hazardous substances, piping and connections to the unloading area
7. Safety training for all employees covering the following main elements:
    a. generating station operation and organization
    b. the risks inherent in the generating station's activities
    c. safe work methods
    d. personal protection through the means available to workers
8. External services subject to a specific authorization and informed of the safety instructions
9. Safety procedures developed for the delivery of diesel and the unloading of tank trucks (use of reserved area, prior verification of the level in the tank, presence of an operator at all times, etc.)
10. Safety procedures developed for the delivery, loading and unloading of substances transported in drums or other containers (oils, coolant and antifreeze, etc.)

11. Measures to control the activities of contractors performing work at the generating station:
    a. knowledge of safety rules
    b. verification of competency (contractors certified and familiar with codes)
    c. inspection of work performed
12. Investigation of accidents and incidents to determine causes and implement corrective measures
13. Regular verification of safety management system compliance
14. Change management and continuous improvement process

8.6 Operation phase – Emergency measures plan

An emergency measures plan will be prepared for the new generating station's operation phase. It will be incorporated into the emergency plan already in place for all Hydro-Québec thermal generating stations, which takes into account their location in small, isolated communities.

The plan's objectives will be to:

- ensure the safety of the public, employees and external stakeholders
- reduce the risk of property damage and environmental impacts in the event of an accident
- plan emergency procedures to minimize response and recovery time and costs
- define the responsibilities of employees and external responders in planning and executing emergency response

This emergency measures plan will include:

- the appointment of an emergency measures plan director
- emergency plan training for each employee
- training for staff on response equipment (fire extinguishers, spill kits) and first aid materials
- the posting of the evacuation plan and safety instructions in the workplace

A preliminary version of these emergency measures is presented in Appendix G.2. The municipality and other public authorities that may be affected will be consulted and the plan will be filed with the MELCC prior to the start of the operation of the generating station.

9 Climate change resilience analysis

9.1 Method

As part of this project, a study on climate change resilience was prepared (WSP, 2021). This section summarizes the main risks and measures that the study indicates Hydro-Québec will implement.

The study presents the different steps proposed by the MELCC, while complying with the requirements of the ISO 31000:2018 risk management standard, which provides a generic approach to gather data, assess the influence of projected changes in climate conditions on the vulnerabilities of the facility under study, and propose control and adaptation measures when the level of risk is deemed too high. The study identifies the project scope, climate trends and associated risks in terms of probabilities and consequences. Its conceptual framework is based on the IPCC Fifth Assessment Report, which defines risk as the product of the probability of observing climate-related impacts on the facility and the severity of the consequences of those impacts. A multi-risk matrix was used to prioritize the risks according to their level and to propose appropriate control measures for both phases of the project, construction and operation of a new generating station.

Two time horizons were considered: a short-term horizon (2041–2070) for mechanical components and a long-term horizon (2071–2100) for buildings. In order to maintain a conservative approach, the level of risk was also assessed based on which GHG emission scenario (passive scenario or active scenario) presents the highest risk for the component under study; this choice may vary depending on the climate hazard under study.

The following steps were taken in full compliance with the guidelines set out by the MELCC:

- A description of the facility, its components, its environment and its life span.
- Identifying relevant climate hazards, determining their probability of future occurrence using climate projections, and assessing the facility's level of exposure to these hazards, i.e., melting permafrost, coastal flooding, snow accumulation, high winds and thunderstorm activity, general temperature increases, and extreme liquid precipitation.
- Identifying the components of the facility that are vulnerable to each selected climate hazard and their potential impacts on the components of the facility, followed by an assessment of the level of vulnerability of the components for each potential impact (combination of the sensitivity and adaptive capacity of each component).

- Establishing the initial risk level of each potential impact by cross-referencing its probability of occurrence and the severity of its consequences from a financial, social and environmental perspective.
- Identifying existing control and adaptation measures and proposal of additional measures to be adopted to reduce the facility's vulnerability to climate change impacts, along with the level of residual risk following the possible implementation of these measures.

9.2 Main risks and proposed control measures

The study identified 15 potential impacts ranging from moderate to high risk for at least one component of the project. These impacts are mainly due to the increasing intensity and frequency of extreme liquid precipitation events, the general increase in temperatures, the frequency of strong winds and thunderstorm activity. The most significant risks relate mainly to the generating station's operations and mainly affect the fuel depot, distribution lines and site access.

The study identified 10 potential impacts that are considered high risk and five that are considered moderate risk. These impacts include inadequate drainage systems and flooding of sensitive components during extreme precipitation events, difficulty in obtaining fuel during extreme weather conditions, expansion or contraction of power lines during extreme temperature events, damage to the access road and power poles due to melting permafrost, and an increase in accidents affecting worker health and safety.

While climate change is often associated with negative impacts, it can also present opportunities. The analysis shows that the general increase in temperature will result in significant energy savings related to heating needs as well as an extension of the season offering favorable conditions for the construction of the generating station. It should be noted, however, that some tasks are easier to perform in winter in northern regions.

9.3 Control measures and level of residual risk

Hydro-Québec evaluated various adaptation measures and used them as a basis for selecting its own. It is considered that, with the adaptation measures in place, the level of resilience of the proposed generating station will be satisfactory.

Table 9-1 summarizes the top 15 risks to the facility with respect to climate change. The engineering and design team for the project has reviewed the information and proposed accommodations.

Table 9-1: Key Climate Change Risks to the Project

Potential impacts	Initial risk score	Proposed adaptation measures	Final risk score	Adaptation measures adopted by Hydro-Québec
Insufficient roof drainage	High	Validate the consideration of increased extreme precipitation in the design of roof drainage. The 18% markup on the IDF curves, frequently used in Québec, may not be sufficient. Apply the CSA Plus 4013:2018 standard, which proposes a 7% increase per degree of anticipated warming, or an approximate 60% increase at the study site for the long-term horizon.	Low	The building shall be protected from roof accumulations due to abnormally heavy rainfall and from the risk of malfunctioning piping, outfall, or the like by the following means: • All basins on the same roof level are connected and can discharge their contents from one to the other as required. • For each roof level, one of the drains is equipped with an overflow to ensure a potential doubling of the drainage volume in case of a major flood. • Some portions of the parapets are lowered or gargoyles are provided to create an outlet for excess water that may accumulate on the roof. • Flat roof water flows into a perimeter ditch of the facility, not into the municipal sewer system, which could back up. • In the event of a 60% increase in precipitation, overflow will occur through the outlets, ultimately towards the ditches
More frequent infiltrations in case of a break in the waterproofing planes	High	Conduct regular envelope inspections, with exploratory borings every five years. Carry out the necessary modifications/repairs as soon as a problem is observed.	Low	The building's preventive maintenance plan will be adjusted as needed.
Lack of efficiency of solar panels	Moderate	Incorporate this risk into the generating station's business continuity plan so that the protocol ensures energy supply if the solar panels do not provide the necessary electricity.	Low	Solar panels are not part of the reliability criterion for energy supply. They have the effect of reducing fuel consumption. If the solar panels do not work efficiently, the diesel engines will provide the full power supply to the grid.
Difficulty in obtaining fuel during extreme weather conditions	High	Integrate this risk into the generating station's business continuity plan. Work with public health agencies and local government to develop a specific response plan for long-term blackouts	Low	Typically, six days of fuel autonomy is required at the site. In this case, the fuel reserve is 11 days to cover any supply problems. The integration of energy from the wind farm will double the number of days of autonomy by reducing the amount of diesel needed to power the village.

Table 9-1: Key Climate Change Risks to the Project *(cont'd)*

Potential impacts	Initial risk score	Proposed adaptation measures	Final risk score	Adaptation measures adopted by Hydro-Québec
Increased snow load on fuel tanks, causing differential settlement, leaks, or even structural failure	Moderate	Following heavy snowfall or rain-on-snow events, quickly clear snow from tanks to limit the load.	Low	It is not recommended to remove snow from the tanks because of the risk of component breakage. In this project, the cylindrical shape of the reservoirs greatly reduces the accumulation of snow on them, thus mitigating the risk.
Flooding of retention systems at the base of tanks	High	Validate the consideration of increased extreme precipitation in the design of the retention system. The 18% markup on the IDF curves, frequently used in Québec, may not be sufficient. Apply the CSA Plus 4013:2018 standard, which proposes a 7% increase per degree of anticipated warming, or an approximate 60% increase at the study site for the long-term horizon. The risk remains low due to the planned protection of the reservoirs.	Low	The retention systems are closed at the base of the tank and are designed to be watertight. They can hold 110% of the nominal tank volume (as per CAN/ULC-S653). The initial risk is considered low.
Rain flooding of the transformer substation	High	Conduct regular inspections of the building envelope and roof, especially in the area of the transformer substation, to ensure that there is no water infiltration. Tune up at the first sign of a leak.	Low	As the substation is in the open, the risk is non-existent. The equipment is installed on steel frames. The floor of the substation is covered with 5–20 mm thick stone to a thickness of 75 mm, which promotes drainage. In addition, the substation will be located at the edge of the site, near the existing embankment where the topography favors drainage and limits rain accumulation.
Expansion or contraction of power lines during extreme temperature events	High	Ensure that lines are designed to accommodate increased expansion (e.g., use taller poles).	Low	The distribution lines will be designed to take into account the constraints of extreme temperatures (from -40°C to 40°C).
Damage to poles and power lines during storm conditions	Moderate	Ensure that the column anchorage is designed to withstand wind loads that correspond to anticipated increases in gust speeds.	Low	The supports in the northern networks are designed to minimally withstand the heavy load conditions of ice and wind (12.5 mm and 400 N/m^2). In addition, the spans between two posts are smaller (±40 m) than the usual spans (±50 m), which strengthens the grid.

Table 9-1: Key Climate Change Risks to the Project *(cont'd)*

Potential impacts	Initial risk score	Proposed adaptation measures	Final risk score	Adaptation measures adopted by Hydro-Québec
Loss of stability or collapse of poles in areas of low-grade permafrost with high ice content	High	To account for permafrost degradation, ensure that poles are installed according to best practices, such as CSA Plus 4011:F19 (Infrastructure in Permafrost: Guidelines for Adaptation to Climate Change) and the concurrent development of complementary technical guidance for highly engineered uses.	Low	Almost all of the supports in this area are installed on rocky ground. For the few other poles, the design standard used takes into account permafrost conditions as well as freezing and thawing of the ground (Hydro-Québec standard B.41-11-A 2000).
Increased risk of accidents in the workplace and risk to the health and safety of workers and	High	Work with the Health and Safety Officer on the implementation of safe work practices that meet the standards of the Commission des normes, de l'équité, la santé et la sécurité au travail (CNESST). These practices may include moving work shifts during storms or wearing crampons when the ground is icy.	Low	OHS reviews, including a risk log, are planned during the detailed engineering design phase of the new generating station to capture OHS risks and implement the necessary measures. In addition, during the construction phase, this log will be part of the contractor's OHS monitoring, which will have to be adapted to their methods. In its approach to adapting to climate change, Hydro-Québec considers this risk to be a priority in the operation phase: the development of internal guidelines will mitigate this risk (to be completed in 2022).
Damage to the access road due to permafrost degradation	High	Check with the organization responsible for managing the asset portfolio in which the road is located to ensure that the design of the road takes into account the presence of permafrost. If not, make them aware of the inherent vulnerability of a road on permafrost.	Low	The access road to the generating station is not on permafrost, but on granular embankments supported directly on bedrock.

Table 9-1: Key Climate Change Risks to the Project *(cont'd)*

Potential impacts	Initial risk score	Proposed adaptation measures	Final risk score	Adaptation measures adopted by Hydro-Québec
Damage to culverts and roads during floods and surges, leading to a loss of accessibility to sites	High	Develop a special response plan when access to the site is blocked.	Low	Hydro-Québec will develop an emergency action plan specific to the inability to access the site. Its current contingency plan already includes the process of setting up an emergency cell, all the related communication logistics, and the roles and responsibilities of each responder. Hydro-Québec shall ensure that it has a representative on the Nunavik Organisation régionale de sécurité civile [regional civil security organization] (OSCQ) at all times. The OSCQ liaises between the various organizations involved and remains available for any emergency in the territory. It will be kept informed of the various stages of the project and the targeted emergency plans.
Widespread power outages	High	Work with local government and public health to develop a special response plan for long-term power outages (more than a few hours) during cold weather.	Moderate	As the village is supplied by two lines, the risk of a widespread outage is very low. An emergency measures plan is presented in Appendix G.
Accelerated wear of wind turbine propellers	Moderate	Plan more frequent maintenance if the number of freeze-thaw episodes tends to increase.	Low	Although the wind turbines are not under the responsibility of Hydro-Québec, it must respect its commitments, as set out in the electricity supply contracts, and will be responsible for this aspect. This is not a risk for Hydro-Québec, nor for the long-term resilience of the project.

10 Environmental monitoring and follow-up

10.1 Environmental monitoring

Hydro-Québec conducts environmental monitoring at all stages of a project.

At the engineering stage, it incorporates all environmental protection measures identified in the environmental assessment into the plans and specifications and other contractual documents for the project.

Prior to construction, the Hydro-Québec environmental officer on site ensures that the environmental measures, requirements, standards and other specifications set out in the contract documents for the project are implemented.

At the start of construction, the contract administrator, the site environmental officer and the construction contractor are provided with information on the company's commitments and specific environmental protection measures.

The site manager is responsible for environmental protection on the site. The site manager ensures that the contractor complies with the environmental protection provisions of the contract and that the contractor is fully aware of the SECs in the contract and any special provisions for the project and specified in the environmental assessment. In addition, the site manager constantly monitors compliance with the company's environmental protection commitments.

At the end of the construction work, the site manager ensures that the site is restored, proceeds with the environmental acceptance of the work and certifies the application of the mitigation measures.

10.2 Environmental follow-up

During the operation phase, the proponent must ensure that the environment is protected in all its activities. Due to the analysis of the project's impacts on the environment, monitoring of the soundscape is proposed during the first year of operation.

This will be done once the new generating station is in operation. This follow-up will have two objectives:

1. Measure the sound level of the equipment to verify the modeling used in the present study, based on the actual sound power.
2. Monitor the receiving points.

Based on the results, mitigation measures may be considered if the noise threshold is exceeded in built and inhabited environments.

Given the nature of the project's impacts, the limited and temporary nature of these impacts and the effectiveness of the proposed mitigation measures, no further environmental monitoring activities are deemed necessary or relevant.

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Printed on paper made in Québec
from 100% postconsumer recycled fibre

Original text written in French.
Ce document est également publié en français.

2021E1792-A