LA GRANDE ALLIANCE

PRE-FEASIBILITY STUDY PHASES II & III - TRANSPORTATION INFRASTRUCTURE

TECHNICAL NOTE 10
GEOTECHNICAL

FINAL VERSION

DATE: MARCH 25, 2024

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EXECUTIVE SUMMARY

The purpose of this Technical Note 10 is to document the preliminary geotechnical assessment that was done for La Grande Alliance proposed transportation infrastructures. This assessment completed within the study area located in the territory of the Eeyou Istchee Baie-James region of northern Québec. The study area is divided in three zones:

- Study Area 1 (SA1): Billy-Diamond Highway Railway – Rupert – La Grande;
- Study Area 2 (SA2): Road & Rail Extension, and Harbour – La Grande – Whapmagoostui/Kuujjuarapik;
- Study Area 3 (SA3): Route 167 - Renard Mine – Trans-Taiga Road.

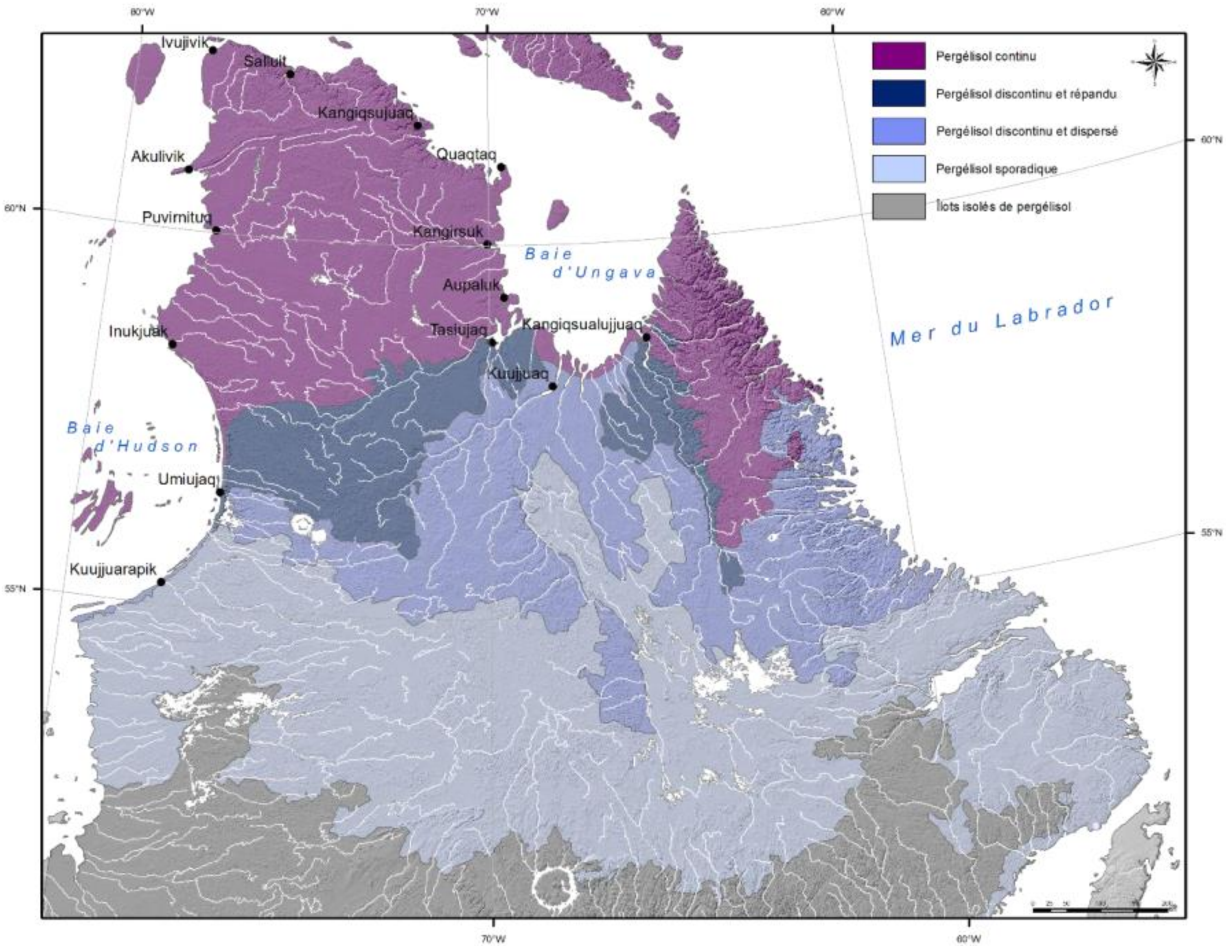
The objective of this preliminary assessment/desktop study was to analyze all available information to have a general overview of the deposits type as well as any potential geotechnical challenges and particularities associated with the proposed infrastructures.

The data collected consisted mainly of previous reports (sources of potential materials), geological maps, morpho-sedimentary zones maps, and borehole and test pits data. A review of existing data in the areas understudy led to the collection and compilation of available geotechnical and geomorphological data. The initial data included those provided by the Client (articles, previous MTQ studies, SDBJ, etc.), public databases such as SIGEOM, GESTIM and the Hydro-Québec database (Cherloc). Data was also obtained from the Centre for northern studies (CEN) at Université Laval and from the Direction générale de l'Abitibi-Témiscamingue at the MTQ.

It should be noted that, during the Study, the proposed roadway of La Grande to Whapmagoostui/Kuujjuarapik was moved to the feasibility stage and thus led to a preliminary field campaign to survey identified sites, and to manually collect soil and rock samples as well as a drilling rig that was carried out for the 6 selected potential quarry sites. The drilling data collected was analyzed and integrated into the Study's Geographic Information System (GIS).

PERMAFROST

According to the map Classification du pergélisol au Québec nordique (Allard et Seguin, 1987), permafrost is sporadic within the study area, except for Whapmagoostui/Kuujjuarapik area where permafrost is discontinuous and scattered. According to the Figure below sporadic permafrost (identified by the letter D) would represent less than 2% of the territory near Whapmagoostui/Kuujjuarapik area. This means that some patches of permafrost may be found in some areas concerned by the northern part of the study area. Moreover, fine-grained soils could contain ice in various forms and, therefore, must be considered unstable to thaw. The permafrost presence will therefore be monitored in areas where fine particles are present, i.e., in marine sediment deposits (silt and clay), in peatlands overlying fine sediments, and in till deposits composed mainly of fine particles. Some forms are identifiable on the aerial photographs and could be studied in greater detail to be avoided as much as possible when optimizing the various alignments.



Source: Extract from « Production de la 2ième approximation de la carte de pergélisol du Québec en fonction des paramètres géomorphologiques, écologiques, et des processus physiques liés au climat, March 2018 »

Figure Permafrost distribution in northern Quebec (Modified from Allard et al., 2012)

STUDY AREA 1 (SA1): BILLY-DIAMOND HIGHWAY RAILWAY – RUPERT – LA GRANDE

This area is the foreseen location for the proposed 340 km railway infrastructures Rupert to La Grande. 40% of the of overburden over the proposed rail corridor (1 km buffer zone on either side of the alignment) is composed of organic soils (about 25%) and clayey soils (about 15%). These areas will pose the greatest challenge for the railway. Furthermore, approximately 44% of the alignment is composed of sand, gravel and till deposits, while the remaining 15% of the alignment is composed of rock. Problematic related to clayey and organic soils are, but not limited to, very low to low geotechnical resistance, susceptibility to freezing, long-term settlements and need in excavation of large slopes.

In terms of constraints, fine deep-water glaciomarine sediments that generally result in areas of clay deposits are found along the rail corridor alignment primarily in the northern part of the segment. The railway also crosses several sporadically scattered rocky areas distributed primarily in the central and northern portions of the alignment. Approximately three areas of moderate slopes and three areas of steep slopes were identified at the center of the rail corridor alignment. Several wetlands were identified along the alignment, with a high proportion of these occurring in the northern portion of the transect. Some of the peatlands are particularly well developed and could represent a considerable risk of subsidence and settlement in the long term. Sixteen peatlands were identified, through photointerpretation, as major constraints, including five in the center of the Waskaganish rail corridor and 11 to the north.

In terms of potential granular material sources for construction purposes, fluvioglacial corridors occur more rarely in the portion south of the Eastman River. However, some till deposits have a grain size suitable for use as granular material. Reworked till is located to the southeast of the transect and could possibly compensate for the lack of granular sources in this area. Furthermore, several old quarries and gravel pits that are no longer in operation but that could be re-exploited (non-exclusive operating leases) are observed along the Billy-Diamond Highway. Some of these sites still contain appreciable quantities of quality material and are therefore easily accessible. To a lesser extent, there are also some sand and moraine deposits. As a result, the southern portion and the northern end of the study area have the highest proportions of borrow pits. In a 75-km portion of the alignment in Eastmain territory, between Kaministikuch and Duxbury lakes, located in the Eastmain and Wemindji communities, only four potential borrow pits have been identified. This will be an important limitation going forward. The morpho-sedimentary zones available on SIGEOM show a higher proportion of fluvioglacial sediments in the northern and central portions of the Waskaganish area.

The problematic areas (clay deposits, peatlands, and crossing of watercourses) should be further investigated with a preliminary drilling campaign and/or preliminary piezocone surveys including some in-situ testing, from which the soil and bedrock properties can be determined. The search for granular material sources by photointerpretation combined with field campaigns to collect spot samples should also be planned. Soil sampling in existing and potential borrow pits, as well as in potential quarries, is essential. Material availability is an important issue within this propose rail corridor along the existing road as the available quantities from sites are relatively small and new sources will need to be analyzed.

STUDY AREA 2 (SA2): ROAD & RAIL EXTENSION, AND HARBOUR – LA GRANDE – WHAPMAGOOSTUI/KUUJJUARAPIK

This area is the foreseen location for the proposed 219 km extension of the railway infrastructures from La Grande, the 207 km of roadway infrastructures extension as well from la Grande and a deep-water port along the Kuujjuarapik coastline (which was then redefined to a seasonal harbour).

The section below is divided into two subsections. First, the general data from the pre-feasibility study for the road and rail corridors is presented followed by a summary of the data from the road corridor specific feasibility study.

PRE-FEASIBILITY ANALYSIS

Previously to the La Grande Alliance transportation infrastructure study, road alignment studies were completed by Hydro-Québec and Poly-Géo. The current proposed road alignment is very similar to the inland proposed concept from 2013, but more respectful of protected and highly sensitive areas such as *Réserve de territoire aux fins d'aire protégée du Lac-Burton-Rivière-Rogan-et-la-Pointe-Louis-XIV* and Rivière-Kanaaupscow-et-Lac-Kukamaw. The section between approximate stations 60+000 and 118+000 includes some alternatives that could be further studied in the next stage as each includes different benefits and impacts.

The stratigraphy of surface soils distributed along the proposed road corridor, for both alternatives 1 and 2, the rail corridor and considering a 1 km buffer zone on either side of the proposed alignments, is composed of slightly more than 50% of till, sand, and gravel deposits. The rest of the alignment is composed of an average of 20% of clayey soils (i.e. silt and clay) and organic soils (from 17 % to 23 %), that may be problematic, and around 26% rock (from 24% to 29%).

In terms of constraints for the railroad corridor and the road corridor - alternatives 1 and 2 combined, in the Whapmagoostui/Kuujjuarapik area, fine deep-water glaciomarine sediments were in the lower elevations. The road and railway corridors cross these areas of fine materials mainly in the central and northern parts of the transect. A high proportion of these deposits are included in the water basins at the center of the road corridor. Although generally anticipated as little problematic given their small thicknesses, these deposits are prone to landslides in areas where they accumulate to large thicknesses.

Although the corridors cross several rock outcrops, these are generally sporadic and show little relief. Therefore, rock outcrops do not generally appear as a constraint to the road and the railway, except for two areas (km 48 and km 197) of moderate slope and one of steep slope (km 201) that were identified in photo-interpretations: two of these areas are located in the south-central part of the road corridor while the third is at the northern end. Also, a total of 22 major streams and water bodies are crossed by the proposed road segment, generally over short distances, while the railroad route intersects 19. However, a significant proportion of lakes are found in the southern part of the road corridor. Of these, three lakes are directly intersected by the proposed road. As for the proposed railway, it crosses a 400 m long stretch of water at km 93, in the center of the route. Wetlands are scattered throughout the corridors and are found in greater quantities at the northern portion of the road and railway corridors. They appear relatively undeveloped and easily crossed by the road and railway. Two more highly developed peatlands were identified in the south and center of the corridors (km 17 and km 130) in which they are considered as major constraints to the road's passage.

In the Whapmagoostui/Kuujjuarapik area, the unconsolidated deposits that dominate the shoreline bordering the port areas understudy are mainly composed of nearshore and prelittoral glaciomarine sediments generally consisting of sand, silt, and gravel deposits. Rock outcrops and bedrock covered by a thin layer of sediments are also found. Specifically, along the Great Whale River, the overburden are mainly composed of fine deltaic, prodeltaic, and deep water glaciomarine sediments which are made up of clays. Moreover, these sensitive clay deposits located near the Great Whale River are subject to reoccurring and sometimes major landslides. It should be noted that most of the drilling data recovered from previous studies in the SA2 area were found in the Whapmagoostui/Kuujjuarapik area. Geomorphological data specific to the port area (proposed seaport) are discussed in more detail in Technical Note 13B.

FEASIBILITY ANALYSIS

During the pre-feasibility mandate, the roadway of La Grande to Whapmagoostui/Kuujjuarapik area was moved to the feasibility stage. Given the remote context of the proposed roadway, the emphasis of the feasibility mandate was placed on finding sources of materials for the road construction. Existing data from previous studies were consulted and additional photo-interpretation works were carried out to identify material sources in the form of potential borrow pits and quarries. The search for borrow pits and quarries was limited to a 2 km radius on either side of the proposed main road corridor. This feasibility work done for the road corridor, described below, is likely to serve as an input for the rail corridor in terms of information on potential material sources since there are adjacent.

A first field visit was made, from July 11 to 15, 2022 to survey all identified sites, and to manually collect soil samples and rock samples from potential future borrow pits and quarries respectively. In total, 31 sites were visited including 15 potentials borrow pits and 16 rock outcrop zones for potential quarries. The soil samples were submitted to laboratory testing to determine if their inherent properties meet the current standards for a granular sub-base material. The rock samples recovered during the visit were reviewed by a geologist. A multi-criteria analysis was performed to select 6 sites along the proposed alignment of the main alternative (alternative 2) and located at an economically viable interval.

A second field campaign with a drill rig was carried out, from August 16 to September 7, 2022, for the 6 selected potential quarry sites. Two boreholes per site of around 15 m deep were drilled to recover sufficient rock core samples for laboratory testing. The results obtained in the laboratory generally show good intrinsic properties of the tested samples (soils and rock) for both granular sub-base and granular foundation materials. In terms of quantities, the road engineering team has defined the quantities of material required for the construction of the proposed road, which has been divided into 20 segments (alternative 2). Overall, 5 of the 20 segments have a granular material deficit of between 70,000 m^3 and 500,000 m^3. These segments are in the northern portion of the proposed alignment, i.e., in the last two-thirds of the alignment to the north of the major borrow pit encountered near km 61. Surplus material is planned for the other 15 segments, so this surplus material could be used in the segments where a potential shortage is anticipated.

To pursue the geotechnical assessment of this area, a detailed mapping of the deposits and technical constraints (topography, low bearing capacity soils) should be done along the alignment. A future detailed drilling campaign from a geotechnical point of view (soil and rock sampling, in situ tests, other types of surveys to be considered) aimed initially at problematic areas (organic and clayey soils, water course crossing areas) that cannot be avoided, should be considered. Finally, it would be necessary to consider carrying out short drilling campaigns according to a regular grid to specify, among other things, the type of subgrade soils of the proposed road and the bedrock elevation.

STUDY AREA 3 (SA3): ROUTE 167 - RENARD MINE – TRANS-TAIGA ROAD

This area is the foreseen location for the proposed 204 km existing Route 167 upgrade and the 172 km road extension from the Stornoway Renard Mine access road to the Trans-Taiga. Overall, the distribution of overburden over the proposed road corridor (1 km buffer zone on either side of the proposed alignment) is composed of almost 100% of till, and to a lesser extent of sand and gravel. Less than 1% of the road corridor is covered with organic soils, and rock outcrops.

In terms of constraints, compared to the Waskaganish and Kuujjuarapik areas, there are no fine deep-water glaciomarine deposits. Although the corridor crosses few rock outcrops, the rock sometimes appears near the surface, resulting in steeper walls in some places. Photointerpretation works identified six areas of moderate slopes and four areas of steep slopes scattered throughout the road corridor understudy. A total of 20 major watercourses are crossed by the proposed road segment. Wetlands are found in very low proportions over the proposed road corridor and are scattered throughout the area in which they appear relatively undeveloped.

With respect to potential sources of granular material, the MERN GESTIM database identifies the presence of a few borrow pits located at the northern and southern ends of the segment, near existing roads. However, no borrow pits were identified at the center of the area due to the absence of roads. According to the morpho-sedimentary data available on SIGEOM, the sources of fluvioglacial materials on both sides of the proposed road appear to be well distributed over the entire alignment, except for an area extending over 25 km between segment 6 of alternative 01 and segment 3 of the main road, where granular materials are rarer. At this location, other fluvioglacial deposits are nevertheless identified along the periphery of the road, within a radius of 5 to 16 km of the proposed alignment. If the operation of these deposits would be less favourable due to the distance separating them from the road, the till deposits that cover most of the area could also be used as granular material in these areas where fluvioglacial sources are rarer.

To pursue the geotechnical assessment of this area, it would be pertinent to initiate photointerpretation works for surface deposits over a more limited pathway. Further photointerpretation analysis for granular material sources combined with a field campaign (as carried out in the summer of 2022 for the SA2 La Grande to Whapmagoostui/Kuujjuarapik roadway) to collect selected samples would also be pertinent. Soil sampling in existing borrow pits to confirm that their inherent properties meet current standards would also be relevant. From a geotechnical point of view, it would be pertinent to consider preliminary drilling campaigns as a priority at locations, along the alignment, where more problematic zones have been identified (water crossings, low bearing capacity soils).

LIST OF ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS/ ACRONYMS	DEFINITION
Client	Cree Development Corporation
COMEX	Environmental and Social Impact Review Committee
GESTIM	Mining Title Management System
GIS	Geographic Information System
HQ	Hydro-Québec
MERN	Department of Energy and Natural Resources
MTQ	Ministère des Transports du Québec
PDF	Portable Document Format
SDBJ	Société de développement de la Baie-James
SIGEOM	Système d'information géominière du Québec

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APPENDIX

1 INTRODUCTION

Given the remote location of the study area and the significant cost associated with conducting investigations in these areas, the geotechnical and geomorphology teams initially devoted their efforts to collecting and compiling any geotechnical and geomorphological data available from development and infrastructure works previously carried out in these areas. The objective was to make this information available to various disciplines, as well as to establish the most detailed profile possible of the geotechnical conditions and challenges associated with the proposed infrastructures.

In order to first trace, and then, collect existing geotechnical data, various resources, including Hydro-Québec (HQ), the Ministère des Transports du Québec (MTQ), the Système d'information géominière of Québec (SIGEOM), and the Société de développement de la Baie-James (SDBJ), were consulted. Several studies have been conducted in the James Bay territory in the past, notably in the context of hydroelectric projects, mining exploration, and geological mapping.

2 DATA COLLECTION AND METHODOLOGY

The following is a summary of the methodology used to conduct the research and extract relevant data:

1. Collection of studies conducted in or near the areas understudy, specifically:
   - Review of inputs received from the Client;
   - Database research in Hydro-Québec's Cherloc public online database;
   - Database research in the Système d'information géominière of Québec (SIGEOM) from MERN;
   - Database research of the Environmental and Social Impact Review Committee (COMEX).
2. Identification of studies containing relevant geological and geotechnical data;
3. Extraction and compilation of data in one single database;
4. Integration and display of data in the Geographic Information System (GIS) created specifically for this study.

An overview of each of these steps is presented in the following sections.

Figure 2-1 present an overview of the study areas.

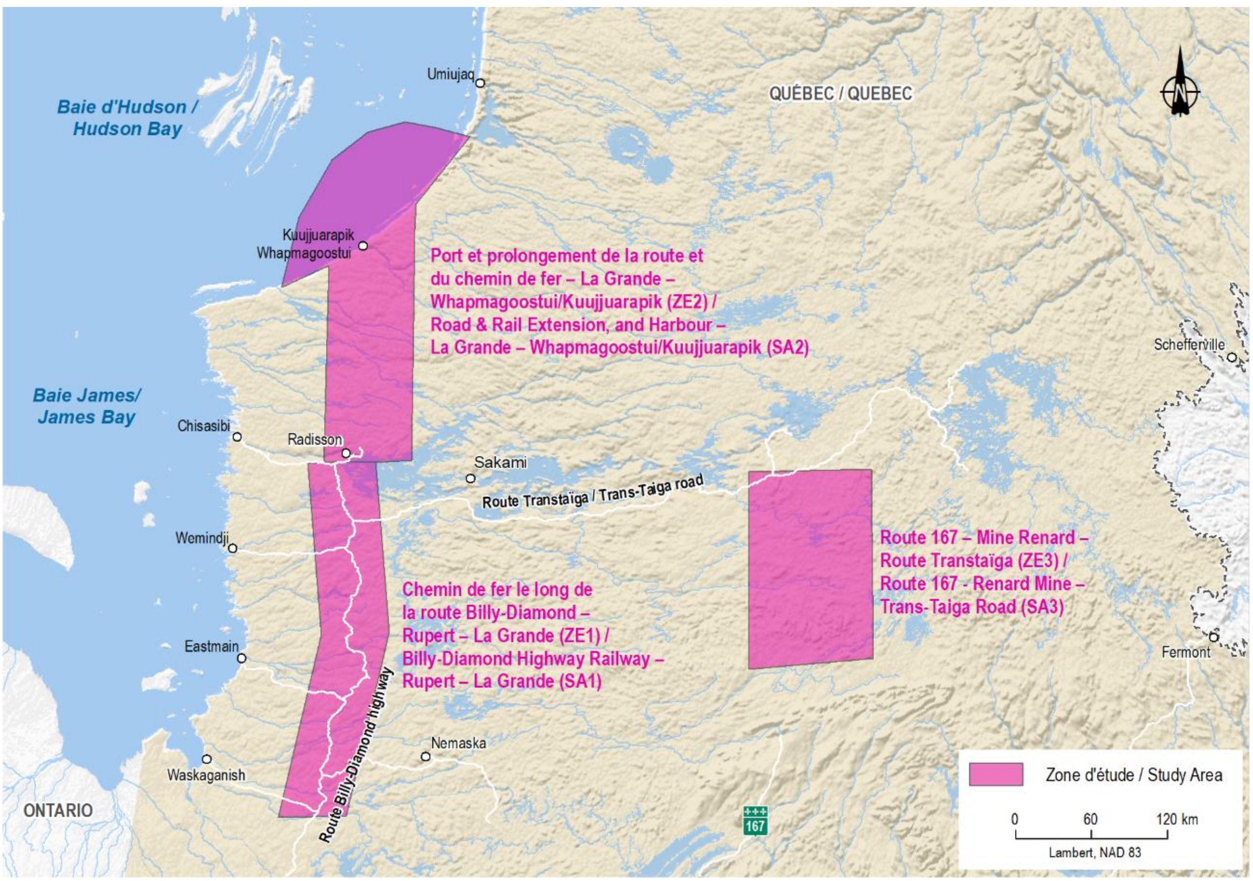


Figure 2-1 Study Areas (SA)

2.1 COMPILATION OF STUDIES CARRIED OUT IN OR NEAR THE STUDY AREA

First, the Client provided inputs, such as studies from, but not limited to, the Ministère des Transports du Québec (MTQ), Hydro-Québec (HQ) and the Société de développement de la Baie-James (SDBJ). Subsequently, requests were made, for instance, directly to the MTQ in order to obtain any previous studies or accessible data possibly related to the specific study areas. It was thus possible to directly collect 61 studies from MTQ, 47 studies from Hydro-Quebec, and a considerable amount of mapping data from SDBJ.

Next, extensive research was conducted in Hydro-Québec's Cherloc online database[1]. This database is composed of over 17,000 reports and studies produced by Hydro-Quebec's environment division over the years. An advanced search function, and search by keyword combination were used to target relevant studies. Thus, keywords such as the name of villages, rivers or bodies of water, hydroelectric infrastructures, roads, as well as technical terms related to geotechnical engineering were used to target relevant data.

Finally, an extensive search was conducted with the Department of Energy and Natural Resources (MERN) using SIGEOM. This digital tool contains a very large amount of geo-scientific information, much of it geo-referenced, which can be viewed using an interactive map. It is also possible to activate a series of filters in order to precisely target the type of information desired. Thus, several data were consulted in order to find the most relevant geological and geotechnical data, mainly diamond drillings, and general morpho-sedimentological zones (map of overburden soils).

2.2 IDENTIFICATION OF STUDIES CONTAINING RELEVANT GEOTECHNICAL DATA

2.2.1 DOCUMENTS SENT DIRECTLY TO WSP

Following the analysis of documents from MTQ, it was possible to identify relevant data from previous projects that were carried out in the areas of Whapmagoostui/Kuujjuarapik and Route 167.

Of the 47 studies from Hydro-Quebec, only 16 studies contained information relevant to the geotechnical aspects of this pre-feasibility study. It was possible to find a few drilling reports, descriptions of surface deposits, location of borrow pits and quarries, a general description of the soils and rocks as well as test pits reports.

Following the analysis of the study conducted by MTQ in 2013 at one of the study areas, it was possible to find descriptions of the surface materials accompanied by several detailed maps as well as the location and description of several borrow pits, accompanied by photographs relevant for photointerpretation.

[1] It is available digitally at https://cherloc.ca/

2.2.2 CHERLOC DATABASE - HYDRO-QUÉBEC

Following a thorough research of Hydro-Quebec's Cherloc database, several geotechnical information were retrieved, including :

- Over 100 detailed reports of geotechnical drilling and test pits;
- Laboratory analytical results, including sieve analyses, hydrometer analyses, Atterberg limits, soil sensitivity analyses, compaction tests, uniaxial compression tests, oedometric consolidation tests, and permeability tests;
- In-situ test results, including vane shear tests, and N values from the standard penetration test (SPT);
- Rock characterization;
- Detailed stratigraphic cross-sections;
- Description and location of several borrow pits, esker, and terraces with descriptions;
- Description of surface materials (geomorphology) with detailed maps and photographs;
- Bathymetric and hydrogeological data, such as water level surveys and permeability tests;
- Seismic surveys;
- Landslide hazardous areas (descriptions and locations);
- Soil descriptions along the coastline with mapping and laboratory analyses.

The following tables summarize the information collected from the Cherloc database.

Table 2-1 Summary of Documents Reviewed

DOCUMENTS	QUANTITY
Total reviewed	25
With relevant data in the study area	17
With survey reports in the study area	8

Table 2-2 Inventory of Available Surveys

SURVEYS	PITS	ROCK DRILLING	SOUNDINGS IN LOOSE DEPOSITS	TOTAL
Compiled	21	22	48	**91**

All references and reports have been consolidated into an input list and saved on the study’s Sharepoint site where they can be accessed by the various disciplines.

2.2.3 CONFIDENTIAL INFORMATION - HYDRO-QUÉBEC

A second list of studies and reports was also compiled from documents obtained from the Cherloc database that contained several non-accessible confidential studies conducted by Hydro-Québec. A request was sent to Hydro-Quebec for permission to access this information. Approximately eleven documents were sent by Hydro-Quebec representing four different studies that were conducted in the La Grande to Whapmagoostui/Kuujjuarapik area above Kuujjuarapik. These documents contained information similar to that mentioned in section 2.2.2. In addition, they included information on bedrock lithology, permeability tests performed in soil and bedrock.

Table 2-3 summarizes the information gathered from these documents provided by Hydro-Québec.

Table 2-3 Information Retrieved from Documents Sent by Hydro-Québec

INFORMATION	QUANTITY
Reviewed reports	11
Drilling reports with description of overburden soils and bedrock	48
Particle size analysis of surface materials	37
Permeability analyses	15
Rock drilling reports with description of rock lithology	11

2.2.4 SYSTÈME D'INFORMATION GÉOMINIÈRE OF QUÉBEC (SIGÉOM) - MINISTRY OF ENERGY AND NATURAL RESOURCES

Following research on SIGÉOM website of the Ministry of Energy and Natural Resources, a significant amount of information was identified, mainly from diamond drilling boreholes of previous mineral exploration campaigns.

The following figure shows the location of these boreholes with respect to the areas covered by the present mandate. The size and color of the symbols refer to the density of the boreholes available at each location.

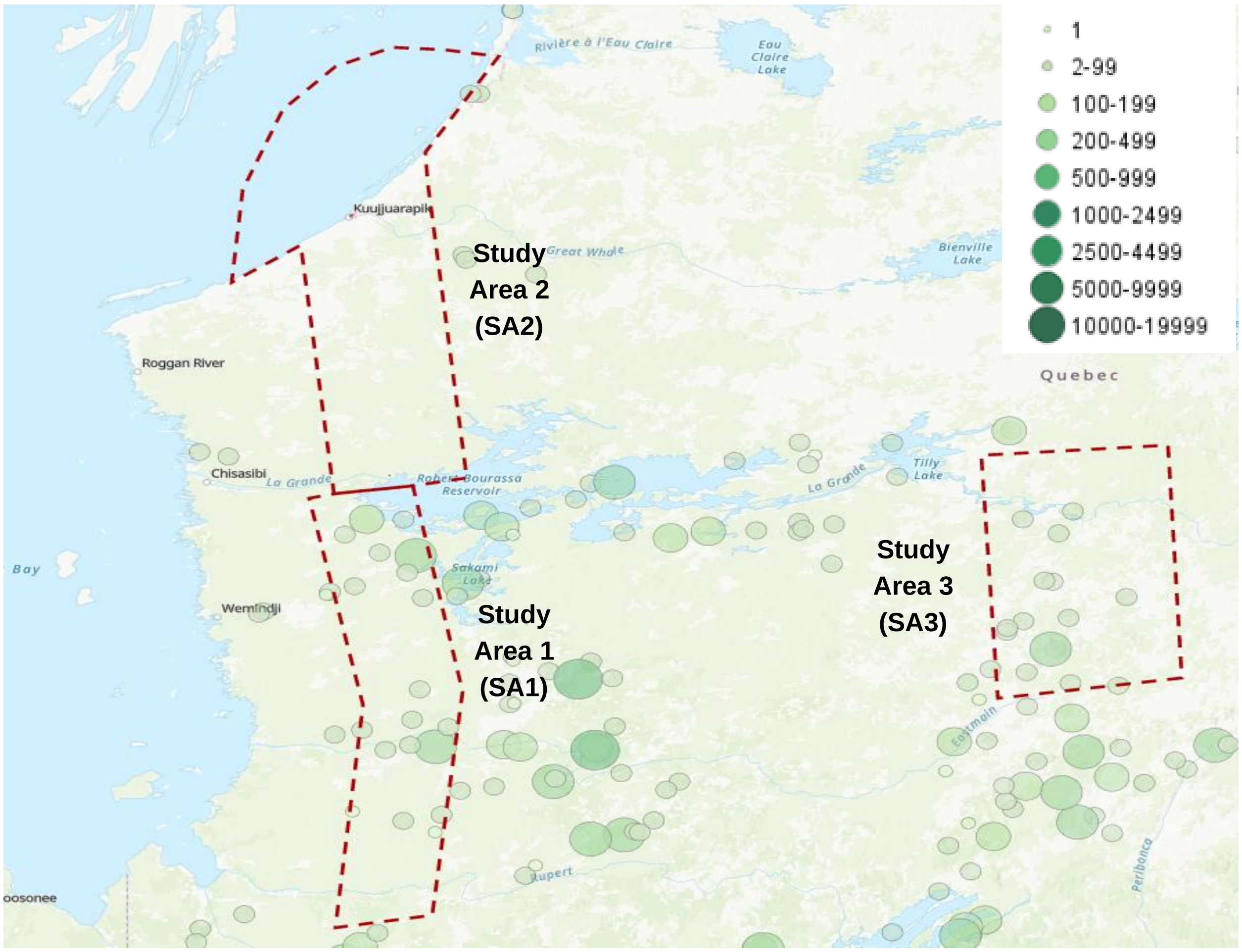


Figure 2-2 Map of Available Boreholes in SIGÉOM

Each group of boreholes is associated with a report including drilling details and analyses. Following a preliminary consultation, approximately sixty studies containing drilling reports with and without description of stratigraphy were identified. However, it should be noted that a large quantity of data was obtained in the Schefferville area where several roads have been built. Following the exclusion of the Schefferville area (extension of the Trans-Taiga road eastward to Schefferville) in the framework of the pre-feasibility study, this data was not taken into account further in this study.

It was possible to obtain via SIGEOM a map of surface deposits at the scale of the entire study area, resulting from a digital compilation of all the data collected mainly by MERN during the mapping of the territory and/or exploration works.

2.2.5 GEOMORPHOLOGICAL DATA COLLECTION

A review of existing literature in the public and scientific domain was used to synthesize information about the physical environment of the study areas. In addition, maps (scale 1:50,000) available from MERN were processed using ArcGIS Pro and ArcGIS Web AppBuilder software. This allowed to complement the information related to surface deposits and landforms.

The proportions of overburden soils in each area were defined using the SIGEOM morpho-sedimentary zones map. For the Kuujjuarapik area, the Poly-Géo study (2013) was consulted to improve textual information since it presented detailed mapping of overburden soils. However, to ensure consistancy with the two other areas, this study was not used for the calculation of overburden proportions covering the proposed alignments in each area.

For the three study areas, the instability zones were localized over the proposed alignments with 200 m buffer zone on either side. The following constraints were identified from the SIGEOM database and by 2D photointerpretation on ArcGIS Pro software:

1 Water bodies;
2 Wetlands;
3 Areas of rugged rock (fractured rock and rocky escarpments);
4 Areas of fine deepwater glaciomarine sediments;
5 Existing infrastructure that intersects with the proposed alignments;
6 Protected areas.

2.2.6 DATA EXTRACTION AND COMPILATION INTO A DATABASE

The extraction and digitization of data generally stored in PDF documents is a necessary step to analyze and facilitate the integration and sharing of data with all stakeholders. A sustained effort was therefore devoted to this step, in order to build a solid database of information from the beginning of this study.

2.2.6.1 DRILLING DATA EXTRACTION

Once studies containing borehole logs were identified, these studies were reviewed and the logs were saved as separate PDF documents. For each borehole identified, the data in the table below was compiled into one spreadsheet.

Table 2-4 Description of the Fields in the Borehole Database

FIELD NAME	DATA
Borehole_No	Borehole identification number in the study
Type	Borehole type (PU: Well, FR: Rock Borehole, FS: Overburden Borehole, TR: Trench/Test pit)
Nt_level	Elevation of natural terrain
Max_Depth	Borehole depth
Rock_Depth	Rock depth
Project_No	Rating or number associated to the document

FIELD NAME	DATA
Area	Area associated with the proposed coordinate system
East_Coord	Proposed Coordinate – East
North_Coord	Proposed Coordinate – North
Longitude	Geographic coordinate – Longitude
Lattitude	Geographic coordinate – Lattitude
Groundwater_Depth	Depth of groundwater table
Groundwater_Date	Date of groundwater depth reading measurement
Document_Name	Name of the PDF document of the borehole log (generally the name of the borehole).
Year	The year the study was published
Study_Title	Title of the study from which the borehole logs were taken
Comments	Any clarification on the entered data
Page	Page number where the borehole logs can be found in the main document
Nb_pages	Number of pages in the borehole logs
SPT N_Cu	Yes/No contains N values from the standard penetration test in the case of cohesionless soils, or from vane shear tests in the case of cohesive soils.
Compression	Yes/no contains uniaxial compression test results
Limits	Yes/no contains Atterberg limits data
Volumetric Unit Weight	Yes/no contains volumetric unit weight measurements
Permeability	Yes/no contains permeability test results
Granulo	Yes/no contains particle size analyses and/or hydrometer analyses.

In several cases, the exact coordinates of the boreholes were not available. When possible, these coordinates were obtained by approximately georeferencing location plans using QGIS software and/or using provided chainage in the document. It should be noted that not all of the information presented in the table above was available for all boreholes.

2.2.6.2 *EXTRACTION OF OTHER DATA*

Other relevant data, such as laboratory test results, detailed stratigraphic cross-sections, and borehole location plans, were also identified in some studies and saved as separate PDF documents. For each document created, the following information was collected.

Table 2-5 Description of the Database Fields Containing Other Geotechnical Data (Maps, Sections, Plans, etc.)

FIELD NAME	DATA
Name	Representative name of the information type
Reference_Document	Source document number
Year	Publication year of the source document
Study_Title	Study Title
Comment	Comment or clarification in relation to the data entered
Page	Page number
Nb_Page	Number of pages

All this information will constitute the raw materials for the geotechnical analyses intended to identify possible challenges and risks in the concerned areas.

2.2.7 *INTEGRATION OF DATA INTO THE GEOGRAPHIC INFORMATION SYSTEM (GIS)*

The technical database is then integrated into the study's geographic information system. Each borehole appears as a point on which it is possible to click on it to access the compiled information: borehole log in PDF format, rock depth, natural ground level, tests performed, etc. The following figure summarizes the process used to collect the data until its integration into the GIS.

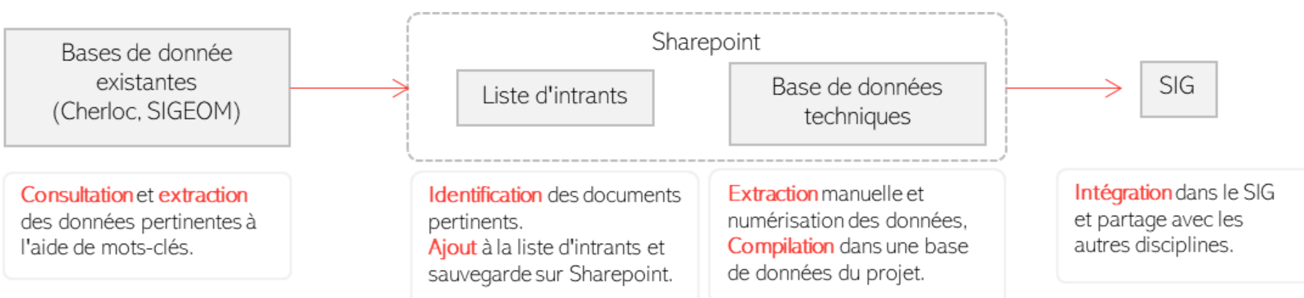


Figure 2-3 Approach Used for Data Collection up to Integration in the GIS

3 OVERVIEW OF THE GEOMORPHOLOGY OF THE STUDY AREAS

The geomorphology component of this technical study aims to investigate the nature of the overburden in the three areas targeted by the pre-feasibility phase II & III study:

– Study Area 1 (SA1): Billy-Diamond Highway Railway – Rupert – La Grande;
– Study Area 2 (SA2): Road & Rail Extension, and Harbour – La Grande – Whapmagoostui/Kuujjuarapik
– Study Area 3 (SA3): Route 167- Renard Mine – Trans-Taiga Road.

The main objectives are:

— Characterize the proportion and arrangement of the various overburden soils distributed in the study areas;
— Identify areas where sediments have a higher potential of granular material;
— Identify significant geomorphic features found in the study areas;
— Identify instability areas that could be problematic for the soil's bearing capacity of future infrastructures.

3.1 RAILWAY: RUPERT TO LA GRANDE (PHASE II)

3.1.1 PHYSIOGRAPHY

The Waskaganish study area is a north-south section about 285 km long and 55 km wide. It is located east of James Bay, between the Rupert and La Grande Rivers. Its northern extremity coincides with the southern limit of the Kuujjuarapik study area. The study area is included in the natural province of the low hills of the La Grande Rivière, that is slightly inclined towards James and Hudson bays to the west (MERN, 2022a).

The Rupert to La Grande section is characterized by curvy plain punctuated by rock outcrops The average elevation along the proposed road corridor is generally between 175 and 225 m. However, the maximum elevation reaches 259 m about 30 km south of the Eastmain River (station B-370 in the SIG database).

The river valleys appear generally narrow and moderately incised. The elevation drops to around 150 m at the Pontax, Eastmain, Opinaca rivers (stations B-306, B-394 and B-412 in the SIG database) and immediately east of Lac du Vieux Comptoir (station B-464 in the SIG database). Further north, east of Yasinski Lake (Range B-542), the elevation drops drastically from 197 m to 135 m over a distance of about 6 km. The elevation then rises gradually to about 175 m up to Radisson.

3.1.2 GEOLOGY

The Rupert to La Grande area is included in the Superior geological province of the Canadian Shield (MERN, 2022b). The northern and central portions of the section straddle the La Grande subprovince, which is composed of volcanic-plutonic rock. Locally, the rock is composed of tonalite, diorite, granite and tonalitic to granodioritic gneiss (MERN, 2022c). The southern part of the section intersects the Nemiscau Subprovince. The bedrock is metasedimentary rock, mainly composed of paragneiss, schist, iron formation and marble (MERN, 2022d). A few narrow bands of felsic to mafic volcanic rock cut the study area, mainly in the northern and central portions.

Structurally, it appears that the rock is highly deformed. In fact, several faults, shear zones, and regional folds cross the Rupert to La Grande site, generally in the east-west direction (MERN, 2022c).

3.1.3 HYDROGRAPHY

The study area falls within the Hudson Bay watershed. Considering basins that are crossed more than once, the proposed rail line will cross 33 Level 1 or 2 watersheds along its route. These basins are oriented east west, as the flow network is directed to the James Bay drainage basin.

The preliminary rail alignment will cross 8 major watercourses, the main ones being the Pontax, Eastmain and Beaver rivers, which flow westward. The same route also crosses 149 minor watercourses, a large proportion of which (30.20%) are in the Eastman watershed, located in the center of the study area.

In addition, several lakes of varying sizes cover the Rupert to La Grande sector, most of which are easily bypassed by the proposed rail route. The northeastern portion of the sector is occupied by the Robert-Bourassa reservoir.

3.1.4 GENERAL MORPHO-SEDIMENTARY AREAS

Map 1 (Appendix A-1) illustrates the layout of overburden in the Rupert to La Grande area. A large portion of the study area is composed of undifferentiated organic sediments (26.04%; Table 3-1). These are sporadically distributed throughout the area, with a higher concentration in the southern part of the section.

In addition, a representative portion of the area is covered by undifferentiated till and bedrock, which occupy 17.74% and 16.54% of the area respectively. These two morpho-sedimentological zones are scattered throughout the northern and central parts of the site, while in the southern part, bedrock is located to the west and till to the east of the section.

Nearshore and prelittoral glaciomarine sediments represent 14.44% of the surface deposits in the Rupert to La Grande area. These sediments are mainly grouped at the middle of the segment, but there are also a few deposits scattered to the north and south of the study site. It should also be noted that 13.93% of the area is covered with fine deep-water glaciomarine sediments, which are located mainly at the northern and southern ends of the segment.

Fluvioglacial sediments (subaqueous proglacial outwash 0.04%, juxtaglacial 0.74%, and frontal moraine 0.60%) are located in the northern and central portions of the study section. These deposits represent a good potential of granular materials and will be described in more detail in section 3.1.4.

Undifferentiated lacustrine sediments cover 7.15% of the study area and are deposited at the bottom of existing lakes, the main reservoir being Robert-Bourassa, which crosses the northern part of the section. Other types of deposits present in the study area generally cover areas of less than 1%.

Particular attention should be paid to the distribution of organic sediments and fine deep-water glaciomarine deposits, which cover a large portion of the Rupert to La Grande area and could represent a stability concern in the design of potential infrastructure. Rockfalls (0.01%) are found in minor proportions in the area and should therefore not present an obstacle to the bearing capacity of future infrastructures.

Table 3-1 Proportions of Overburden in the Rupert to La Grande Area

TYPE OF DEPOSIT	SUPERFICIE (HA) SURFACE AREA (HA)	PROPORTION OF THE STUDY AREA (%)
Undifferentiated alluvium	26,618.74	0.643
Current alluvium	9,818.42	0.237
Aeolian sediments	842.07	0.020
Rockfall deposits	404.29	0.010
Subaqueous proglacial sediments	1,738.23	0.042

TYPE OF DEPOSIT	SUPERFICIE (HA) SURFACE AREA (HA)	PROPORTION OF THE STUDY AREA (%)
Juxtaglacial sediments	30,514.60	0.737
Frontal moraine sediments	24,678.26	0.596
Undifferentiated lake sediments	296,020.67	7.148
Deep water fine glaciolacustrine sediments	180.50	0.004
Coastal and pre-littoral glaciolacustrine sediments	22,193.33	0.536
Deep-sea fine glaciomarine sediments	577,000.75	13.932
Nearshore and prelittoral glaciomarine sediments	598,096.60	14.442
Deltaic and prodeltaic glaciomarine sediments	4,284.17	0.103
Undifferentiated organic sediments	1,078,455.33	26.041
Undifferentiated rock in place	684,906.01	16.538
Undifferentiated Till	734,711.35	17.741
Fusion or ablation till	50,953.33	1.230

3.1.5 NATURE OF THE UNCONSOLIDATED DEPOSITS IN THE CORRIDOR

Table 3-2 illustrates the layout of overburden along the alignment represented the proposed rail corridor at the Rupert to La Grande area, including a 200 m buffer zone on either side. The 400 m wide buffer zone was determined to cover the entire area where unstable deposits could affect the proposed rail alignment. A significant portion of the proposed rail corridor is covered by undifferentiated organic sediments (24.99%), a high concentration of which is located to the south of the segment. However, it should be noted that detailed mapping could allow this proportion to be reduced.

Near-shore and pre-shore glaciomarine sediments cover around 18.41% of the surface deposits in the proposed rail corridor and are primarily clustered in the center of the section. In addition, 16.04% of the corridor is covered by fine deepwater glaciomarine sediments. A large proportion of these deposits are located in the northern parts of the corridor, but they are also found to a lesser extent just north of the Eastmain River, which runs through the center of the study area.

In addition, a significant portion of the rail corridor is characterized by till (undifferentiated till: 14.21%; melting till: 2.08%) and bedrock (14.27%). The undifferentiated till deposits are scattered throughout the corridor, with a higher concentration in the central part. The few melting till deposits is also found in the center of the corridor. Rock outcrops are mostly located at the northern and central portions.

Although little frontal moraine sediments cover the Rupert to La Grande study area, the corridor at the proposed rail corridor line crosses a significant proportion of these deposits (8.48%) at its northern part. Finally, the other types of deposits present at the study area cover less than 1%.

Table 3-2 Proportion of Overburden in the Proposed Corridor in the Rupert to La Grande Area

TYPE OF DEPOSIT	SURFACE AREA (HA)	PROPORTION OF THE CORRIDOR (%)
Undifferentiated alluvium	204.92	0.556
Current alluvium	-	-
Aeolian sediments	67.09	0.182
Rockfall deposits	-	-
Subaqueous proglacial sediments	-	-
Juxtaglacial sediments	186.33	0.505
Frontal moraine sediments	3,126.65	8.477
Undifferentiated lake sediments	66.72	0.181
Deep water fine glaciolacustrine sediments	-	-
Coastal and pre-littoral glaciolacustrine sediments	0.94	0.003
Deep-sea fine glaciomarine sediments	5,914.80	16.036
Nearshore and prelittoral glaciomarine sediments	6,790.44	18.410
Deltaic and prodeltaic glaciomarine sediments	40.38	0.109
Undifferentiated organic sediment	9,216.49	24.987
Undifferentiated rock in place	5,261.97	14.266
Undifferentiated Till	5,239.76	14.206
Fusion or ablation till	768.39	2.083

3.1.6 POTENTIAL SOURCES OF GRANULAR MATERIALS

MERN's Mineral Title Management System (GESTIM) document distribution site groups the borrow pits located in the study area. In general, numerous gravel and crushed stone operations are observed along the Billy-Diamond Highway. To a lesser extent, sand, and moraine deposits are also present. As a result, the southern portion and the northern extremity of the study area have the highest proportions of borrow pits. A smaller amount of borrow pits are found on the portion of the proposed corridor located between Kaministikuch and Duxbury lakes, which extends for approximately 75 km (stations B-352 to B-422 in the SIG database). There are only four borrow pits on this segment, two of which are sand, one is gravel, and one is crushed stone.

The morpho-sedimentary areas available on SIGEOM show a higher proportion of fluvioglacial sediments, mainly composed of juxtaglacial deposits and frontal moraine, in the northern and central portions of the Rupert to La Grande area. In fact, south of the Eastman River (station B-370 in the SIG database), fluvioglacial strips are very rare.

However, some till deposits have a grain size that can be used as granular material, such as reworked till (Tr), wasked-out till (Td), melt-out or ablation till (Tf), hummocky till (Tb), and ridged till (To). Reworked till is located to the southeast of the transect and could possibly compensate for the lack of granular sources in this area.

3.1.7 LANDFORMS

The entire study area is covered with glacial marks and tapered forms deposited during the last glaciation. Notably, several drumlinoid fields form elongated spurs along the NE-SE axis, which represent evidence of local glacial flow to the SE (see figure 3-1).

The Sakami Moraine, which extends from Lake Mistassini to Kuujjuarapik, marks the regional deglaciation (Hardy, 1982). In the study area, it forms an arch that extends from the eastern limit of the Opinaca River in the study area (opposite station B-430) to the northern end of the section. It appears as a discontinuous strip of sandy -gravelly and sandy deposits. Series of De Geer moraines have also developed at the southern end of the segment and just north of Boisrobert Lake (station B-380 in the SIG database). These parallel crests are oriented NW-SE and formed during the retreat of the glacial margin at the contact with a water body. A few series of north-south oriented moraines are also found in the northeastern part of the segment, just west of Sakami Lake (opposite station B-536 in the SIG database).

In addition, several beach crests are grouped together in the southern part of the Rupert to La Grande area. These form sinuous strips that mark former levels reached by the Tyrrell Sea. A few clusters of dunes are also observed to the south and east of the segment and illustrate the reworking of sediments by wind.

Figure 3-1 Glacial Formations around the Proposed Railroad (Grey Dotted Line) in the Central Rupert to La Grande Area. NE-SW Trending Drumlinoid Fields (Red Lines) and NW-SE Trending De Geer moraine Series are Observed

3.1.8 RAILWAY CORRIDOR CONSTRAINTS

Constraints to the proposed railway line have been identified within the corridor that includes the proposed rail corridor line including a buffer zone of 200 m on either side. This section presents their extent and arrangement. The technical characteristics associated with each of the constraints are described in Section 6.

Fine deep-water glaciomarine sediments, located in areas of lower elevation, scattered along the route of the railway, primarily in the northern part of the section. Areas where these deposits are accumulated to large thicknesses may be unstable and will need to be studied in detail. The study of Macleod et al (1999) identifies three areas of low strength marine clay deposits along the road between Matagami and Billy-Diamond Highway. The first area extends over 40 km on either side of the Eastmain River and is characterized by a high thickness of sensitive clays, covered by less than 1 m of peat. The two other areas are found over 10 and 16 km to the north of the area. They consist of sensitive clays covered by 1 to 2 m of peat and discontinuous permafrost.

The corridor crosses several sporadically scattered rocky areas distributed mainly in the central and northern parts of the segment. In general, rock does not appear to be a constraint to the passage of the rail corridor, except for some areas where the relief is more observed. Three areas of moderate slopes (B-478, B-461 and B-408 in the SIG database) and three areas of steep slopes (B-394, B-412 and B-473 in the SIG database) were identified that will require detailed analysis to assess whether the segment will need to be relocated accordingly (see Figure 3-2). These six rocky sites are located in the center of the corridor.

Figure 3-2 Steep Rocky Mounds Crossed by the proposed Railroad (Black Dotted Line) in the Center of the Rupert to La Grande Area, 1 Km North of the Opinaca River. The Red Lines Show the Contour Lines at 10 m of elevation

In addition, the study corridor crosses 66 water bodies, but the majority are not directly intersected by the rail corridor and therefore do not represent major obstacles to the passage of the infrastructure.

Several wetlands have been identified along the rail corridor, a high proportion of which are found in the northern portion of the transect. Although most of these wetlands appear to be small and therefore should not affect the corridor crossing, some peatlands are particularly well developed and could represent a considerable risk of subsidence and settlement in the long term. In fact, the photointerpretation works identified 16 peatlands as major constraints to the railway crossing (see Figure 3-3). Of these, there are five in the center of the Waskaganish corridor and 11 to the north. In addition, Keyser and Laforge (1978) identified 17 areas of peat deposits exceeding 1.5 m in thickness along the Billy-Diamond Highway (BDH), which runs along the proposed rail line. Five of these areas are located south of the study area, only one is located in the center of the area, just south of the Eastmain River, while the remaining 11 peatlands are located north of the BDH.

Figure 3-3 Peatland Crossed by the proposed Railway (Black Dotted Line) for Approximately 1.5 Km, at the Northern End of the Waskaganish Area

The study segment also crosses five power lines along its alignment (B-393, B-473, B-525, B-544 and B-610 in the SIG database), three of which are located in the northern part of the area. These include 3, 7 and 1 tower(s) respectively included in the corridor on either side of the proposed railway. The other two power lines are located in the middle of the segment, and each of them has only one tower in the area of the proposed alignment.

With regard to environmental constraints, the proposed Waskaganish Biodiversity Reserve is located at the southern end of the segment. The rail corridor crosses this reserve at three locations, for a total distance of 12 km. In the north central part of the study area, the proposed rail corridor runs along the existing road and is bordered by the proposed Paakumshumwaau-Maatuskaau Biodiversity Reserve for approximately 90 km. The reserve is intersected by the corridor at nine relatively short segments, summing up to approximately 5 km of length.

3.2 ROADWAY AND RAILWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASE II & III)

It should be noted that the proposed roadway has two alternatives, the segment of which between kilometers 59 and 115 extends further east of the road initially proposed in the study by Poly-Géo Inc. (2013). Alternatives 1 and 2 move away to the east by about 17 km and 6 km respectively from the route projected by Poly-Géo Inc. Geotechnical assessment was carried out for both, but further analysis during the course of the study prioritized the alternative 2, hence why the proposed phase III railway line is along that proposed roadway corridor.

3.2.1 PHYSIOGRAPHY

The La Grande to Whapmagoostui/Kuujjuarapik study area is a north-south oriented corridor approximately 260 km long and 70 km wide. The site is located east of James Bay and extends from Radisson to Hudson Bay in the north. It is included in the 173,000 km^2 Lower Grande River Hills Natural Province (MERN, 2022a). This area is characterized by a gently inclined platform towards James and Hudson Bays to the west.

The relief forms an undulating plain whose topography is mainly controlled by the bedrock which outcrops in abundance. The average elevation along the proposed road and railway corridors is generally between 125 and 150 m. However, the maximum elevation reaches 236 m approximately 62 km from the northern end of the road (station B-558 in the SIG database) and then gradually decreases to Hudson Bay to the north. Valleys are generally narrow and slightly incised (MERN, 2022a), except for the Great Whale River valley, which is incised to depths of 50 to 100 m.

3.2.2 GEOLOGY

The rock covering the study corridor is part of the Superior Geological Province of the Canadian Shield, which is Archean in age (MERN, 2022b). The northern and central portions of the section overlap the Bienville Domain (Minto Subprovince), which is predominantly granitic to tonalitic orthogneiss (MERN, 2022c). The southern end of the area cuts the Radisson pluton (Minto Subprovince), which is composed mainly of hornblende-bearing quartz monzodiorite (Goutier et al., 1999). Finally, a narrow band of Proterozoic age (2.5 to 1.6 Ga) rock borders the Hudson Bay coast. This is composed of sedimentary rocks (dolomite, quartzite, basalt) belonging to the Nastapoka Group.

Structurally, a few regional faults cut the bedrock along the coast, northeast of Kuujjuarapik, as well as in the southern portion of the study area (MERN, 2022c).

3.2.3 HYDROGRAPHY

The study area is included in the Hudson Bay watershed. The road alignments for Alternatives 1 and 2 will cross, respectively, 15 and 10 watershed sections (Level 1 or 2), some of which will be crossed more than once. These watersheds are oriented east west, given the flow network directed towards the James Bay and Hudson Bay drainage basins.

The main tributaries intersecting the roadway and railway are the Piagochioui River to the south and the Great Whale River to the north, both flowing westwards. Several lake and river systems running in an east-west direction are also crossed on the study transect, particularly at the center and the south of the area. The main water bodies covering the area are the Robert-Bourrassa reservoir located at the southern limit of the area, as well as Julian, Craven and Roggan lakes, which are mainly located in the center of the area.

For both road alternatives, a total of 22 major water bodies or streams are crossed by the proposed road. On Alternative 1, the proposed route intersects 142 minor watercourses distributed evenly throughout the segment. A large proportion of these minor streams (34.5%) are intersected in the Roggan River watershed, located in the south-central part of the area. Alternative 2 will intersect 198 minor streams, the majority of which (25.25%) are also included in the Roggan watershed. The planned railway will cross 19 major water bodies and 145 minor watercourses.

3.2.4 GENERAL MORPHO-SEDIMENTARY AREAS

This area is mostly characterized by undifferentiated bedrock, which covers around 36.01% of the study area (Table 3-3; Appendix A-2, Map 2), in which bedrock outcrops are scattered almost over the entire study segment. Undifferentiated till covers around 31.65% of the study area and is relatively uniformly distributed over the La Grande to Whapmagoostui/Kuujjuarapik area.

On the other hand, 10.20% of the territory is covered by undifferentiated lacustrine sediments placed at the bottom of existing lakes. Large number of small lakes are found sporadically throughout the territory. Also, fine deep-water glaciomarine sediments (9.78%) and littoral and prelittoral glaciomarine sediments (8.97%) cover the valleys of the current rivers, forming corridors mainly in the northern and central parts of the area. The glaciomarine sediments were deposited during the post-glacial marine incursion. The sea has now retreated in response to isostatic rebound.

Although found in a small proportion over the territory, fluvioglacial sediments (subaqueous proglacial outwash sediments 0.02%, juxtaglacial sediments 0.31%, and frontal moraine sediments 0.32%) offer a strong potential of granular material. These deposits are scattered throughout the area and range in grain size from silty sand to gravels and boulders.

It should be noted that 39.67% of the study area is covered by water, in which most of it is concentrated in the Hudson Bay, to the north of the segment. As it presented no obstacles to the layout of future infrastructures, the Hudson Bay area was excluded from the sediment analysis. Rockfall deposits (0.001%) and undifferentiated organic sediments (2.58%; located mainly to the north and to the east of the segment) are found in relatively small quantities in the study area, which should not present bearing capacity problems for potential future infrastructure. Finally, the presence of fine deep-water glaciomarine sediments would need to be considered when designing future facilities, since these deposits are considered relatively problematic presenting instability concerns.

Table 3-3 Proportion of Overburden in the La Grande to Whapmagoostui/Kuujjuarapik Area

TYPE OF DEPOSIT	SURFACE AREA (HA)	PROPORTION OF THE STUDY AREA (%)
Current alluvium	1,176.18	0.030
Rockfall deposits	48.27	0.001
Subaqueous proglacial sediments	878,53	0.023
Juxtaglacial sediments	12,129.11	0.311
Frontal moraine sediments	12,301.44	0.316
Undifferentiated lake sediments	397,212.23	10.198

TYPE OF DEPOSIT	SURFACE AREA (HA)	PROPORTION OF THE STUDY AREA (%)
Deep-sea fine glaciomarine sediments	381,079.83	9.784
Nearshore and prelittoral glaciomarine sediments	349,232.81	8.966
Deltaic and prodeltaic glaciomarine sediments	4,112.06	0.106
Undifferentiated organic sediments	100,394.88	2.578
Undifferentiated rock in place	1,402,494.40	36.008
Undifferentiated Till	1,232,747.84	31.650
melt-out or ablation till	1,129.02	0.029

3.2.5 NATURE OF DEPOSITS AT THE CORRIDOR

Table 3-4 presents the disposition of overburden along the corridor formed by the proposed roadway and railway including a 200 m buffer zone on either side of the road, at the La Grande to Whapmagoostui/Kuujjuarapik area. The two road alternatives proposed between Km 59 and 115 (A1 and A2) were considered in the surficial deposits analysis. It should be noted that this is a general characterization of the corridors under study and that the route will not necessarily pass through these areas.

A large proportion of the corridors is covered by undifferentiated till (V1: 42.35%; V2: 46.39%; Iron Road: 44.13%). Till deposits are distributed all along the corridor but they are more concentrated in its southern portion. Rock is also abundant on the proposed alignments (A1: 26.10%; A2: 23.43%; Railway: 23.88%). Rock outcrops are scattered throughout the corridor and are more prominent in its northern and central portions.

Deepwater fine glaciomarine sediments (A1: 16.42%; A2: 15.24%; Railway: 16.78%) intersect the projected corridor mainly in the northern and central portions, as do nearshore and prelittoral glaciomarine sediments (A1: 9.07%; A2: 8.15%; Railway: 8.28%). In addition, it should be noted that a small proportion of the corridor is intersected by organic soils (A1: 4.96%; A2: 5.17%; Railway: 4.95%), mostly concentrated at the northern end of the proposed road.

Despite its presence in small proportions on the proposed road, a significant deposit of juxtaglacial sediments (A1: 0.42%; A2: 0.44%; Railway: 1.10%) is identified around kilometer 61. Because of their proximity and their grain size distribution, these sediments could possibly be used as granular material during the road design. The other types of deposits identified in the vicinity of the proposed road and railway represent less than 1%.

Table 3-4 Proportion of Overburden in the Proposed Corridor of the La Grande to Whapmagoostui/Kuujjuarapik Area

TYPE OF DEPOSIT	ROAD - ALTERNATIVE 1		ROAD - ALTERNATIVE 2		RAILWAY	
	AREA (HA)	CORRIDOR PROPORTION (%)	AREA (HA)	CORRIDOR PROPORTION (%)	AREA (HA)	CORRIDOR PROPORTION (%)
Current alluvium	-	-	-	-	-	-
Rockfall deposits	-	-	-	-	-	-
Subaqueous proglacial sediments	-	-	-	-	-	-

TYPE OF DEPOSIT	ROAD - ALTERNATIVE 1		ROAD - ALTERNATIVE 2		RAILWAY	
	AREA (HA)	CORRIDOR PROPORTION (%)	AREA (HA)	CORRIDOR PROPORTION (%)	AREA (HA)	CORRIDOR PROPORTION (%)
Juxtaglacial sediments	64.15	0.420	64.15	0.438	96.345	1.099%
Frontal moraine sediments	-	-	-	-	-	-
Undifferentiated lacustrine sediments	31.66	0.207	98.12	0.670	28.24	0.322%
Deep-sea fine glaciomarine sediments	2509.10	16.416	2230.81	15.236	1471.48	16.782%
Nearshore and prelittoral glaciomarine sediments	1386.19	9.069	1193.40	8.151	725.83	8.278%
Deltaic and prodeltaic glaciomarine sediments	75.42	0.493	75.42	0.515	48.51	0.553%
Undifferentiated organic sediments	757.35	4.955	757.35	5.173	434.20	4.952%
Undifferentiated rock in place	3988.50	26.095	3430.67	23.431	2094.15	23.883%
Undifferentiated Till	6472.37	42.345	6791.83	46.387	3869.44	44.130%
Till of fusion or ablation	-	-	-	-	-	-

3.2.6 POTENTIAL SOURCES OF GRANULAR MATERIALS

The report on the access road to the communities of Whapmagoostui and Kuujjuarapik published by Poly-Géo Inc. in 2013 (Appendix B) provides an inventory of potential sources of construction materials in a 5 km wide band centered on the road route. The largest potential borrow sources are located in the southern portion of the transect, near Awahagats Lake, where two sand and gravel deposits are located with approximate potential volumes of over 500,000 m³ and 2.5 M m³. In the northern portion of the road, several smaller sand and gravel deposits (between 50,000 and 500,000 m³) are located near Benoit and Mach lakes. An additional sand and gravel deposit of more than 500,000 m³ located on the south shore of the Great Whale River, at the northern extremity of the road.

Apart from these potential sources, the study corridor provides small amounts of granular deposits. For this reason, Poly-Géo Inc (2013) also identified areas of dry till deposits, which could be potentially used for backfills and road construction in some areas. The till comprising the drumlinoid and De Geer moraines was prioritized in the study, as most of these landforms have good drainage as well as significant volumes of material. These till sources, although generally offering smaller exploitable volumes, are found throughout the transect, in which they could be used as backfill material in areas where granular material sources are more limited, such as at the southern and central portions of the proposed road. The portion of the road between the Vaquelin River and Takutakamaw Lake, in the northern central part of the segment, was identified to be mainly composed of rock with very little sources of till and granular materials, appearing to be problematic, in which it should be given special attention further in the study.

In addition, the WSP report produced in 2017 on the search of materials in the municipalities of Akulivik and Kuujjuarapik/Whapmagoostui presents potential sources of granular deposits in the vicinity of the village of Kuujjuarapik. A total of 13 sites were documented, including five existing sand pits (BEE-KUU1 to BEE-KUU5), two existing quarries (84,505 and CAE-KUU2), and six potential quarries (CAP-KUU1 to CAP-KUU6) (Appendix C).

The five sandpits are composed of nearshore and pre-shore marine or aeolian deposits whose grain size does not offer a strong potential of granular materials. The quarries are composed of granitic rocks offering a high quality of granular materials. Among these, the existing quarry 84505 has a potential exploitation volume evaluated at 220,000 m^3. In addition, the potential quarries CAP-KUU1 and CAP-KUU2 offer exploitable volumes of 120,000 m^3 and 300,000 m^3 respectively.

Finally, according to the morpho-sedimentary regions available on SIGEOM, it was noted that fluvioglacial sediments are distributed throughout the study area, mainly on the west side of the proposed road. Although found in small proportions over the region, these deposits could represent potential sources of granular materials.

A field campaign conducted by the WSP team in the summer of 2022 targeted and characterized borrow pits with high mining potential along the proposed road alignment (Alternative 2). The results of this campaign are presented in Section 8.

3.2.7 LANDFORMS

Several landforms mark the deglaciation of the study area. The most important landform is that of the Sakami moraine, which forms an arch extending about 630 km from Lake Mistassini to Kuujjuarapik (Hardy, 1982). It illustrates the position of the ice front, parallel to the James Bay coast, during the glacial retreat eastward around 7,900 years before the present. This form is composed of sandy-gravelly and sandy materials, arranged in discontinuous sections to the west of the road corridor.

Series of De Geer moraines have also developed in the southern part of the study area and in smaller quantities in the center of the transect. They form thin parallel crests formed during deglaciation at the contact between the glacial margin and water bodies.

In addition, a few beach crest clusters are located around the village of Kuujjuarapik (Figure 3-4). These crests form a series of strips that run parallel to the James Bay coast. These deposits, shaped by the waves, mark former levels reached by the Tyrrell Sea, which overflew the territory during the late deglaciation.

Finally, before the current vegetation covered the territory, a few dunes were established around the village of Kuujjuarapik, along the coast of Hudson Bay, where they form small crests of sandy sediments that are remobilized by wind activity dominated by southeast and north winds (WSP, 2017).

Figure 3-4 Series of Beaches (Dotted Lines) and Dune Clusters (Triangle) North of the Village of Kuujjuarapik. The Dotted Red Line Illustrates the Northern Extremity of the Proposed Road

3.2.8 ROADWAY AND RAILWAY CORRIDOR CONSTRAINTS

The extent and arrangement of the areas of instability were identified within the corridor including the proposed road with a 200 m buffer on either side of the road. The same process was carried out for the corridor including the proposed railway and 200 m on either side. Chapter 6 presents the technical characteristics associated with each of these constraints.

In the La Grande to Whapmagoostui/Kuujjuarapik area, fine deep-water glaciomarine sediments are located at lower elevations. They are the remnants of the Tyrrell Sea, which invaded the area to an elevation of about 270-280 m during the last deglaciation. The roadway and railway corridor crosses these areas of fine material primarily at the central and northern portions of the transect. A large proportion of these deposits are included in the Roggan and Vaquelin River watersheds at the center of the corridor. Although generally not problematic due to their small thicknesses, these deposits are susceptible to landslides in areas where they accumulate to large thicknesses.

Although the corridors cross several rocky areas, they are generally sporadic and illustrate little relief. The rock is therefore not generally a constraint to the passage of the road. However, two areas of moderate slopes (km 48 and km 197 of the roadway) and a large area of steep slope (km 201 of the roadway) are intersected by the routes of the proposed roadway and railway and will therefore have to be subject to a specific study in order to assess their complexity with regard to the passage of the tracks.

Furthermore, 22 major watercourses and water bodies are crossed by the proposed road segment, generally over short distances, while the railway route intersects 19. However, a high proportion of lakes is observed in the southern part of the corridor, where seven water bodies are accumulated over approximately 3.5 km of the proposed road. Of these, three lakes are directly intersected by the proposed road. It may be possible to move the proposed alignment westward in this location to minimize the costs and risks associated with water body crossings. As for the proposed railway, it crosses a stretch of water nearly 400 m long opposite km 93, in the center of the alignment.

Although found in smaller proportions than observed over the Waskaganish corridor, wetlands are found throughout the La Grande to Whapmagoostui/Kuujjuarapik corridor. These wetlands are found in greater quantities to the north of the corridor. They appear to be relatively undeveloped and easily crossed by the roadway and railway corridor. It should be noted that two more highly developed peatlands were identified by photointerpretation as being major constraints to the passage of the road and railway at the south and center of the corridor. The first is located south of the study area (km 17) and is intersected only by the proposed railway. The second problematic peatland is located further north of the area (km 130) and is intersected by the proposed roadway and railroad.

With respect to existing infrastructure, it was noted that the proposed railway segment crosses a power line at the southern end of the segment (see Figure 3-5). This area is problematic as a power tower is located at the site of the proposed alignment.

Figure 3-5 Power Line Crossed by the proposed Railway (Black Dotted Line) at the Southern Extremity of the La Grande to Whapmagoostui/Kuujjuarapik Area

From an environmental perspective, the proposed road crosses the Burton Lake/Roggan River/ Pointe-Louis XIV protected area for approximately 85 km at the middle of the segment. The road corridor will most likely have to be relocated to bypass this protected area.

3.3 ROUTE 167: UPGRADE & EXTENSION TO TRANS-TAIGA (PHASE II)

3.3.1 PHYSIOGRAPHY

Study zone covers a rectangular north-south area of approximately 155 km long and 100 km wide. It is located 415 km to the east of James Bay where it is intersected by the Grande Rivière, which leads to La Grande 4 reservoirs. The study area is included in the 159,000 km^2 Central Plateau Natural Province of Northern Quebec, which forms a high plateau inclined to the north and the west (MERN, 2022d).

The study site presents a platform punctuated by hills (Topographic Map, 2022). To the south of the segment, the land rises to about 800 m, then decreases in elevation down to 370 m towards the northwest. The average elevation along the proposed road corridor is generally between 450 m and 530 m. However, the maximum elevation reaches 561 m approximately 32 km north of the southern boundary of the transect.

3.3.2 GEOLOGY

The area of Route 167 is within the Superior Geological Province of the Canadian Shield (MERN, 2022b). The northern and central parts of the segment overlap the La Grande subprovince, which is composed of volcanic-plutonic rock. Locally, the rock is composed of tonalite, diorite, granite and tonalitic to granodioritic gneiss (MERN, 2022c). The southern part of the segment crosses the Opinaca subprovince, formed of metasedimentary rock essentially composed of paragneiss, schist, iron formation, and marble. A few narrow bands of mafic to intermediate volcanic rocks cross the center of the study area.

The bedrock appears to be highly deformed structurally. Several faults, shear zones, and regional folds cut the section from east to west, particularly in the southern portion of the Route 167 area (MERN, 2022c).

3.3.3 HYDROGRAPHY

The entire study area is included in the level 1 watershed of the Grande Rivière. This watershed is subdivided into 4 watersheds of level 2 intersecting the segment. The Sakami River and Pontois River sub-watersheds are located to the south and southwest of the area respectively. The sub-basin surrounding the Henri-Bourassa reservoir extends to the northwest of the study area. Finally, the sub-basin to the northeast of the area extends to Lake Caniapiscau.

The main tributaries intersecting the study area are the Sakami River and the Grande Rivière, flowing westward through the central, and northern part of the area respectively. The northern portion of the segment is covered by small, elongated water bodies in a NW-SE direction, present between the crests of the numerous ribbed moraines (Rogen). A total of 20 major and 100 minor water bodies or streams are crossed by the proposed road.

3.3.4 GENERAL MORPHO-SEDIMENTARY AREAS

Most of the study area is composed of glacial sediments (Table 3-5; Appendix A-3, Map 3), i.e., undifferentiated till (84.78%), and melt-out or ablation till (5.53%). In addition, 5.73% of the segment is covered by undifferentiated lacustrine sediments that align the bottom of the numerous small lakes present throughout the area. The southern portion of the area is punctuated by undifferentiated bedrock which outcrops over 1.38% of the area.

Some surface deposits that present a strong potential of granular material have been identified on the territory. In fact, subaerial proglacial outwash sediments (0.39%), and juxtaglacial sediments (1.41%) are found along fluvioglacial corridors-oriented NE-SW. These corridors are scattered throughout the area, although mostly concentrated in the southern portion of the study area.

The low proportions of organic sediments (0.37%), and talus deposits (0.004%) present along the corridor should not cause problems in the design of future infrastructure in the area.

Table 3-5 Proportion of Overburden in the Route 167 Area

TYPE OF DEPOSIT	SURFACE AREA (HA)	PROPORTION OF THE STUDY AREA (%)
Undifferentiated alluvium	8,454.74	0.124
Rockfall deposits	286.63	0.004
Subaerial proglacial outwash sediments	26,557.76	0.388
Juxtaglacial sediments	96,432.17	1.409
Undifferentiated lake sediments	392,503.23	5.734

TYPE OF DEPOSIT	SURFACE AREA (HA)	PROPORTION OF THE STUDY AREA (%)
Coastal and pre-littoral glaciolacustrine sediments	17,089.17	0.250
Deltaic/prodeltaic glaciolacustrine sediments	2,387.12	0.035
Undifferentiated organic sediments	25,282.42	0.369
Undifferentiated rock in place	94,587.67	1.382
Undifferentiated Till	5,803,189.50	84.779
Melt-out or ablation Till	378,273.09	5.526

3.3.5 NATURE OF DEPOSITS AT THE CORRIDOR

Table 3-6 illustrates the layout of the overburden soil along the proposed road corridor at the Route 167 area, including a 200 m buffer zone of either side of the road. The till deposits (undifferentiated till: 86.66%; fusion till: 9.58%) cover almost the entire road corridor, in which it is scattered throughout the corridor.

In addition, 1.93% of the corridor is covered by juxtaglacial sediments, which are arranged in narrow strips that cross the entire corridor. Each of the other types of deposits identified along the proposed road are found in small quantities, in the order of less than 1%.

Table 3-6 Proportion of Overburden in the Proposed Route 167 Corridor

TYPE OF DEPOSIT	SURFACE AREA (HA)	CORRIDOR PROPORTION (%)
Undifferentiated alluvium	23.97	0.296
Rockfall deposits	-	-
Subaerial proglacial outwash sediments	79.89	0.987
Juxtaglacial sediments	156.07	1.928
Undifferentiated lake sediments	3.03	0.037
Coastal and pre-littoral glaciolacustrine sediments	-	-
Deltaic/prodeltaic glaciolacustrine sediments	-	-
Undifferentiated organic sediments	40.26	0.497
Undifferentiated rock in place	1.39	0.017
Undifferentiated Till	7,014.51	86.655
Fusion or ablation till	775.68	9.582

3.3.6 POTENTIAL SOURCES OF GRANULAR MATERIALS

The MERN GESTIM database identifies the presence of a few borrow pits in the study area. These are located at the northern and southern extremities of the segment, near existing roads. To the south, 21 gravel pits are located, while the five borrow pits located to the north include two gravel pits, two sand pits, and one crushed stone pit. No borrow pits were identified at the center of the area.

Based on the morpho-sedimentary data available on the SIGEOM, the sources of fluvioglacial material disposed on either side of the proposed road appear to be relatively well distributed throughout the alignment. For Alternative Route 01 (Segments 1 through 6) located at the southern end of the proposed route, juxtaglacial and outwash deposits intersect the route at regular, close intervals (3.5 to 17 km apart).

Immediately to the north of Alternative 1 the sand and gravel deposits are spread further apart, where it was observed that to the south of the main road, between segment 6 of Alternative 1 and segment 3 of the main road, the sources of granular material intersecting the road where at approximately 25 km apart. Other fluvioglacial deposits have been identified along the periphery of the road, within 5 to 16 km of the proposed alignment. In the event that the exploitation of these deposits would be less favourable due to the distance separating them from the road, the till deposits covering the majority of the study area could also be used as granular material where fluvioglacial sources are scarcer.

For the central and northern portions of the proposed main road (segments 3 to 17), numerous fluvio-glacial deposits are located within 2 km of the alignment, at intervals of 5 to 15 km. It should be noted that the majority of these banks are directly intersected by the main road.

More rigorous photointerpretation analyses and further investigations could determine the potential of each deposit to be used as granular materials.

3.3.7 LANDFORMS

The glacial flutings is very well developed in the Route 167 area, where NE-SW directed drumlinoid clusters present evidence of the last local SW glacial flow. Perpendicular to these forms are numerous series of ribbed moraines (Rogen) arranged parallel to the glacial front, i.e. on a NW-SE axis (see Figure 3-6).

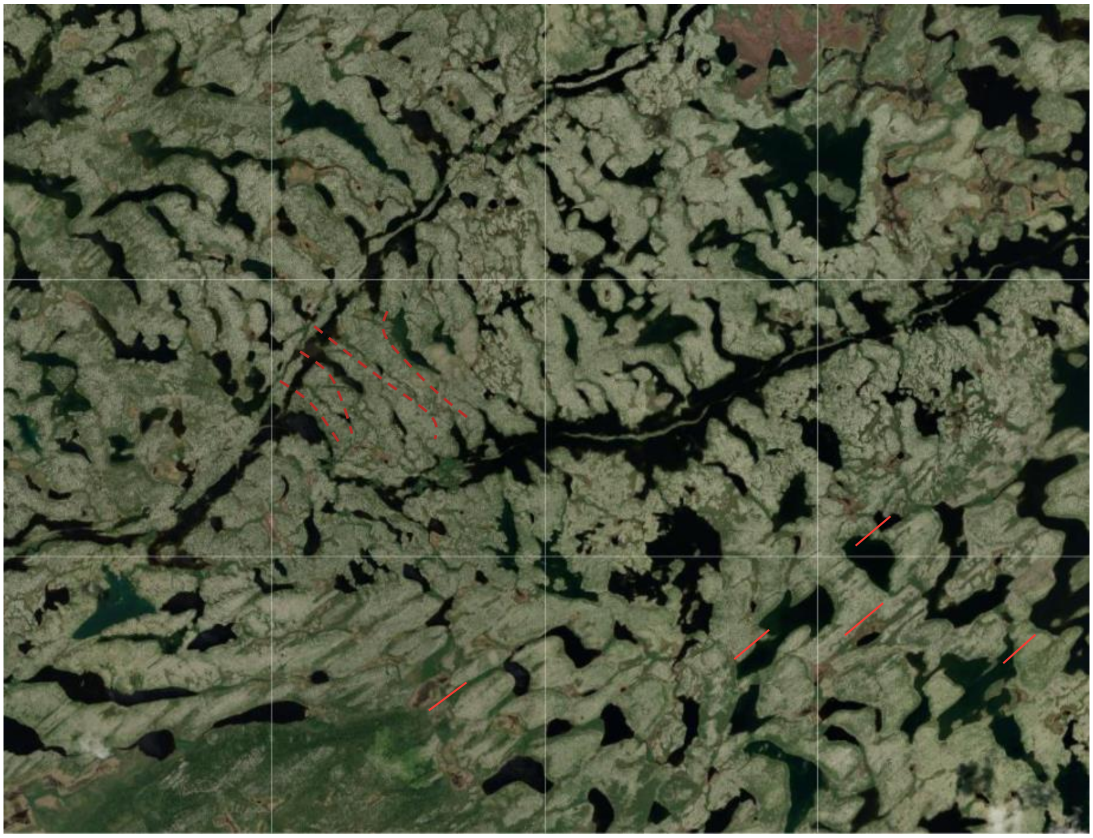


Figure 3-6 Drumlinoids (Red Lines) and Ribbed Moraine Series (Red Dashed Lines) at the North End of the Route 167 Area

These moraines are characterized by short, undulating, and sometimes weakly arched crests. They are easily identifiable over the study area as they form parallel bulges across the water bodies.

Several fluvioglacial forms visible in the study segment were developed during the last deglaciation. Numerous channels of melted water are cut through the overburden layer. The area is also punctuated by kettles forming rounded topographic depressions that are often filled with water (Flint, 1971). In the study area, these forms are often small, averaging a few hundred meters in diameter. In addition, numerous eskers traverse the area. They form narrow bands of fluvioglacial deposits arranged along a NE-SW axis, parallel to the glacial retreat towards the NE.

3.3.8 ROAD CORRIDOR CONSTRAINTS

Areas of instability have been identified within the corridor including the proposed road with the 200 m of buzzer zone on either side. This section presents their extent and layout, while Chapter 6 presents the technical characteristics of each of these constraints.

Compared to the Rupert to La Grande and La Grande to Whapmagoostui/Kuujjuarapik areas, the Route 167 area is located further inland. As a result, it has not been influenced by the postglacial intrusion of the Tyrrell Sea and therefore does not contain any fine deep-water glaciomarine deposits.

Although the corridor passes over a few rocky areas (0.017%), where the rock appears occasionally close to the surface, resulting in steeper walls at certain locations. Through photointerpretation, six areas of moderate slopes and four areas of steep slopes were identified to be scattered throughout the study corridor. These areas will need to be studied in more detail to assess their complexity with respect to the passage of the corridor.

There are 20 major watercourses or water bodies crossed by the proposed road segment. The most significant watercourse crossings will require more detailed investigations to assess whether the proposed alignment should be relocated to minimize the costs and risks associated with watercourse crossings.

Wetland are found in relatively small proportions over the Route 167 corridor. They are scattered throughout the study area, and they and appear to be relatively undeveloped. However, the proposed road corridor crosses eight more highly developed peatlands (see Figure 3-7), at which the alignment of the future infrastructure may have to be re-evaluated.

Figure 3-7 Peatlands Crossed by the Proposed Road (Black Dotted Line) over Approximately 1 km in the Center of the Route 167 Area

4 OVERVIEW OF GEOTECHNICAL DATA BY INFRASTRUCTURE

The geotechnical component of this technical study is intended to investigate the three areas targeted by the phases II & III pre-feasibility study:

– Study Area 1 (SA1): Billy-Diamond Highway Railway – Rupert – La Grande;
– Study Area 2 (SA2): Road extension – La Grande – Whapmagoostui/Kuujjuarapik;
– Study Area 3 (SA3): Route 167- Renard Mine – Trans-Taiga Road.

The main objectives of this geotechnical overview are to:

— Identify the types of overburden soils;
— Identify soils geotechnical parameters and characteristics such as stratigraphy, density, compactness or soils consistency;
— Identify variations in groundwater table depths ;
— Identify bedrock type and general characteristics.

The following sections provide a summary of the geotechnical information collected in these areas.

4.1 RAILWAY: RUPERT TO LA GRANDE (PHASE II)

4.1.1 DESCRIPTION OF RELEVANT DOCUMENTS

A total of four studies were found pertinent in the Rupert to La Grande area in which they contained useful geotechnical data that presented information of the type of soil deposits along the rail corridor, geotechnical issues, and sites of problematic soils. The studies are summarized in table 4-1.

Table 4-1 List of Relevant Studies

AUTHORS	TITLE	YEAR	RELEVANT INFORMATION
Keyser & Laforte (a)	Construction and performance of pavements over muskeg	1978	— Road design details and typical stratigraphic cross-sections; — Description of deposits encountered along the road; — Description and properties of peatlands; — Results of settlement studies
Keyser & Laforte (b)	Road construction in palsa fields	1978	— Description issues related to the construction in Palsa zones; — Presentation of methodologies to mitigate palsas degradation
Lefebvre & Gingras	La route d'accès au territoire de la Baie-James	1980	— Summary of major issues encountered during the design process.
MacLeod, Davidson, Dion, Brassard	Long Term Pavement Performance of the James Bay Access Road	1999	— Road design details; — Description of issues encountered during construction; — Classification of subgrade soils along the existing road corridor.

4.1.2 DATA FROM PREVIOUS STUDIES

The following subsections present a compilation of the most relevant data collected from previous studies. It should be noted that these studies are based on the construction of the Billy-Diamond Highway, which is located near the alignment of the study rail corridor. For further details, refer directly to the articles presented in Table 4-1.

STUDY: *LONG TERM PAVEMENT PERFORMANCE OF THE JAMES BAY ACCESS ROAD* BY MACLEOD, DAVIDSON, DION, BRASSARD (1999)

This map presents a classification of subgrade soils present along the existing road alignment between Matagami and Billy-Diamond Highway. Although different types of soils were encountered in each section, this classification shows the soils that were encountered the most. Figure 4-1 presents a summary of the location of each type of foundation soil along the proposed rail corridor alignment. Table 4-2 presents a summary of the thickness of each type of foundation soil overlying the existing road alignment between Matagami and Billy-Diamond Highway as identified in the above-mentioned study. Table 4-3 presents in more detail the stratigraphy encountered by section as illustrated in Figure 4-1. It should be noted that the yellow dots represent peatlands that are more than 1.5 m in thickness (refers to the information provided in Table 4-5) while the numbers 1 to 12 represent the sections discussed in Table 4-3.

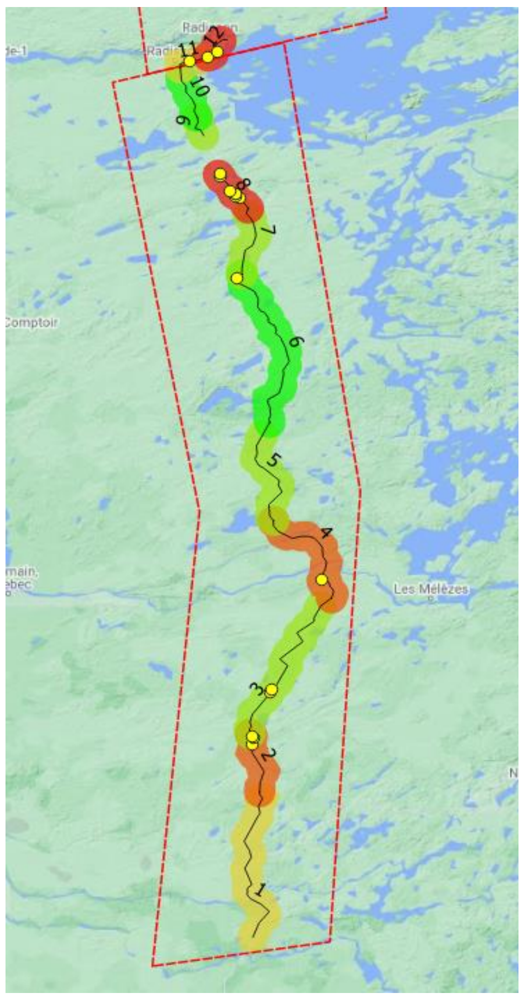


Figure 4-1 Distribution of Foundation Soils Encountered on the Proposed Rail Corridor Alignment between km 257 and km 544.

Table 4-2 Description and Thickness of Each Type of Foundation Soil Covering the Existing Road Between Matagami and La Grande (Billy-Diamond Highway)

FOUNDATION SOILS		FOUNDATION LAYER	
TYPE	DESCRIPTION	THICKNESS (m)	CBR (CALIFORNIA BEARING RATIO)
1	Soil of lower resistance. Typically, soft, sensitive, marine clay deposits covered by 1-2 m of muskeg (peat). Pockets of permafrost were also encountered.	1.2	1.5 - 2
2	Typically, marine clay deposits of soft consistency generally covered by less than 1 m of muskeg (peat).	0.6	3
3	Typically, silty till with high water content. Although competent, was generally not used as fill material. Shallow rock and thin muskeg (peat).	0.6	5
4	Boulder till with lower silt content of that of type 3 soil. Several sections with shallow rock and thin muskeg (peat).	0.6	8
5	Deposits of sand and gravel of high thicknesses	0	15

Table 4-3 Type of Foundation Soils Along the Existing Road Between Matagami and La Grande (Billy-Diamond Highway)

NO[1]	STATION (KM)		LENGTH (KM)	TYPE OF FOUNDATION SOIL	DESCRIPTION
	START	END			
1	240	298	58	3	Silty till deposit
2	298	320	22	2	Silty till deposit
3	320	380	60	4	Boulder till, cuttings and shallow rock fills
4	380	420	40	2	Deep deposit of sensitive clay
5	420	460	40	4	Boulder till, cuttings and shallow rock fills
6	460	520	60	5	Massive sand and gravel deposit
7	520	544	24	4	Boulder till, cuttings and shallow rock fills
8	544	560	16	1	Discontinuous permafrost
9	574	582	8	4	Boulder till, cuttings and shallow rock fills
10	582	600	18	5	Massive sand and gravel deposit
11	600	610	10	3	Boulder till, cuttings and shallow rock fills
12	610	620	10	1	Discontinuous permafrost

[1] *The number refers to the sections shown in Figure 4-1.*

STUDY: *CONSTRUCTION AND PERFORMANCE OF PAVEMENTS OVER MUSKEG* BY KEYSER & LAFORTE (1978)

Table 4-4 presents the percentage of each type of surface deposit overlying the existing road (BDH) obtained from the Keyser & Laforte (1978) study. No figure was produced from the information presented below.

Table 4-4 Percentage of each type of surficial deposit along the rail corridor alignment obtained from the Keyser & Laforte (1978) study

GENERAL CLASS[1]	CODE CGC-Q*	KEYSER & LAFORTE, 1978 (KM 275 - KM 620)		DEFINITION
		MIN – MAX[2] (%)	AVERAGE (%)	
Organics	O	2 – 12	9	Peat bog, marsh and swamp sediment whose exact formation processes could not be determined.
Rock	R	3 – 33	16	Rock outcrops occasionally presenting a thin cover of sediment (less than 30 cm), and whose exact nature could not be determined.
Till	T	8 – 32	20	Glacial diamicton whose exact formation processes could not be determined
	Tf			Loose-matrix, generally washed-out diamicton that is generally more than 1 m thick; surface generally punctuated by numerous pebbles and boulders. Ablation moraine contains a greater proportion of silt and sand than the base moraine.
Sand and gravel	A	20 - 57	37	Alluvial sediment deposited along watercourses, but whose exact formation processes could not be determined.
	GxT			Till, diamicton, boulders, sand and gravel; laid down at the front of the glacier; consisting of one or more crests whose surface is generally hummocky and strewn with boulders.
	Gx			Sand and gravel, boulders, some till or diamicton; forming eskers, kames and morainal crests with a generally hummocky surface.
Silt and clay	L	6 - 10	13	Sediment deposited in a current lacustrine water plan, but whose exact formation processes could not be determined.
	MGb			Stratified and generally well-sorted sand, sandy silt, gravelly sand, and gravel; settled in shallow water; surface generally marked by beach crests and sometimes reworked by wind action.
	Mga	0 - 20	7	Clayey silt and silty clay, medium to dark gray, massive, laminated, or layered, locally including rhythmites; ranging from less than; primarily emplaced by settlements during the glaciomarine flood phase.

1 *Note that this classification is approximate; the various morpho-sedimentological groups have been grouped into general classes for the purposes of this deliverable.*

* *It should be noted that the colors used for each soil deposit type do not represent the exact color shown on the map of morpho-sedimentological areas of Quebec, but rather the colors used in the figures of this report.*

2 *The % refers to deposits that are more than 1 m in thickness that were encountered during the original investigation; less than 5% would have been encountered on the route of the constructed road.*

Multiple areas of peat were identified in the areas between Matagami and La Grande, summarized in Table 4-5. A total of 17 areas were identified in the study along the alignment of the existing road between Matagami and La Grande (Billy-Diamond Highway). The thickness of these peat layers varied between 1.6 and 3.0 m. These peat areas were classified between 4 and 10 on the Van Post scale, which classifies peat according to its degree of decomposition. In terms of underlying soils, areas ranked 4 and 5 on the Van Post scale (4: plant material is decaying and 5: some decomposed material is present) were primarily composed of low plasticity (ML) silt, areas ranked 7 or 8 (7: plant material is visually indistinguishable 8 : No significant roots or fibers) were primarily composed of silty sands (SM), low plasticity clays (CL), or low plasticity silts (ML), and areas classified 10 (10: homogeneous pudding), were primarily composed of silty or poorly graded sands (SM-SP). Undrained shear strength (Su) values of the peat areas ranged from 0 to 93 kPa. Settlement of these peat areas was also recorded over a 10-year period, which ranged from 0.5 to 1.0 m.

More details on the location, coordinates, and properties of peat deposits of thicknesses greater than 1.5 m encountered along the existing road can be found in the study by Keyser & Laforte (1978).

Table 4-5 Characteristics of Peatland Areas Identified Along the Existing Billy-Diamond Highway obtained from the Keyser & Laforte (1978) study

STATION[1] (KM)	THICKNESS (m)	VON POST[2]	S_U (kPa)	UNDERLYING SOIL TYPE	UNDERLYING SOIL S_U (kPa)	10-YEAR SETTLEMENT (m)
316.3	2.50	H-5	0-20	ML	45-70	-
318.5	2.35	H-8	0-25	ML-CL	70-80	0.90
319	2.30	H-8	0-17	ML-CL	70-80	0.75
336.4	2.50	H-7	0-15	ML-SM	-	0.75
337.6	2.10	H-7	0-27	ML-SM	75-80	0.75
388.9	3,00	H-8	6-48	ML	80-105	1.00
518	2.50	H-10	0-12	SM-SP	N=25	0.90
548.1	2.50	H-6	0-20	ML	-	0.70
549.7	2.00	H-10	93	SM-ML	N=20	0.75
550.4	2.00	H-7	12-30	ML	N=66	0.60
550.6	2.10	H-4	3-18	ML	6.6-1.2	-
552.5	2.00	H-6	18-39	ML (IP=3)	-	-
558.4	1.60	H-7	6-27	-	N=67+	0.50
559.3	1.80	H-7	0-12	ML	-	-
604.1	1.95	H-6	30-40	ML	120	0.60
609.9	2.60	H-4	12-50	ML	110	0.51
613.2	2.10	H-5	50-60	ML	140	0.80

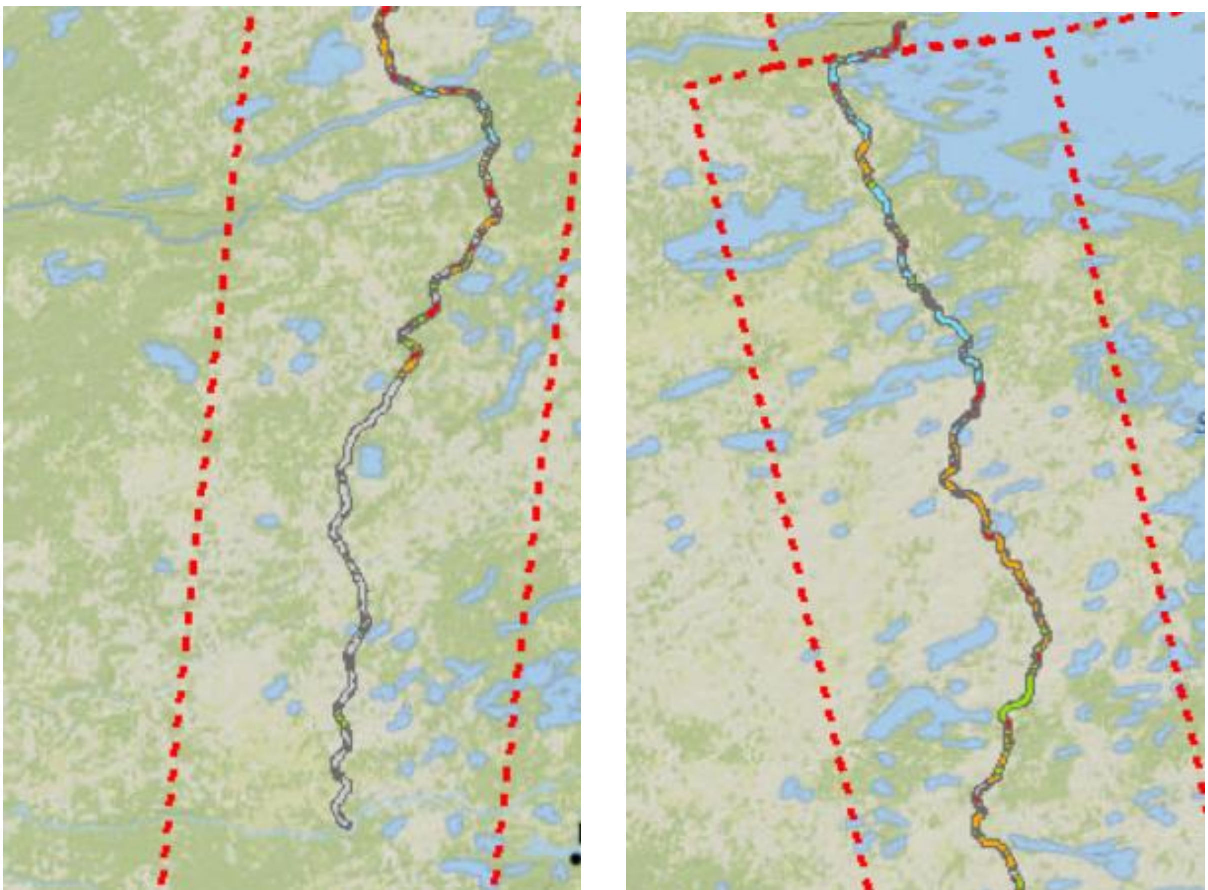
1. Corresponds to the kilometre marker along the road;

2. Classification of the degree of decomposition of the peat following its compression.

4.1.3 DISTRIBUTION OF SURFACE SOILS DEPOSIT

RAILWAY: RUPERT TO LA GRANDE

Table 4-6 presents the percentage of each type of surficial soil deposits overlying the rail alignment along the Billy-Diamond Highway in the Rupert to La Grande area, including a 1 km buffer zone on each side of the alignment, for figure presentation purposes, obtained from MERN's map of general morpho-sedimentological zones in Quebec. A summary of the location of each soil type present along the proposed alignment is shown in figure 4-2.



(a) Approximately first half of the corridor

(b) Approximately second half of the corridor

Figure 4-2 Type of Surface Soils on the Proposed Rail Corridor Alignment Between Rupert and La Grande According to the Map of General Morpho-Sedimentological Zones of Quebec; (a) Northern section of the alignment, (b) Southern section of the alignment

Table 4-6 Summary of Overburden Coverage Along the Railway: Rupert to La Grande According to the General Morpho-Sedimentology Map of Quebec

GENERAL CLASS[1]	LEGEND	CGC-Q CODE	SPECIFIC COVERAGE	TOTAL COVERAGE	TOTAL LENGTH (KM)	SOIL DESCRIPTION
Organic soils		O	25.57%	25.57%	143	Undifferentiated organic sediments
Silt, clay		L	0.16%	15.20%	85	Silt and sandy silt, generally massive or weakly stratified;
		MGa	15.04%			Clayey silt and silty clay, medium to dark grey, massive, laminated or stratified
Sand, gravel		A	0.59%	28.07%	157	Undifferentiated alluvium
		Ed	0.16%			Fine sand with diffuse oblique stratifications laid down by the wind in the form of parabolic dunes formed on the surface of freshly exposed littoral and alluvial sediments; may contain organic horizons such as paleosols
		Gx	0.58%			Sand and gravel, boulders, some till or diamicton;
		MGb	18.17%			Stratified and generally well-sorted sand, sandy silt, gravelly sand and gravel;
		MGd	0.04%			Sand, gravelly sand and gravel, stratified and well sorted
		GxT	8.53%			Till, diamicton, boulders, sand and gravel
Till		T	14.00%	16.26%	175	Sand, gravel, silt and clay with boulders
		Tf	2.27%			Loose matrix diamicton; pebbles and boulders. Ablation moraine contains a higher proportion of silt and sand than the base moraine
Rock		R	14.90%	14.90%	84	Rock outcrops and rock with a thin cover of loose sediment

[1] Note that this classification is approximate; the various morpho-sedimentological groups have been grouped into general classes for the purposes of this deliverable.

4.1.4 SYNTHESIS

Table 4-7 summarizes the potential geotechnical challenges along the proposed rail corridor between Rupert to La Grande, based on encountered soil types.

Table 4-7 Summary of Potential Geotechnical Issues Along the Proposed Railway: Rupert to La Grande

SOIL TYPE	COVERAGE	LEVEL OF RISK	POTENTIAL ISSUES
Silt and clay	15%	Moderate to high	Refer to section 6.1.1
Organic soils	26%	High	Refer to section 6.1.2
Sand and gravel	28%	Low	Refer to section 6.1.3
Till	16%	Low	Refer to section 6.1.4
Rock	15%	Low	Refer to section 6.1.5

4.2 ROADWAY AND RAILWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASE II & III)

This section presents a summary of the data collected from studies conducted in the La Grande to Whapmagoostui/Kuujjuarapik area. These studies are summarized in Table 4-8.

There are three proposed infrastructures in this area. The first infrastructure is the development of a port that will be located along the Hudson Bay shoreline at Kuujuarapik. The second is a road corridor linking La Grande and Whapmagoostui/Kuujjuarapik, and the third is a rail corridor relatively parallel to the road corridor, linking La Grande and Whapmagoostui/Kuujjuarapik. It should be noted that during the execution of this mandate, the road corridor linking La Grande and Whapmagoostui/Kuujjuarapik was moved to a feasibility study level which will be discussed in section 8.

This section also addresses some geotechnical issues related to the sediments of the Great Whale River as it crosses Hudson Bay, as shown in figure 4-3, making it equally important to identify the type of sediment being transported from the river to Hudson Bay.

For further details, refer directly to the documents presented in Table 4-8.

Table 4-8 List of Previous Studies in the La Grande to Whapmagoostui/Kuujjuarapik Area

AUTHOR	TITLE	YEAR	AVAILABLE INFORMATION
Hydro-Québec	Estuaire de La Grande Baleine Releve des Fonds	1976	– Soil stratigraphic cuts; – Borehole logs.
Hydro-Québec	*GBA 160 Complexe Grande Baleine - site GB1 - investigations géologiques 1977*	1977	– Overburden description; – Presence of organic soils; – Granulometric analysis; – Borehole logs with SPT values.
Hydro-Québec	*GBA-187.4 Complexe Grande-Baleine - site GB 1 - investigations géologiques 1978 - rapport de synthèse*	1978	– Overburden description; – Presence of organic soils; – Particle size analysis; – Borehole logs with SPT values.

AUTHOR	TITLE	YEAR	AVAILABLE INFORMATION
Hydro-Québec	*GBA-245.2 Complexe Grande Baleine - site GB-1 (variante Domanchin) - investigations 1981 - volume 2 description des forages*	1981	– Overburden description; – Presence of organic soils; – Granulometric analysis; – Borehole logs with SPT values. – Bedrock lithology; – Permeability testing.
MTQ	*Rapport de caractérisation environnementale- Terrain du hangar de l'aéroport (MTQ)*	2012	– Overburden description; – Borehole and test pit logs; – Description of environmental characteristics.
MTQ	*Étude de corridor routier et tracé préliminaire* *Route d'accès aux communautés de Whapmagoostui et Kuujjuarapik*	2013	– Road design details. – Description of overburden encountered along the road. – Description of peat properties.
MTQ	*Avis Géotechnique- Agrandissement du socle et nouveau chemin d'accès*	2015	– Overburden description; – Impact of permafrost on construction; – Presence of organic soils; – Considerations when building on organic soils; – Borehole and test pit logs.
MTQ	*Projet de construction d'un garage d'entretien à l'aéroport de Kuujuarapik, Nord du Québec, MRC de Kativik (Québec)*	2016	– Overburden description; – Description of environmental characteristics; – Presence of organic soils; – Particle size analysis; – Borehole logs with SPT values.
Emmanuel L'Hérault et Michel Allard	*Production de la 2e approximation de la carte de pergélisol du Québec en fonction des paramètres géomorphologiques, écologiques, et des processus physiques liés au climat*	2018	– Permafrost distribution; – Permafrost thickness.
Denis Lord	*Glissement de terrain au Nunavik: les impacts ne sont pas encore connus*	2021	– Description of landslide along the Great Whale River; – Presentation of the causes of the landslide.

4.2.1 OVERBURDEN DESCRIPTION

According to the general morpho-sedimentological map of Quebec produced by MERN and obtained from SIGEOM, the overburden that dominates the coastline bordering the port areas is mainly composed of nearshore and prelittoral glaciomarine sediments (MGb), with a few segments covered by rock outcrops (R) and bedrock covered by a thin layer of sediments (see figure 4-3).

However, it should be noted that the overburden found along the Great Whale River is primarily composed of fine deltaic, prodeltaic,and deep-water glaciomarine sediments (MGa and MGd) that are composed of clays. The presence of these types of deposits in the study areas could be highly possible due to the recurrent landslides that occur along the river. More details regarding this topic are presented in section 6.1.1.3.

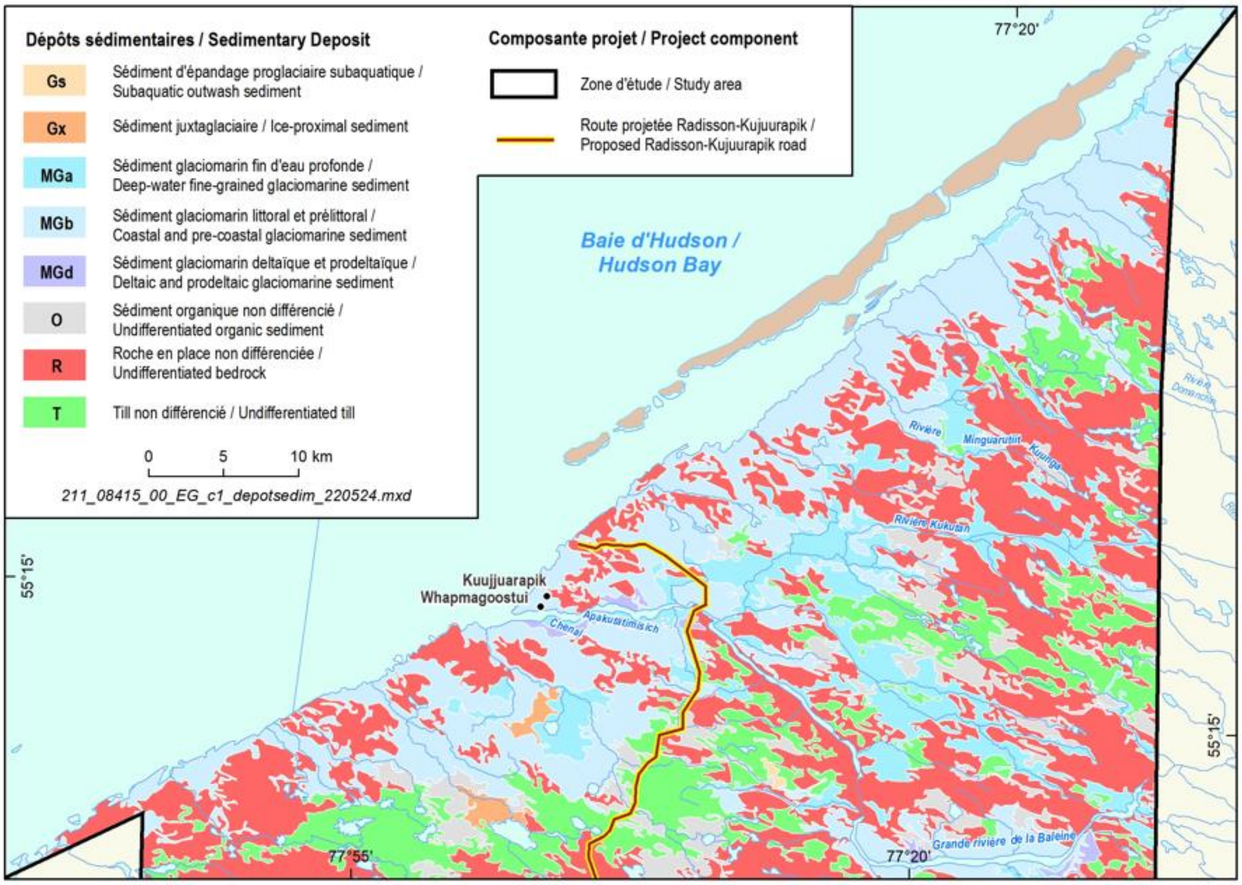


Figure 4-3 Distribution of Morpho-Sedimentological Areas in the Study Area According to MERN Map of Morpho-Sedimentological Zones

4.2.1.1 *DISTRIBUTION OF SURFACE SOIL DEPOSIT*

ROADWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASE II) (ALTERNATIVE 1 AND 2 – PHASE II)

Table 4-9 presents the percentage of each type of surficial deposit overlying the two proposed alignments identified as alternative 1 and 2 for the Billy-Diamond Highway extension (SA2) that will link La Grande and Whapmagoostui/Kuujjuarapik, including a 1 km buffer zone on each side of the corridor, for figures presentation purposes, obtained from MERN's general morpho-sedimentological zones map of Quebec. It should be noted that the original main alignment has been set aside as it crossed a protected area. Figures 4-4, 4-5 & 4-6 summarize the location of each soil type along the proposed alignment.

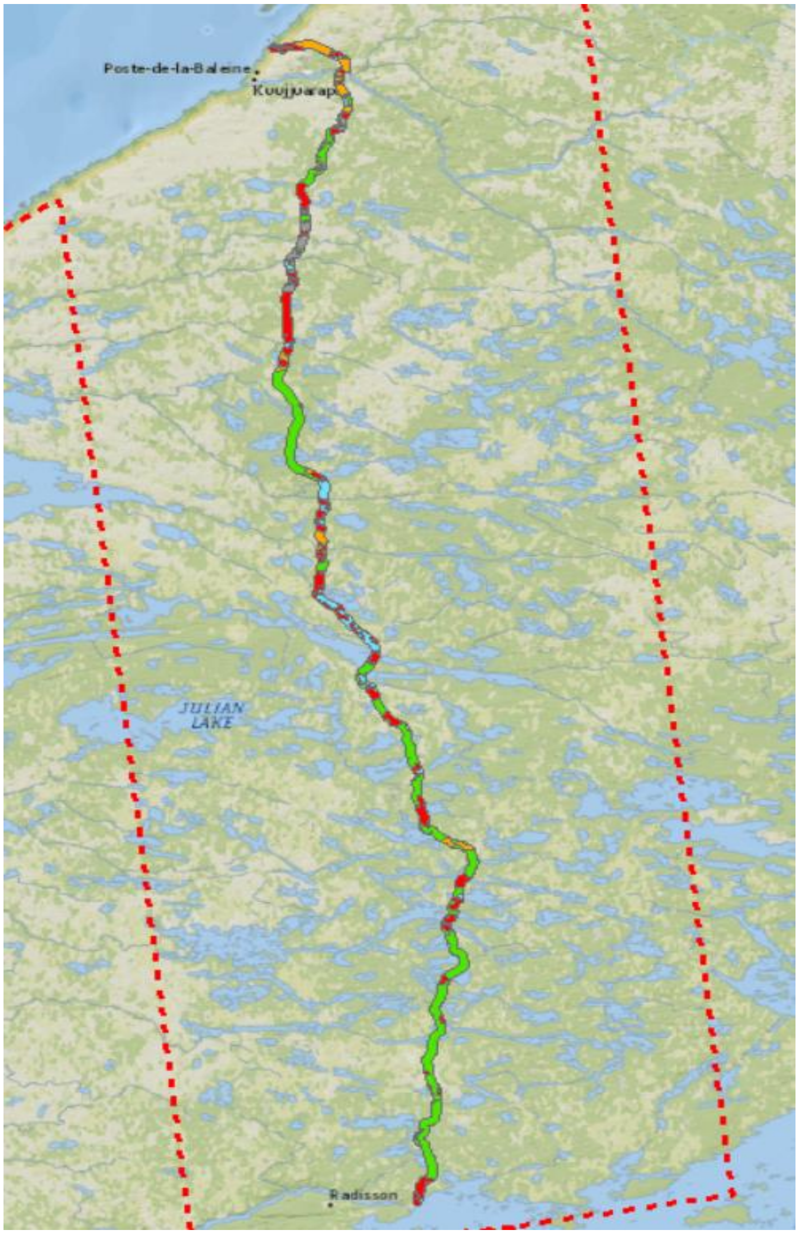


Figure 4-4 Surface Soil Types on the Proposed Main Alignment of the proposed road between La Grande and Whapmagoostui/Kuujjuarapik according to the Map of General Morpho-Sedimentological Zones of Quebec

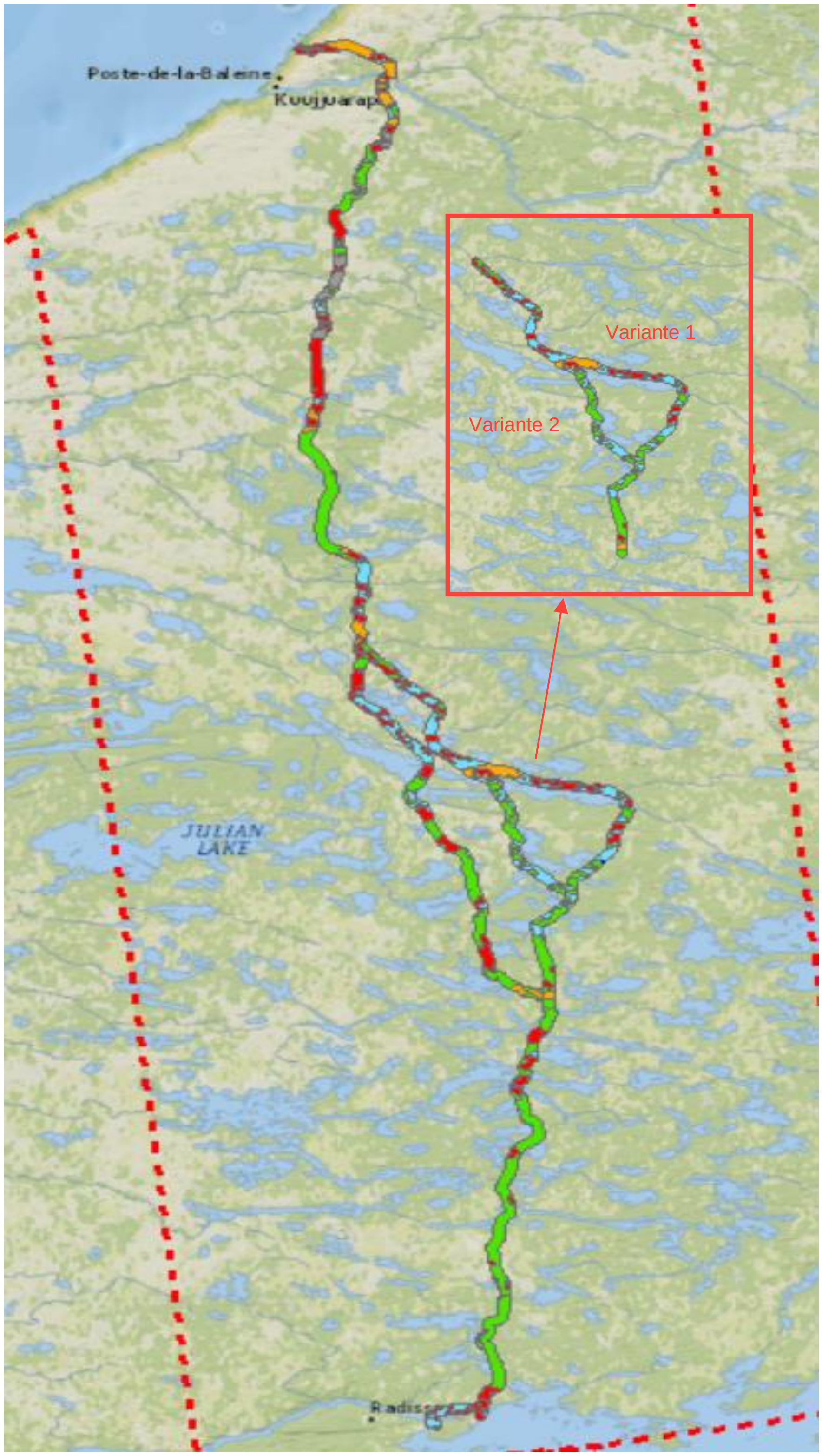


Figure 4-5 Surface Soil Types on Both Alternatives of the Proposed Main Alignment of the road between La Grande and Whapmagoostui/Kuujuarapik according to the Map of General Morpho-Sedimentological Zones of Quebec

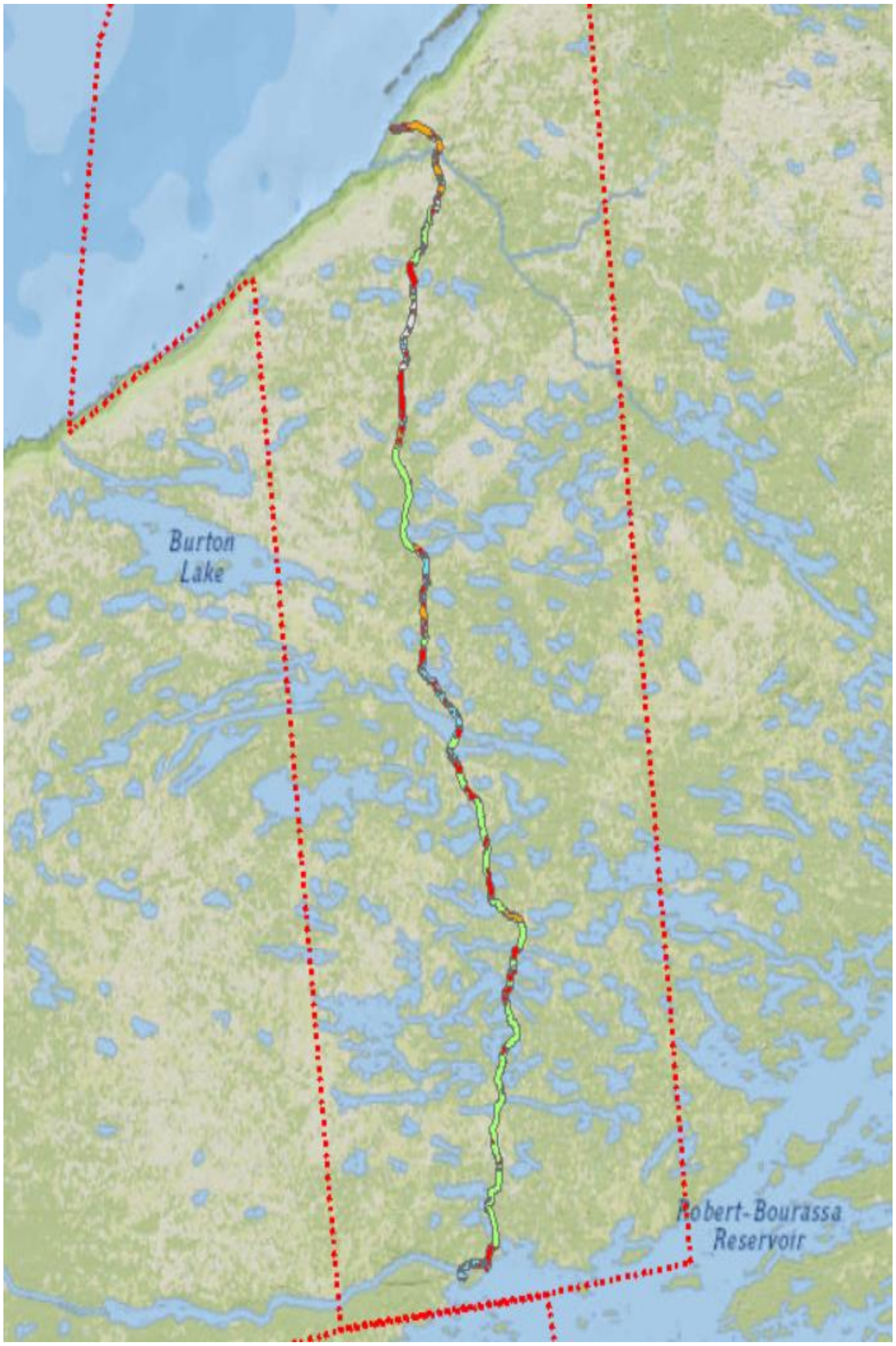


Figure 4-6 Type of Surface Soils on Alternative 2 of the Proposed Alignment for the road between La Grande and Whapmagoostui/Kuujuarapik according to the Map of General Morpho-Sedimentological Zones of Quebec

Table 4-9 Summary of Overburden Coverage Along the Two Proposed Road Alignment Alternatives in the La Grande to Whapmagoostui/Kuujuarapik area According to the General Morpho-Sedimentological Map of Quebec

GENERAL CLASS[1]	LEGEND	CGC-Q CODE	SPECIFIC COVERAGE	TOTAL COVERAGE	TOTAL LENGTH (KM)	SOIL DESCRIPTION
Alternative 1						
Organic soils		O	5.4%	5.4%	12.0	Undifferentiated organic sediments
Silt, clay		L	1.3%	18.3%	40.8	Silt and sandy silt, generally massive or weakly stratified
		MGa	17.0%			Clayey silt and silty clay, medium to dark grey, massive, laminated or stratified
Sand, gravel		Gx	0.4%	9.4%	21.0	Sand and gravel, boulders, some till or diamicton
		MGb	8.6%			Stratified and generally well-sorted sand, sandy silt, gravelly sand and gravel
		MGd	0.4%			Stratified and well-sorted sand, gravelly sand and gravel, locally including prodeltaic silt-sand sediments
Till		T	41.4%	41.4%	92.4	Sand, gravel, silt and clay with boulders
Rock		R	25.6%	25.6%	57.1	Rock outcrops and rock with a thin cover of loose sediment
Alternative 2						
Organic soils		O	5.4%	5.4%	11.5	Undifferentiated organic sediments
Silt, clay		L	0.8%	12.3%	26.3	Silt and sandy silt, generally massive or weakly stratified
		MGa	11.5%			Clayey silt and silty clay, medium to dark grey, massive, laminated or stratified
Sand, gravel		Gx	1.2%	8.9%	19.0	Sand and gravel, boulders, some till or diamicton
		MGb	7.3%			Stratified and generally well-sorted sand, sandy silt, gravelly sand and gravel
		MGd	0.4%			Stratified and well-sorted sand, gravelly sand and gravel, locally including prodeltaic silt-sand sediments
Till		T	44.7%	44.7%	95.1	Sand, gravel, silt and clay with boulders
Rock		R	28.6%	28.6%	60.7	Rock outcrops and rock with a thin cover of loose sediment

[1] Note that this classification is approximate; the various morpho-sedimentological groups have been grouped into general classes for the purposes of this deliverable.

RAILWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASE III)

Table 4-10 presents the percentage of each type of surficial deposit overlying the proposed alignment of the La Grande to Whapmagoostui/Kuujjuarapik rail corridor, including a 1 km buffer zone on each side, for figures presentation purposes, obtained from the MERN's general morpho-sedimentological zones map of Quebec. It should be noted that the rail corridor has been aligned along the proposed road corridor between La Grande and Whapmagoostui/Kuujjuarapik presented in the previous section. Figure 4-7 presents a summary of the location of each soil type along the proposed alignment.

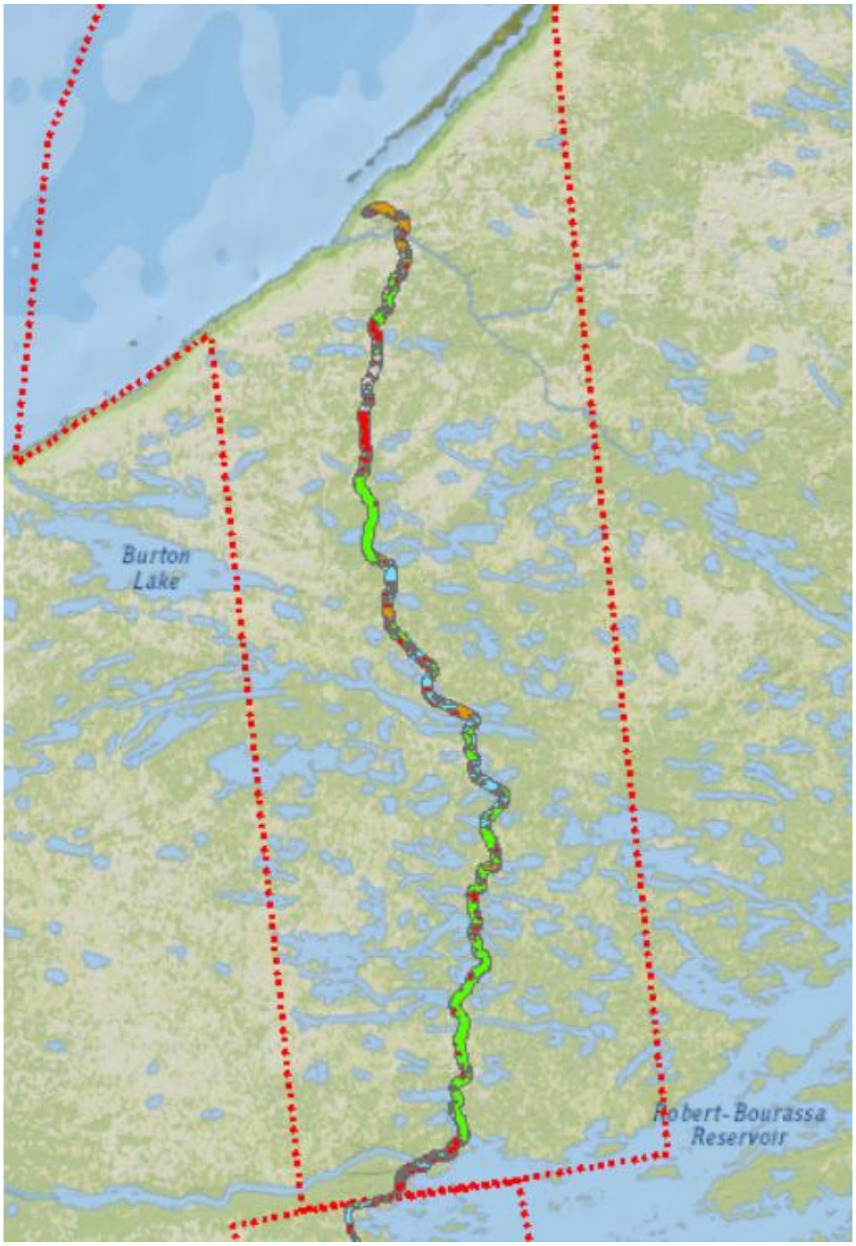


Figure 4-7 Surface Soil Types on the Proposed La Grande to Whapmagoostui/Kuujjuarapik Rail Corridor according to the Map of General Morpho-Sedimentological Zones of Quebec

Table 4-10 Summary of Overburden Coverage Along the Proposed Rail Corridor Alignment in La Grande to Whapmagoostui/Kuujuarapik area According to the General Morpho-Sedimentology Map of Quebec

GENERAL CLASS[1]	LEGEND	CGC-Q CODE	SPECIFIC COVERAGE	TOTAL COVERAGE	TOTAL LENGTH (KM)	SOIL DESCRIPTION
Proposed alignment						
Organic soils		O	5.0%	5.0%	11.0	Undifferentiated organic sediments
Silt, clay		L	0.2%	17.2%	37.6	Silt and sandy silt, generally massive or weakly stratified
		MGa	17.0%			Clayey silt and silty clay, medium to dark grey, massive, laminated or stratified
Sand, gravel		Gx	1.1%	9.7%	21.25	Sand and gravel, boulders, some till or diamicton
		MGb	8.1%			Stratified and generally well-sorted sand, sandy silt, gravelly sand and gravel
		MGd	0.5%			Stratified and well-sorted sand, gravelly sand and gravel, locally including prodeltaic silt-sand sediments
Till		T	44.4%	44.4%	97.2	Sand, gravel, silt and clay with boulders
Rock		R	23.6%	23.6%	51.8	Rock outcrops and rock with a thin cover of loose sediment

[1]Note that this classification is approximate; the various morpho-sedimentological groups have been grouped into general classes for the purposes of this deliverable.

4.2.2 SYNTHESIS

4.2.2.1 ROAD CORRIDOR

Table 4-11 summarizes the potential geotechnical challenges along the proposed road corridor alignment in La Grande to Whapmagoostui/Kuujuarapik area, based on encountered soil types.

Table 4-11 Summary of Potential Geotechnical Issues Along the two Proposed Roadway Alignment Alternatives in the La Grande to Whapmagoostui/Kuujuarapik area

SOIL TYPE	COVERAGE	LEVEL OF RISK	COVERAGE	LEVEL OF RISK	POTENTIAL ISSUES
	ALTERNATIVE 1		ALTERNATIVE 2		
Silt and clay	18%	Moderate to high	12%	Moderate to high	Refer to section 6.1.1
Organic soils	5%	Moderate	5%	Moderate	Refer to section 6.1.2
Sand and gravel	9%	Low	9%	Low	Refer to section 6.1.3
Till	42%	Low	45%	Low	Refer to section 6.1.4
Rock	26%	Low	29%	Low	Refer to section 6.1.5

4.2.2.2 RAIL CORRIDOR

Table 4-12 summarizes the potential geotechnical challenges along the proposed rail corridor alignment in La Grande to Whapmagoostui/Kuujuarapik area based on encountered soil types.

Table 4-12 Summary of Potential Geotechnical Issues along the Proposed Rail Corridor Alignment in the La Grande to Whapmagoostui/Kuujuarapik area

SOIL TYPE	COVERAGE	LEVEL OF RISK	POTENTIAL ISSUES
Silt and clay	17%	Moderate to high	Refer to section 6.1.1
Organic soils	5%	Moderate	Refer to section 6.1.2
Sand and gravel	10%	Low	Refer to section 6.1.3
Till	44%	Low	Refer to section 6.1.4
Rock	24%	Low	Refer to section 6.1.5

4.2.3 DRILLING DATA COLLECTED - WHAPMAGOOSTUI/KUUJUARAPIK GENERAL AREA

According to existing drilling data collected during various geotechnical studies carried out at the Kuujuarapik airport, at the Great Whale River, and northeast of the Great Whale River presented in Appendix D of this document, the soil deposits encountered in these areas are mainly composed of fine to coarse sands, varying from silty sands to gravelly sands, with variable proportions of gravel and silt. These proportions were identified in the study conducted by the MTQ in 2016, and in the studies conducted by Hydro-Quebec in 1978 and 1981, in which an analysis of the particle size distribution was carried out on a few samples and the "N" values from the standard penetration test (SPT) were collected: the "N" values when taken in accordance with the ASTM D1586 standard provide information on the compactness of the granular soil deposits. The average thicknesses of the layers encountered were calculated from the available borehole logs and are summarized in Table 4-14.

According to the SPT "N" values presented in the MTQ geotechnical investigation conducted in 2016, which ranged from 8 to 45 blows, the sand deposits encountered in this study are of medium to dense density. This is also confirmed by the "N" values obtained during the geotechnical investigation studies that were carried out by Hydro-Quebec in 1977 and 1978, in which the sand deposit is medium to very dense ("N" values ranging between 15-50 blows on average). However, the drilling data presented in the study carried out by Hydro-Quebec in 1981 show "N" values varying between 1 and 30 blows, indicating a loose to medium density soil deposit, with some dense horizons with values exceeding 30 blows.

As shown in blue on the map in Appendix D of this document, the soil stratigraphy is slightly different from that observed in the rest of the boreholes. It is mainly composed of an upper layer of organic material of an average thickness of 0.7 m, followed by a relatively thin layer of silty sands, and then very loose layers of clayey silt and silty clayey sand. The thickness of these clayey silt layers ranges from 2.0 to 6.5 m, with "N" values not exceeding 10. A summary of the average thickness of each layer is presented in Table 4-13. This finding was also established by the drilling data presented in the 1981 Hydro-Quebec study, where surface layers of organic soils and peat were found in the boreholes in the vicinity of the watercourses, as shown in Study 4 in the map in Appendix D of this document. A clayey silt to silt and clay layers were also identified in some of the boreholes with an average thickness of 5.6 m. A summary of the layers encountered, and their thicknesses is presented in Table 4-13.

The bedrock was intercepted, according to Hydro-Quebec borehole logs (1977 and 1978), at depths varying between 5 and 12 m, except for two boreholes where it was intercepted at depths greater than 30 m. The bedrock encountered consists of granite and granitic gneiss with rock quality designations (RQD) ranging from 55% to 100%.

It should be mentioned that all these data give a general overview of the stratigraphy encountered in this area. The thicknesses presented in the table remain approximate and relative to the time of drilling.

Table 4-13 Summary of the Stratigraphic Layers and Their Average Thicknesses Encountered in Previous Studies

SOIL TYPE	AUTHOR (YEAR)					
	HQ (1976)	HQ (1977)	HQ (1978)	HQ (1981)	MTQ (2012)	MTQ (2016)
	Average thickness (m)					
Organic Soils/ Peat	--	--	0.7	0.5	--	0.20
Granular soil deposits (sand, silt and gravel)	9.0	2.0	9.0	18.5	8.0	4.0
Cohesive soil deposits (silt and clay)	--	--	8.5	6.0	--	--
Probable till deposits (sand, silt, gravel, and clay)	3.9		--	7.0	--	--

-- Layer not encountered

4.3 ROUTE 167: UPGRADE & EXTENSION TO TRANS-TAIGA (PHASE II)

After a thorough search of existing studies and geotechnical investigations that have been conducted in this area, only one study was found. The SIGEOM data for this area did not reveal any relevant information as it essentially consisted of diamond drilling boreholes dedicated for mineral explorations. This study was carried out by the MTQ in which approximately 150 soundings (around 19 boreholes, and more than 100 test pits), were completed as shown in the figure below.

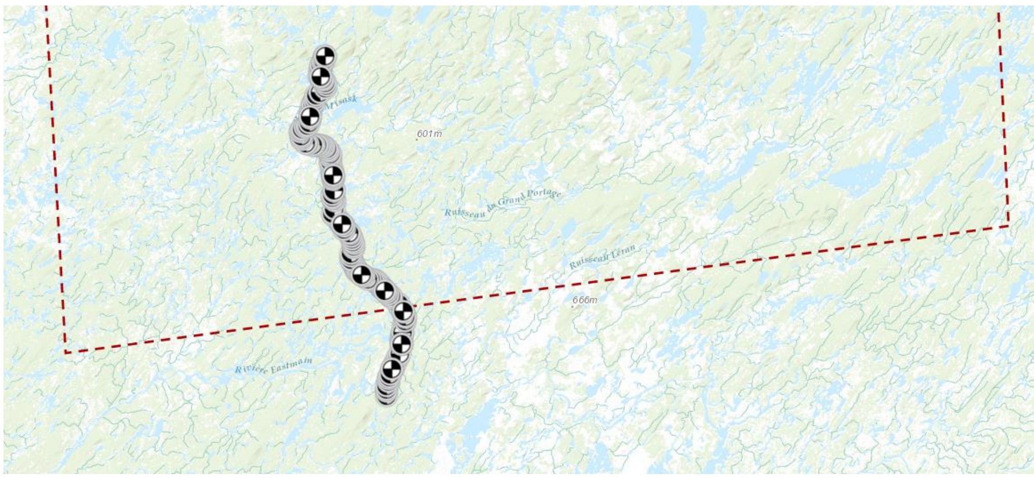


Figure 4-8 Location Plan of the Existing Boreholes of the Environmental and Social Impact Study of Route 167 North Towards the Otish Mountains Carried Out by MTQ

As mentioned in section 3.3, according to the geomorphological analysis of this area and as observed in the consulted borehole logs, the natural soil deposit consists mainly of a granular soil deposit followed by a till deposit.

The granular soil deposit was encountered at approximate depths ranging from the ground surface down to 9.0 m of depth with an average thickness of 3.0 m. This deposit was generally in a loose to compact condition, based on the SPT N values, which ranged between 4 and 30 blows. Based on the results of particle size analyses performed on samples collected from the granular soil deposit, this deposit is primarily composed of silt (6% -98%) and sand (2% - 56%) with varying proportions of gravel ranging from 0 to 34%. It was also classified, according to the Unified Soil Classification System (USCS), as a silty sand (SM) in most boreholes except for the few boreholes in which it was classified as a low plasticity silt.

The till deposit was encountered at approximate depths ranging between 0.6 m and 8.4 m, with a thickness ranging from 1.2 m to 8.4 m and an average of about 4.0 m. The till deposit was generally in a compact to very dense state according to the N values from the SPT test, which ranged from 10 to 50 blows. Results of particle size analysis on samples collected from the till deposit indicated that the deposit is primarily composed of sand (45% to 83%) with variable proportions of silt (4% to 29%) and gravel (7 to 36%).

The bedrock was encountered at depths ranging from 1.9 to 7.5 m and is composed mainly of igneous/metamorphic rocks such as medium to excellent quality granitic gneiss, medium to good quality basalt, or poor-quality pink granite. Three rock cores were tested for uniaxial compression, two of them were taken from the granite bedrock, and one from the granitic gneiss bedrock, in all three samples, the uniaxial compressive strength of the rock was around 200 MPa.

Regarding the groundwater table, it was encountered at shallow depths ranging between 0.5 m and 3 m. It should be noted that several areas characterized by till deposit were identified as reusable in this study.

4.3.1 DISTRIBUTION OF SURFACE SOIL DEPOSITS ON THE PROPOSED ALIGNMENT

ROUTE 167: UPGRADE & EXTENSION TO TRANS-TAIGA

Table 4-14 presents the percentage of each type of surficial deposit overlying the proposed Route 167 alignment, including a 1 km buffer on each side, for figures presentation purposes, obtained from the MERN map of general morpho-sedimentological zones in Quebec. Figure 4-9 presents a summary of the location of each type of foundation soil present over the road alignment.

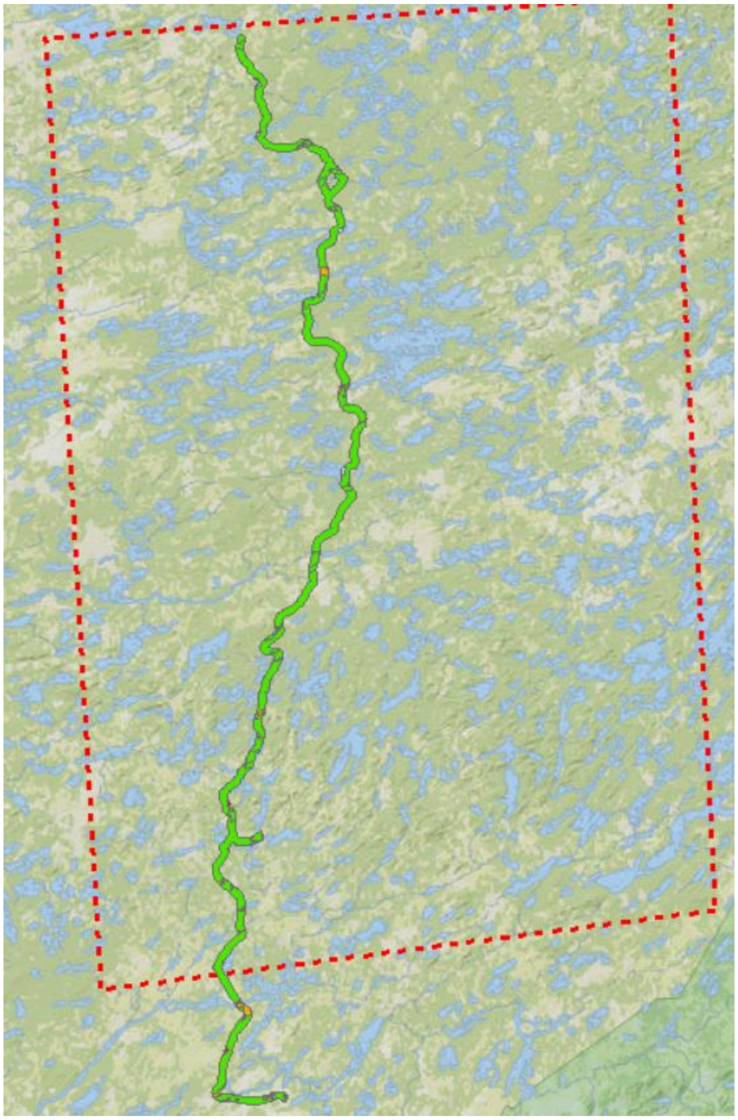


Figure 4-9 Surface Soil Type on the Proposed Upgrade & Extension in the Route 167 Area According to the Map of General Morpho-Sedimentological Zones of Quebec

Table 4-14 Summary of the Overburden Cover Along the Proposed Upgrade & Extension in the Route 167 Area According to the General Morpho-Sedimentological Map of Quebec

GENERAL CLASS[1]	CGC-Q CODE	LEGEND	SPECIFIC COVERAGE	TOTAL COVERAGE	TOTAL LENGTH (KM)	SOIL DESCRIPTION
Organic soils	O			0.38%	2	Undifferentiated organic sediments.
Sand and gravel	A		0.28%	3.20%	13	Undifferentiated alluvium.
	Go		0.98%			Sand, gravel, and boulders, with an overall decrease in grain size downstream; forming flats and outwash plains, the surface of which is often marked by old, shallow, sinuous channels.
	Gx		1.97%			Sand and gravel, boulders, some till or diamicton; forming eskers, kames and morainal crests with a generally hummocky surface.
Till	T		86.79%	96.37%	390	Diamicton, sand, gravel, silt,and clay with boulders.
	Tf		9.58%			Diamicton with a loose and generally washed-out matrix and a thickness generally exceeding 1 m; surface generally punctuated by numerous pebbles and boulders. Ablation moraine contains a greater proportion of silt and sand than the ground moraine.
Rock*	R			0.02%*	0.063	Igneous/metamorphic rocks (Granite, granodiorite, tonalite gneiss).

[1] *Note that this classification is approximate; the various morpho-sedimentological groups have been grouped into general classes for the purposes of this deliverable.*

* *It should be noted that this percentage corresponds to a total length of approximately 63 m.*

4.3.2 SYNTHESIS

Table 4-15 summarizes the potential geotechnical challenges along the proposed alignment in Route 167 area, based on encountered soil types.

Table 4-15 Summary of Potential Geotechnical Issues Along the Proposed Route 167: Upgrade & Extension to Trans-Taiga

SOIL TYPE	COVERAGE	LEVEL OF RISK	POTENTIAL ISSUES
Organic soils	<1%	Moderate	Refer to section 6.1.1
Sand and gravel	3%	Low	Refer to section 6.1.3
Till	96%	Low	Refer to section 6.1.4
Rock	<1%	Low	Refer to section 6.1.5

5 PERMAFROST OVERVIEW

The following paragraphs discuss permafrost conditions and challenges for the three study areas in Phases II and III:

— Study Area 1 (SA1): Billy-Diamond Highway Railway – Rupert – La Grande;
— Study Area 2 (SA2): Road extension – La Grande – Whapmagoostui/Kuujjuarapik;
— Study Area 3 (SA3): Route 167- Renard Mine – Trans-Taiga Road.

5.1 PERMAFROST CONDITIONS

According to the map *Classification du pergélisol au Québec nordique* (Allard et Seguin, 1987), the permafrost in the three study areas corresponds to sporadic permafrost, except for Kuujjuarapik, where permafrost is considered to be discontinuous and dispersed. This means that some patches of permafrost can be found in some zones of the study area.

According to Figure 5-1 on the following page, which is an excerpt from the map entitled Permafrost Distribution in Northern Quebec in the Guide des bonnes pratiques au Nunavik (2nd edition) produced by the Société d'habitation du Québec (Government of Quebec, 2018), sporadic permafrost (identified by the letter D) would represent less than 2% of the territory. As for discontinuous and dispersed permafrost (identified by the letter C), it would represent less than 50% of the territory.

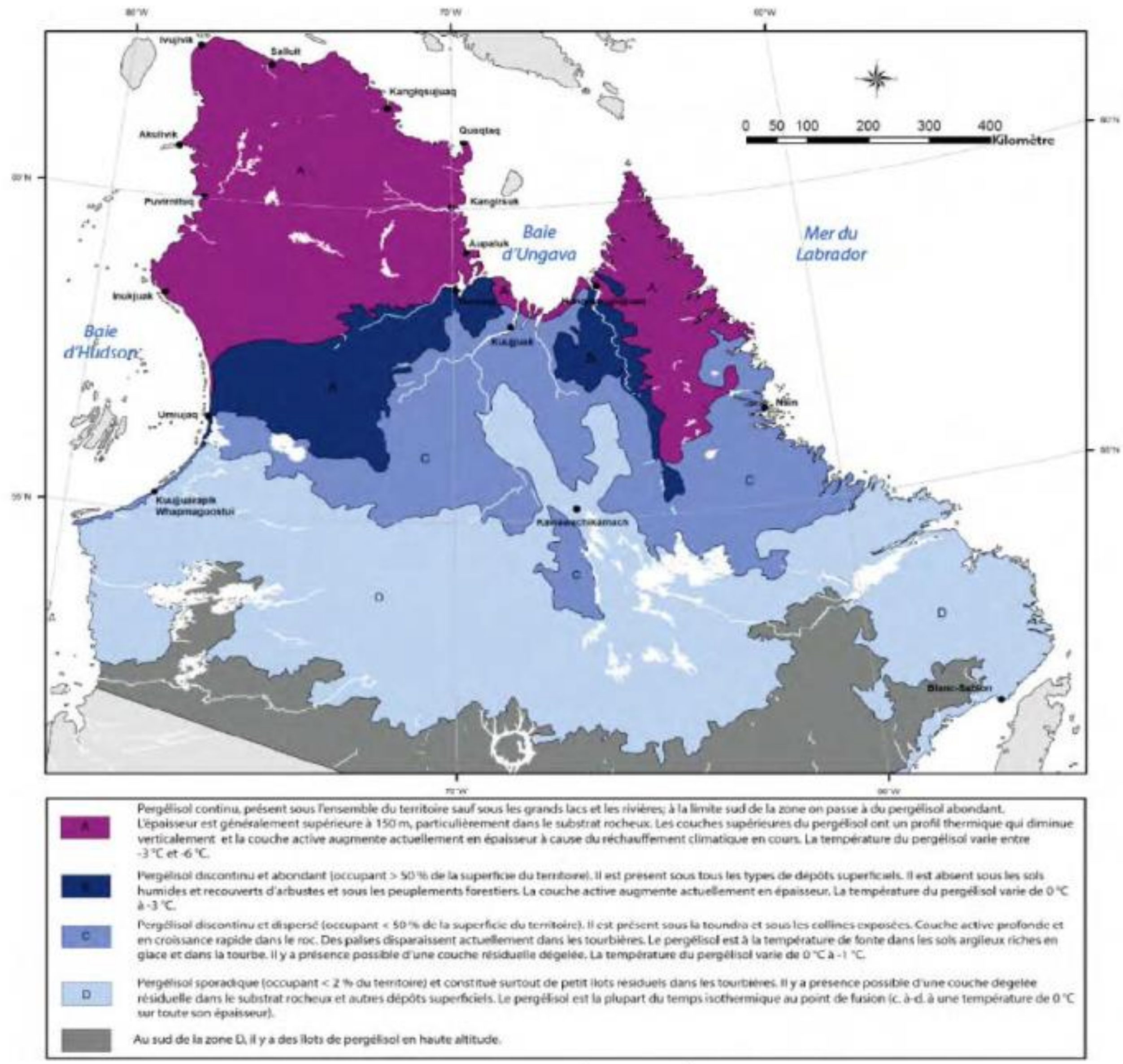


Figure 5-1 Permafrost Distribution in Northern Quebec (Guide des Bonnes Pratiques au Nunavik, 2018)

Despite the low proportion of permafrost in the areas under study shown in the above figure, some patches of permafrost may be encountered. Fine-grained soils could contain ice in various forms and, therefore, must be considered unstable to thaw. The permafrost presence will therefore be monitored in areas where fine particles are present, i.e., in marine sediment deposits (silt and clay), in peatlands overlying fine sediments, and in till deposits composed mainly of fine particles. Note that isolated palsas and small palsa fields have developed in peatlands overlying fine sediments: palsas are very often associated with permafrost. These forms are identifiable on the aerial photographs and can be studied further to be avoided as much as possible when optimizing the proposed alignments.

In the next stages of the study, particular attention will have to be paid to the soil composition to assess the risks of settlement that may be associated with thawing.

6 POTENTIAL GEOTECHNICAL CHALLENGES

The potential geotechnical challenges listed below are only general and informative. They represent an overview of what may need to be considered in the design and/or construction of future infrastructures. It should be noted that conditions may change depending on the structure to be constructed and site-specific conditions.

6.1 COMPRESSIBLE SOIL DEPOSIT

6.1.1 *CLAY DEPOSIT*

6.1.1.1 *CLAY DEPOSIT ISSUES*

A clay deposit consists primarily of fine soil particles, less than or equal to about 0.002 mm. This type of deposit is characterized by possessing a strong cohesion between soil particles and can present consistencies ranging from very soft to hard, and from low to high plasticity. A clay deposit may be normally consolidated or overconsolidated depending on the stresses experienced since its formation. Normally consolidated clays are generally more problematic. Clay deposits can generally lead to the following problems:

- Low geotechnical resistance. This would require the use of deep foundations on piles or rafts for future instrastructures (such as bridges, culverts, etc.);
- Susceptibility to freezing (freeze-thaw cycle), especially for clays undergoing their first freeze-thaw cycles;
- Long-term settlements (consolidation settlements);
- Poor drainage, thus, the need to install a drainage system in the short and/or long term;
- Risks of settling of neighbouring structures in case of a decrease in the groundwater table;
- Large excavation slopes or the need for sustained excavations; resulting in additional costs;
- Risk of heaving of excavation bottoms in the case of deep excavations;
- Risks of cracking caused by swelling/drying cycles of clayey soils.

6.1.1.2 *NORMALLY CONSOLIDATED CLAY (COMPRESSIBLE)*

Normally consolidated clays are clays that continue to consolidate (settle) under the existing weight of overlying soils. These clays can be problematic when being imposed to additional loads that can induce long-term settlements that could last for years. Laboratory consolidation tests can determine total settlements and consolidation time (the total period over which consolidation settlements will end). These clays generally have low bearing capacity (geotechnical strength) which requires additional measures during design and construction. In summary, the following elements should be considered:

- Low geotechnical resistance;
- Compaction difficulties during backfilling of the excavation;
- Long-term settlement, thus, the need to use known techniques (surcharges with vertical drains) to increase the preconsolidation stress and improve the undrained shear resistance. These techniques thus reduce the magnitude and duration of settlements. An alternative to these time-consuming soil improvement techniques is the use of lightweight fill material. These techniques excavate clayey soils to a certain thickness and replace them with a lightweight fill material.

6.1.1.3 *SENSITIVE CLAYS*

Very sensitive to extremely sensitive clays, as defined in section 5.2.3 of the *Manuel Canadien d'Ingénierie de Fondations* (MCIF, 2013), are clays with remoulded strengths less than or equal to 25% of the intact strength when measured on site. The natural water contents of these clays are at or above their liquid limit, which may account for their sensitivity. In summary, the following elements should be considered:

- Low geotechnical strength: if the sensitive clay deposit is on the surface, it could be excavated and replaced with a controlled fill or a light fill;
- High susceptibility to remoulding, resulting in multiple restrictions during excavation works related to excavated soil piles, traffic, and machinery;
- Difficulty in carrying out deep excavations;
- Longer construction periods for deep foundations;
- A susceptibility to liquefaction; this issue is of particular concern if the sensitive clay deposit is on a slope, as it liquefies, it can lead to a landslide and slope failure or flow. In all cases and particularly in the case of flat land, the liquefaction or softening of the sensitive clay layer results in a drastic reduction of its undrained shear strength and thus of its bearing capacity. In the case of a non-liquefiable soil layer above a highly sensitive layer, the period of liquefaction is also dependant on the horizontal forces that the non-liquefiable deposit will exert on the structures it is in contact with (foundation walls, bridge abutments, etc.).

A landslide, as defined in the document *Glissements de terrain dans les dépôts meubles* produced by the Ministère de la Sécurité publique and the Ministère des Affaires municipales et de l'Habitation, is the downslope movement of a soil mass along a failure surface, which is initiated in a slope under the effect of gravity. This phenomenon is common in Quebec and occurs frequently. Their occurrence is usually the result of a combination of aggravating or triggering factors, including the presence of erosion, sensitive clays, unstable slopes, human activities, geological, and geotechnical properties of the soils and groundwater conditions.

A major landslide occurred in April 2021 in the Great Whale River area, upstream of Kuujjuaraapik/Whapmagoostui. According to the article *Glissement de terrain au Nunavik : Les impacts ne sont pas encore connus* dated May 14, 2021 and published by Michel Allard, approximately 45 million m^3 of debris were precipitated into the Great Whale River when its 40 m high cliffs collapsed over a length of 1.8 km and a width of 500 m. The article links the landslide to the presence of sensitive marine clays from melting glaciers 8,000 years ago. It also mentions that this is a recurring phenomenon in the region, usually occurring in the spring when the snow melts, and the ground becomes waterlogged. This soil deposit along the Great Whale River is considered to have a high liquefaction potential.

6.1.2 PEATLAND AREAS

According to the literature, peat deposits are the partially or completely decomposed, fragmented remains of plants that have accumulated underwater and became fossilized. They are generally characterized as highly compressible soils with a high void ratio and water content, in which they present difficult conditions for construction, especially for roads, including high initial costs, and continuous maintenance operations. Some of these conditions are similar to clay deposits such as:

- Relatively high compaction, thus, the need to over-excavate all peat layers if found on small thicknesses;
- Very low geotechnical resistance;
- Excavations of large slopes, if they are of low thicknesses;
- Precompress peat layers if they are thick or perform soil improvement techniques (costly);
- Major backfill techniques (major operations).

However, the easiest method is to try to avoid peatlands, as they are considered very problematic and, in addition, they are also non-reusable soils that will need to be properly disposed.

Furthermore, according to the document produced in 2015 by the MTQ *Avis sur les contraintes géotechniques - Agrandissement du socle et nouveau chemin d'accès à l'aéroport de Kuujjuarapik, Nunavik*, there are layers of compressible (normally consolidated) soils consisting mainly of organic soils with a thickness varying between 0.5 and 2.0 m, located north of the airport runway. These compressible soil layers were also confirmed by the report produced by the MTQ in 2016 for the geotechnical study that was conducted for the construction of the Kuujuarapik airport garage. According to this document, in addition to the challenges listed above, these compressible soil layers could lead to the following issues:

— Generation of pore pressures during backfilling, resulting in delays;
— Settlement during backfilling can reach approximately 18% of the total backfill thickness;
— Slope stability issues;
— Significant water infiltration during construction.

6.1.3 GRANULAR SOIL DEPOSITS

Granular soils are generally soils that contain varying proportions of sand, silt, and gravel, often with sand as the primary matrix.

Granular soils generally present relatively good bearing capacity if the density is medium to very dense. However, saturation of these soils very often affects their density and therefore, their bearing capacity. Saturated granular soils can often be loose or very loose and therefore of low bearing capacity and susceptible to liquefaction. During construction, with saturated granular soils, drainage issues must be anticipated. If these low bearing capacity granular soils can be excavated, it is preferable to do so. Otherwise, soil improvement techniques such as controlled modulus columns are available. However, the high cost of these techniques must be considered. In summary, the following elements should be considered:

— Drainage issues during excavation work;
— Lowering of the water table required during excavation work;
— Over-excavation of low bearing capacity soils requiring the use of controlled backfill;
— Low geotechnical strength if soils are loose and saturated;
— Liquefaction potential if soils are loose, saturated, and if their granulometry is consistent (mostly composed of particles of the same size): soil improvement techniques can be anticipated (costly).

6.1.4 TILL DEPOSIT

According to the general morpho-sedimentological map of Quebec, it was noted that till deposits cover nearly half or more of the surficial deposits along the Rupert to La Grande, La Grande to Whapmagoostui/Kuujjuarapik and the Route 167 areas with coverage percentages of 55%, 87%, and 47% respectively.

Till, as described in Section 5.2.7 of the *Manuel Canadienne d'Ingénierie des Fondations* (CFEM, 2013), is unstratified, unsorted glacial material deposited directly by and beneath glaciers. Its particles are generally angular, and all grain sizes are normally present (gravel, sand, silt, and clay) (Legget, 1962, 1979; Legget and Karrow, 1983). Bottom till (consolidated under the total weight of the glacier) is normally very dense, whereas recessional till (deposited by the glacier during its recession) may not be dense.

Generally, till deposits present few problems in the design of structures: the bearing capacity of this type of deposit is good. However, this depends on the percentage of fine to coarse particles, as fine till can have soft consistency horizons that result in low bearing capacity and susceptibility to frost. On the other hand, granular till can have large boulders that pose difficulties during excavation and also presents problems related to frost heave (bolder till). The presence of pebbles and boulders also poses the problem of pile driving because of the risk of deflecting the piles or rolling the piles on themselves.

In summary, till deposits can lead to:

- Remoulding of excavation surfaces if the till deposit includes a certain proportion of fine particles (silt and clay), thus, the need to protect the bottom of the excavation (with a granular mat or a layer of lean concrete);
- Low bearing capacity issues in the case of recession till whose matrix is composed mainly of silt and/or clay);
- Grading, compaction and excavation difficulties due to the presence of large proportions of boulders are to be considered if the till deposit includes a major proportion of boulders (boulder till), thus, the need to use controlled fill.

6.1.5 PRESENCE OF BEDROCK

The presence of bedrock along the alignment may require rock excavation by drilling and blasting methods depending on the road profile and bedrock topography. If there is a major rock cut (for example, a rock hill along the alignment), the width of the blasted area will have to be sufficient for the construction of catchment ditches and thus avoid incidents associated with boulders falling on the road. In addition, if the lithology and properties of the bedrock allow, the blasted rock could be used, after proper crushing, as backfill or crushed stone.

Rock escarpments will need to be considered in the final road design. Escarps, also known as cliffs, often pose significant boulder fall hazards and it remains preferable to keep a safe distance from the cliffs to overcome the risk of boulders fall. Work to secure cliffs can be costly and requires regular inspections and maintenance.

6.1.6 WATER

The presence of groundwater may be problematic or require additional measures depending on the type of soil deposit and its depth. Here is an overview of groundwater potential issues and some measures:

- If the water table is higher than the final road surface, a permanent drainage system should be considered;
- If granular deposits are present below the water table, their susceptibility to liquefaction will increase;
- Depending on the hydraulic gradient, water could cause internal erosion problems in granular deposit excavations;
- Excavations in cohesive deposits overlying granular deposits below the water table could impose heave problems on the bottom of the excavation;
- If the presence of a watertight support is required during the excavation works (such as sheet piles), the excavations will generate a hydraulic gradient with the risk of developing the phenomenon of Boulance (soil particles floating in the water);
- Presence of ferrobacteria that can clog the drainage system, hence the necessity to install a specific drainage system.

The presence of watercourse crossings also brings its share of complexity. Geotechnical problems with the foundations that will be used to cross the watercourses are possible if the deposits are composed of low bearing capacity soils and/or fractured rock and/or deep rock. In all cases, and depending on the type of proposed structure, if foundations are required in the watercourse, piles or caisson piles are often the type of foundation chosen. As for the approaches to the structure, it all depends on the type of soil and its bearing capacity: conventional foundations (surface or invert foundations) or deep foundations (piles) are the main options.

6.1.7 PERMAFROST

Overburden soils consisting of sand and gravel with small proportions of fine particles are considered stable to thawing, in which they are likely to contain little or no ice. However, fine-grained soils such as silt and clay deposits (marine sediments) may contain ice in various forms and, therefore, must be considered unstable to thaw. Fine grained soils can therefore be problematic during excavations and infrastructure construction. Significant differential settlements can be anticipated in the presence of this type of soil. Attention must also be paid to excavation slopes that could be unstable in the presence of permafrost.

On a larger scale, climate warming may present another challenge in areas with fine-grained soils where permafrost has been identified. In fact, climate warming may lead to permafrost degradation and significant differential settlement.

The presence of permafrost will therefore be monitored in marine sediments and in till deposits composed mainly of fine particles.

6.1.8 POTENTIAL SOURCES OF MATERIAL

The description of potential sources of granular material by area is presented in section 3, in subsections 3.1.6, 3.2.6 and 3.3.6 respectively.

6.1.9 ADDITIONAL COMMENTS

Despite all potential geotechnical challenges mentioned above, there are numerous mitigation measures available, some of which are:

- Over-excavation of the following types of soils if they are present in thin layers;
  - Layers of liquefiable clay on the surface or normally consolidated clay;
  - Loose granular deposit layers susceptible to liquefaction;
  - Peat layers.
- Installation of deep foundations in the presence of liquefiable clay over a significant thickness, if over-excavation is not an option for future infrastructures (such as bridges, culverts, etc.);
- Soil improvement techniques (controlled modulus columns or ballasted columns) increase bearing capacities and in some cases eliminate the risk of liquefaction.

7 RECOMMENDED INVESTIGATIONS AND NEXT STEPS

The main objectives for subsequent steps will be to confirm the nature of the data collected in this study, to characterize the deposits and obtain the geotechnical parameters of the soils found on the selected alignments, to identify any features or critical areas, and to locate all potential borrow sites. Below is a detailed description of the data to be collected by type of stratigraphy.

- In organic/peat soils, the objective is to identify:
  - Overall thickness;
  - The grain size distribution and water content of soils;
  - The classification of organic soils according to the Von Post scale;
- In cohesive deposits, the objective is to identify:
  - Overall thickness;
  - Soil grain size distribution, consistency, and moisture content;
  - Undrained shear strength;
  - Cohesive soil sensitivity;
  - Potential settlement;
  - Soil geotechnical resistance;
- In granular soil deposits and till deposits, the objective is to identify:
  - Overall thickness;
  - Soil grain size distribution , compactness, and water content;
  - Soil geotechnical resistance;
  - Liquefaction potential;
  - Possibility of reusing soils as fill materials.

7.1 RAILWAY: RUPERT TO LA GRANDE

Once the alignment alternative has been selected, a drilling campaign will be required. The investigation campaign shall include, but not be limited to, the following:

- The completion of geotechnical boreholes. The number and spacing of the boreholes will vary according to the proposed alignment at the stage of future studies;
- Soil sampling will differ from one borehole to another depending on the type of soil deposit encountered: either remoulded samples or intact samples;
- Installation of piezometers and/or open standpipes to monitor groundwater table;
- Any problematic areas identified in this report, such as near-stream or peatland areas, will most likely need to be investigated through drilling and/or piezocone surveys and any other in-situ testing deemed appropriate;
- Soil sampling in borrow pits to confirm whether soils and aggregates can be used or not;
- Confirm whether the identified borrow pits are sufficient in volume and identify any other potential borrow pits.

Based on this pre-feasibility study, it was noted that organic and cohesive soils are expected to cover approximately 40% of the proposed rail corridor alignment, which may require additional drilling and specific in-situ testing, as these soils present potential issues that should be investigated.

It should be noted that given the presence of the Billy-Diamond Highway in the vicinity of the study alignment, access to the equipment could be primarily made by the road. The construction of temporary roads and clearing of trees to access sounding locations must be anticipated.

7.2 ROADWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK

During the pre-feasibility study, the La Grande to Whapmagoostui/Kuujjuarapik sector, more specifically the future road corridor linking La Grande and Kuujjuarapik, was moved to the feasibility phase. Along this alignment, the feasibility study focuses on the study of potential supply materials to determine the possibility of building the road itself. The following are the key elements of this study:

- Soil sampling in the borrow pits to confirm whether or not they can be used;
- Confirm whether the identified borrow pits are sufficient in terms of volume;
- Identify potential quarry sites and sample rock at selected sites.

These elements were considered the most critical to evaluate the feasibility of the proposed infrastructures. This feasibility study includes a site visit and a helicopter drilling campaign. Laboratory tests are also planned to determine the recovered soil and rock sample parameters.

According to this pre-feasibility study, it was noted that organic and cohesive soils are expected to cover approximately 20% (average of alternatives 1 and 2) of the proposed alignment, these specific locations may require additional drilling and specific in-situ testing (as proposed in section 7.1) as these soils present potential issues to be investigated in a later phase of the proposed infrastructures. Any problem areas identified in this report, such as areas near watercourses, will also be investigated in a later phase.

Future studies requiring heliborne drilling campaigns should therefore be anticipated.

7.3 RAILWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK

As described for the proposed roadway corridor, one of the key next steps for the railway corridor is the assessment of the quality and the quantity of granular materials available for the construction of the railway. The results of the feasibility study of the road corridor could serve as inputs for the railway corridor. In this sense, depending on the adjustments made to the route, an additional study on the materials could be carried out. This complementary study could include, among other things, the collection of manual samples, a drilling campaign, and laboratory testing.

As described earlier, over the corridor extending from La Grande to Whapmagoostui/Kuujjuarapik, organic and cohesive soils are expected to cover approximately 22% of the proposed alignment, these specific locations may require additional drilling and specific in-situ testing (as proposed in section 7.1) as these soils could present certain challenged that will need to be investigated in a later phase of the proposed infrastructures. Any problematic areas identified in this report, such as areas near watercourses, will also need to be investigated in a later phase. Future studies requiring heliborne drilling campaigns should therefore be anticipated.

7.4 ROUTE 167: UPGRADE & EXTENSION TO TRANS-TAIGA

According to Table 4-14 presented in section 4.3.1 of this report, it was found that the majority of the soil on the Route 167 alignment consists of till deposits, which generally does not cause major issues. However, the following work will still be required:

— A preliminary site visit;
— Identification of borrow pits and geo-locations in the area;
— The drilling of geotechnical boreholes. The number and spacing of the boreholes will vary according to the proposed alignment at the upcoming study stage;
— Soil sampling will differ from one borehole to another depending on the type of soil deposit encountered: remoulded samples and intact samples will be taken and when boreholes are completed, installation of piezometers and/or open standpipes to monitor the water table;
— Soil sampling in the borrow pits to confirm whether or not they can be used;
— Confirm whether the identified borrow pits are sufficient in volume and identify any other potential borrow pits.

Given the location of the site, future studies requiring confirmation of sufficient volumes as per requirements heliborne drilling campaigns and local clearing must therefore be anticipated.

7.5 PERMAFROST AREAS

In areas of the study alignments where the presence of permafrost is anticipated, specific investigation campaigns by means of test pits may be carried out in a later phase of the proposed infrastructures. The following outlines the next steps related to permafrost.

— Conduct exploratory wells (target period: July to August) to determine the depth of the active layer (the permafrost ceiling). The active layer represents the surface layer above the permafrost that is subject to freeze-thaw cycles. If permafrost is present, a refusal on frozen ground will be encountered. The depth of this refusal will correspond to the depth of the top of the permafrost;
— Perform temperature readings inside samples during test pits and drilling works;
— Assess grain size distribution of soils in place through sieve analyses. In addition, laboratory determinations of moisture content can also provide an insight on the ice content of soils in place;
— It may also be appropriate to install thermistor chains in some boreholes in areas where permafrost is present to install monitor soil temperatures. This will help anticipate settlements that may be associated with thawing.

8 FEASIBILITY – ROADWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASE II)

Given that the proposed roadway of La Grande to Whapmagoostui/Kuujjuarapik was moved to the feasibility stage during the course of the Study, a preliminary field campaign was implemented to focus on the retained alternative 2 of the proposed road corridor, as well as, to survey all identified sites, and to manually collect soil and rock samples. Boreholes were also carried out for the 6 selected potential quarry sites. The drilling data collected was analyzed and integrated into the Study's Geographic Information System (GIS).

8.1 PREPARATORY WORK

8.1.1 REVIEW OF EXISTING DOCUMENTS

This step of the mandate includes the collection and review of all data relevant to the proposed infrastructures study area, i.e. documentation provided by the Client and information available in the public and scientific domain.

To select potential sites for the supply of materials, the following document was consulted:

Rapport technique final Étude de corridor routier et tracé préliminaire - Route d'accès aux communautés de Whapmagoostui et Kuujjuarapik

The report was produced in 2013 by GENIVAR and consisted in presenting the results of the road corridor study and the analysis of the proposed preliminary alignment. The firm Poly-Géo was also mandated by GENIVAR to address the characterization of the physical environment, geomorphology, photointerpretation and mapping aspects of the study.

In addition, the following public data complemented the information in this research:

- Bedrock and Quaternary geology maps (scale 1:50,000) from the Geomineral Information System of Quebec (SIGEOM) of the Ministère de l'Énergie et des Ressources naturelles (MERN);
- MERN's Mineral Title Management System (GESTIM) surface mineral maps;
- Review of aerial photographs available on ArcGIS Online.

The aerial photographs and maps were reviewed by geomorphology and geology professionals of WSP.

8.1.2 SITE SELECTION

Potential sites for material development were selected in advance to plan the site reconnaissance visit. A total of 42 sites were selected for the field visit, including 19 potential borrow pits and, 23 outcropping rock sites for potential quarries (Appendix E-1 / Map 5). During fieldwork, one additional borrow pit (B-017) and one additional potential quarry site (R-140B) were identified and characterized. These sites were selected based on pre-established criteria, including the nature and quantity of the material that could be exploited, accessibility (proximity to a watercourse or wetland, borrow pits that were already active, etc.), spatial distribution along the alignment, and distance from the proposed road.

Ten granular borrow pits were selected from the report prepared by Poly-Geo Inc. In addition, two sites, one potential quarry and one potential borrow pit, were selected based on GESTIM data from existing quarries/sand pits.

The remaining granular borrow pits and potential quarry sites were identified by our team of professionals following a photo-interpretation analysis performed in 2D visualization on screen using ArcGIS mapping software. The search for potential quarries and additional borrow pits focused on a 2 km radius on either side of the proposed road. Material mapping was performed in conjunction with data analysis from LiDAR, the GESTIM database and, as a backdrop, maps from SIGEOM. LiDAR was used to estimate the thickness of rock and granular deposits, particularly in wooded areas or areas with relatively flat topography. The boundaries of each site were defined to maintain a distance of at least 30 m from wetlands and water bodies, in accordance with section 121 of the guide to the application of the regulation respecting the sustainable development of forests in the domain of the State (MFFP, 2022).

According to photointerpretation results, sites with the highest exploitation potential for were selected according to the selection criteria mentioned above. All this information was compiled in a georeferenced database.

The results of the sites investigated during the reconnaissance visit are discussed in Section 8.2.

8.1.3 HEALTH, SECURITY, AND ENVIRONMENT

Various actions were taken to ensure the health and safety of everyone during this mandate and the field work. Mainly, a Health, Safety and Environment (HSE) plan was developed. The following points were discussed:

- Definition of roles and responsibilities of stakeholders;
- Identification of the work program and location of sites under investigation;
- Development of a communication plan;
- Development of a rescue and evacuation plan;
- Development of a travel management plan;
- Hazard assessment and management;
- Development of risk control measures;
- Management of subcontractors;
- Management and implementation of COVID-19 sanitary restrictions;
- Limiting risks of environmental damage.

Each stakeholder was required to sign the HSE plan to ensure everyone's understanding.

A specific health and safety meeting for the field work to be carried out in the summer of 2022 was held for the various teams participating in the field work. In addition, the "*Field Level Risk Assessment*" (FLRA) form was completed prior to each field trip as a reminder of the risks.

Various training courses including remote first aid and forest survival were taken by the team members involved in the field work.

8.1.4 COORDINATION WITH SUBCONTRACTORS

8.1.4.1 HELICOPTER SUPPLIER

The investigation was carried out by heli-lifting the teams and equipment using the subcontracting company Héli-Inter. The helicopter landing site was located at 106 Chemin du Parc-Industriel in Radisson. The detailed planning of departure times and meeting points was established on site with the pilot. It should be noted that a specific start-up meeting was held prior to the drilling campaign. When new team members arrived, a demonstration of helicopter entry and exit procedures was performed.

8.1.4.2 *DRILLING SUPPLIER*

The drilling was subcontracted to Succession Forage George Downing Ltée under the supervision of a WSP geotechnical supervisor. The drill rig, the drilling equipment, and the samples were moved from one site to another by slinging under the supervision of the Heli-Inter team members. It should be noted that a specific start-up meeting was held prior to the drilling campaign.

8.2 SITE VISIT

Geotechnical field work was performed in the summer of 2022 by a team of professionals from WSP. The geotechnical investigation consisted of a site visit from July 11 to 15, 2022, followed by geotechnical drilling from August 16 to September 7, 2022. The purpose of the site visit was to evaluate the conditions at the preliminarily selected sites. A summary of the work performed during the site visit is presented below:

- Soil sampling with a hand shovel including the description of the sample taken manually;
- Manual sampling of the outcropping rock including a brief lithological description of the rock and nearby outcrops;
- General description of the site (accessibility in relation to the alignment, clearing, proximity of wetlands and water bodies, etc.) and photos;
- Detailed description of the rock by an experienced geologist at the WSP laboratory;
- Selection and analysis of soils samples from potential borrow pit sites for various material characterization tests;
- Summary of the results and observations made in the field;

Refer of Appendix E-1 for more details.

8.2.1 *POTENITAL BORROW PITS*

Following the visit to the various potential borrow pits, it was possible to assert that of the 19 potential borrow pits and the additional pit investigated, six were found to be non-exploitable. Pits B-125, B-140 and D-198 have a high proportion of rock on the surface and therefore have no potential as granular material. Pit BV-082, composed of till, was not sampled since the material matrix was deemed too fine for granular material needs. Pit D-205 was also not characterized due to the presence of First Nations camps on the site. Finally, pit 95882, located at the northern end of the proposed road, was excluded from the potential pits since the water table appears to be less than 1 m from the surface over the entire site.

In the southern portion of the study area, the pits visited consisted mainly of till. Although in small proportions, the matrix of these deposits contained mostly of fine particles, making the use of the deposit as granular material not favorable. For this reason, an additional borrow pit (B-017) was added and characterized during the field work.

The observations from the reconnaissance visit to the potential granular borrow pits are summarized in the tables below.

Table 8-1 General Characteristics of the Borrow Pits Investigated

Site	Coordinates X	Coordinates Y	Anticipated Material	Approximative area (m^2)	Exploitable Depth (m)	Potential Exploitable Volume (m^3)	Shortest distance to road (m)	Surface Materials: Pebbles (%)	Surface Materials: Boulders (%)	Environments in the Vicinity: Wetland	Environments in the Vicinity: Water	Access to Road Alignment	Topography	Topographical Description	Abundance of Vegetation	Work Area	Additional Information
D-010	-77.43934322	53.8806184	Till	239,411	3	718,233	0	5	30	Yes	No	Easy	Rugged	Moraine ridge	Sparse	Yes	N/A
B-017	-77.4065052	53.92154651	Till	207,054	2	414,108	0	5	15	Yes	No	Easy	Relatively flat	Moraine ridge	Sparse	Yes	N/A
D-025A	-77.43209858	53.99170491	Till	315,159	3	945,477	0	10	20	Yes	Yes	Easy	Relatively flat	Moraine ridge, about 40 m wide	Sparse	Yes	Exploitable depth varies from 2.5 to 4 m.
B-034	-77.39713812	54.07134118	Till	182,268	4.5	820,206	0	10	25	Yes	Yes	Easy	Relatively flat	Moraine ridge, about 25 m wide	Sparse	Yes	Metric boulders on the surface.
D-046	-77.39533206	54.15806098	Till or fluvioglacial	288,318	5	1,441,590	195	10	10	No	Yes	N/A	Relatively flat	N/A	Sparse	Yes	N/A
D-061	-77.3435031	54.27026717	Gravelly sand	3,551,571	15	53,273,565	0	30	10	Yes	Yes	Easy	Relatively flat	Up to 25-30 m high.	Sparse	Yes	Light clearing required.
BV-082	-77.37942003	54.42483874	Till	253,418	5	1,267,090	0	10	3	Yes	No	Fairly easy	Relatively flat	Extended rocky mound, 6m wide and 4m high.	Abundant	No	Wetland in the vicinity. Till with fine sand matrix with trace of silt and presence of pebbles. Less dense vegetation on the rocky mound.
BV-089	-77.41005693	54.4774748	Till	131,564	3	394,692	90	30	10	Yes	No	Easy	Relatively flat	Point of the linear rocky mounds, 7m wide and 3m high	Sparse	Yes	Medium clearing. Till of fine sand, traces of silt and gravel.
B-110	-77.53812067	54.61390855	Sandy Till	470,027	2	940,054	312	30	10	Yes	Yes	Easy north of the alignment	Rugged	Extended rocky mound from 2 to 4m high	Sparse	N/A	Several metric boulders on the surface, variable deposit thickness.
B-119	-77.64479543	54.69233945	Sand and gravel	51,302	5	256,510	278	0	5	Yes	No	N/A	Relatively flat	N/A	Sparse	Yes	Potential location south of the pit initially identified. Variable depth, the rock seems close to the surface.
B-125	-77.54715755	54.62709475	Sand	45,064	N/A	N/A	34	N/A	N/A	Yes	No	N/A	N/A	N/A	N/A	N/A	Rock on the surface, not exploitable.
B-140	-77.6862113	54.84917347	Till	99,447	N/A	N/A	230	N/A	N/A	Yes	No	N/A	Relatively flat	Steep outcrop	Sparse	N/A	Presence of rock and apparently thin material.
B-146	-77.70402177	54.90037855	Till	196,777	3	590,331	0	3	5	No	Yes	N/A	Steep	Relatively flat area in the center with some elongated rocky mounds at the ends	Sparse	Yes	Gently inclined hill with an average height of 3 m, but bedrock is nearby.
D-164	-77.64446833	55.04872387	Sand and gravel	545,847	8	4,366,776	463	10	15	Yes	No	N/A	Steep	Large area up to 8m high, with a gentle slope	Sparse	Yes	Lots of rock on the surface on the west side. Lots of boulders and pebbles on the surface, but few in the sediments.

Site	Coordinates		Anticipated Material	Approximative area (m^2)	Exploitable Depth (m)	Potential Exploitable Volume (m^3)	Shortest distance to road (m)	Surface Materials		Environments in the Vicinity		Access to Road Alignment	Topography	Topographical Description	Abundance of Vegetation	Work Area	Additional Information
	X	Y						Pebbles (%)	Boulders (%)	Wetland	Water						
D-181A	-77.62548501	55.18477847	Sand and gravel	100,408	3	301,224	0	0	0	Yes	Yes	N/A	Relatively flat	Fairly flat area	Sparse	Yes	Large area of medium to coarse sand at the end of a rocky mound.
D-192	-77.59336807	55.27650269	Sand	657,643	8	5,261,144	0	0	0	Yes	No	N/A	Relatively flat	Large flat area with steep edges	Sparse	Yes	N/A
D-198	-77.62353599	55.31358444	Sand	46,267	N/A	N/A	0	N/A	N/A	Yes	No	N/A	N/A	N/A	N/A	N/A	Bedrock in surface~~,~~ insignificant exploitation.
D-201B	-77.66301178	55.31451606	Sand	91,309	2	182,618	282	0	0	No	No	Easy	Flat	N/A	Sparse	Yes	Sand and gravel area confined between two rocky mounds.
D-205	-77.7239227	55.30496403	Sand	122,522	N/A	N/A	779	N/A	N/A	Yes	No	N/A	N/A	N/A	N/A	N/A	Native camp on site, flyover only.
95882	-77.72194374	55.3184003	Gravel	6,951	N/A	N/A	144	0	0	Yes	Yes	Easy	Flat	N/A	Absent	Yes	Excavator present on site. Pond of water in the center of the site and water table less than one meter deep.

Table 8-2 Characteristics of the Samples Taken from the Investigated Borrow Pits

Site	Sample No	Coordinates		Organic Soil Thickness	Stratigraphy Description	Sample Depth	Humidity	Color	Water Infiltration	Apparent Density	Additional Notes
		X	Y								
D-010	D-010-01	-77.43932468	53.88061913	0.15	Sand, some silt, traces of gravel, brown, dry.	0.3	Dry	Brown	None	Compact	Difficult excavation due to boulders.
B-017	B-017-01	-77.40651565	53.92155275	0.1	Sand, some silt, traces of gravel. Presence of pebbles (5%) and boulders (10%).	0.6	Dry	Grey brown	None	Compact	Presence of several parallel morainic cordons. Moraine of about 25 m wide.
D-025A	D-025A-01	-77.43205949	53.99176112	0.1	Sand, some gravel, traces of silt, brown, dry.	0.45	Dry	Brown	None	Loose	Presence of moraine horizons in the vicinity. The site is located southwest of the original D-025A.
	D-025A-02	-77.43119364	53.9901687	0.15	Same as D-025A-02, with more pebbles (10%)	0.7	Dry	N/A	N/A	Loose	N/A
B-034	B-034-01	-77.39711951	54.0713314	0.13	Sand, some silt, traces of gravel, grey-brown, dry.	0.7	Dry	Grey	None	Compact	N/A
	B-034-02	-77.39660797	54.07081008	0.2	Silty sand, traces of grey-brown gravel, dry.	0.6	Dry	Grey brown	None	Dense	Presence of boulders 30% and pebbles 5%.
D-046	D-046-01	-77.39534014	54.15805913	0.15	Sand a little gravel, traces of silt, brown, dry. Presence of pebbles.	0.55	Dry	Brown	None	Compact	Not many boulders on the surface of the soil. About 10% at the sample level.
D-061	D-061-01	-77.3434949	54.27026445	0.1	Medium to coarse homogeneous sand, loose and dry.	0.5	Dry	Beige	None	Loose	N/A
	D-061-02	-77.31937538	54.27320668	0.1	Sand and gravel with pebbles and boulders (40%). Form of superimposed horizons with a lot of pebbles and boulders on the surface.	0.5	Dry	Beige	None	Loose	Looks exploitable on 10 to 12 m of depth, then becomes fine to medium sand, without pebbles and boulders.
	D-061-03	-77.31894598	54.27248033	0.05	Medium sand with pebbles and boulders (15%), little gravel.	0.5	Dry	Beige	None	Loose	N/A
BV-089	BV-089-01	-77.40989158	54.47777481	0.1	Till with fine sand matrix, traces of silt and gravel. Weakly moist.	0.45	Low Moisture	Olive grey	None	Dense	N/A
BV-110	B-110-01	-77.53947971	54.61541546	0.2	Till with fine sand matrix, some gravel and silt. Presence of centimetric to decimetric pebbles, sometimes joined. Moist.	0.8	Moist	Olive grey	None	Very Loose	N/A
B-119	B-119-01	-77.6434422	54.69316224	0.05	Medium to coarse sand, traces of gravel and pebbles. Moist.	0.4	Moist	Orange brown	None	Loose	Traces of oxidation.
	B-119-02	-77.64241446	54.69424152	0.1	Sand, some silt, traces of gravel. Moist. Presence of metric boulders on the surface.	0.5	Moist	Orange brown	None	Loose	N/A
B-146	B-146-01	-77.70395362	54.90036929	0.7	Coarse sand, some gravel, and traces of pebbles. Moist.	0.5	Moist	Orange beige	None	Loose	N/A
D-164	D-164-01	-77.64449074	55.04870653	N/A	Medium to coarse sand, trace gravel, loose and dry. Well-sorted sediment with horizontal bedding.	0.7	Dry	Beige	None	Loose	N/A
D-181A	D-181A-01	-77.62547496	55.18479366	0	Medium to coarse sand, loose and moist. Horizontal bedding with coarse sand banks (1-11mm). Gravel and pebble area 90 m west of the sample.	0.9	Moist	Beige	None	Loose	Presence of a 0.4 m layer of medium sand slightly hardened at depth. Located just before the rocky mound to the southeast.
D-192	D-192-01	-77.59336007	55.27651453	0.1	Fine to medium sand, very well sorted, rather massive, moist and loose.	0.95	Moist	Beige	None	Loose	Seems a good potential, good thickness, and easily exploitable.
	D-192-02	-77.60243744	55.27833832	0.1	Same as D-192-01.	0.6	Moist	Beige	None	Loose	N/A
D-201B	D-201B-01	-77.66297709	55.31452762	0.1	Gravelly sand, compact and moist.	0.5	Moist	Rust brown	None	Compact	N/A
95882	95882-01	-77.72195233	55.31848648	0	Sand, traces of silt and gravel, brown and moist.	0.35	Moist	N/A	Yes, on the surface	Very Loose	N/A

8.2.1.1 *BORROW PITS GEOMORPHOLOGICAL DESCRIPTION*

The following paragraphs group the different borrow pits according to their modes of deposition: glacial till, fluvioglacial (sand and gravel), and glaciomarine (sand, gravel, silt and clay).

GLACIAL MATERIAL PITS (TILL)

The last glaciation allowed the deposition of glacial sediments (till) that covers the bedrock in a discontinuous manner in the study area. The distribution of overburden soils along the proposed road corridor (section 3.2.5) shows a high proportion of till in the southern portion of the proposed road. Seven investigated borrow pits were identified in these deposits (D-010, B-017, D-025A, B-034, D-046, BV-082, BV-089). However, the till cover becomes more sporadic in the northern and central portions of the proposed road.

During deglaciation, contact between the ice margin and the waters of the post-glacial Tyrrell Sea helped shape series of De Geer moraines. These form thin parallel crests that developed in the till deposits. They range in length from a few hundred metres to 2 km, while they are about 15 m to 50 m wide. On average, 250 m separate the moraines from each other.

Till is a diamicton that varies in matrix and stoniness depending on the genesis of the deposit. Till deposits characterized by a sandy matrix and medium to high stoniness have good potential as granular materials. This is the case for borrow pits D-025A, D-046, and BV-089, which are composed of gravelly sand with trace to a little silt.

Borrow pits B-017, B-034 and BV-082 have a silty sand or silt matrix, in which they are less suitable for use as granular material. Lastly, pit D-010 is composed of a gravelly and silty sand with the presence of pebbles.

FLUVIOGLACIAL MATERIAL PITS (SAND AND GRAVEL)

Glacial retreat resulted in the deposition of large volumes of meltwater material (sand and gravel) in the form of glaciofluvial complexes (eskers, kames, and outwash). However, the proposed road alignment intersects very few of these fluvioglacial sediment areas, with the exception of an important juxtaglacial deposit (D-061) identified around kilometer 61, i.e. at the southern junction between the preliminary rooublad of Poly-Géo and the road alternative proposed by WSP.

The field visit and grain size distribution analyses confirmed the high potential of this deposit as granular material. In fact, the field characterization revealed that the pit D-061 forms an elongated strand that extends from east to west for nearly 6 km (Figure 8-1 A). Its maximum thickness appears to be about 30 m, while its width varies between 300 m and 700 m. The sediments are arranged as overlapping horizons and have a high proportion of pebbles and boulders on the surface (40%) (Figure 8-1 B-C). At the top (sample D-061-02), the sediment appears to be sand and gravel with the presence of boulders and pebbles (40%) on the surface. On the lower levels in elevation (samples D-061-01 and D-061-03), the sediment becomes a gravelly sand with traces of silt and has slightly less pebbles and boulders on the surface (15%). In addition, based on laboratory test results, sample D-061-03 does not meet the criteria for sub-base material (see Section 8.4.2.1) and therefore has a low potential to be used as granular material.

Lastly, destructive drilling in the vicinity pit D-061 confirmed the large thickness of material available. The deposit was drilled to a depth of 14 m, i.e. to the limit of the drill rig in destructive mode. Considering its surface area of 3,633,265 m2 and an average thickness of 15 m, the volume of exploitable material corresponds to 54,498,975 m3, which could meet the granular material requirements for a significant portion of the proposed road.

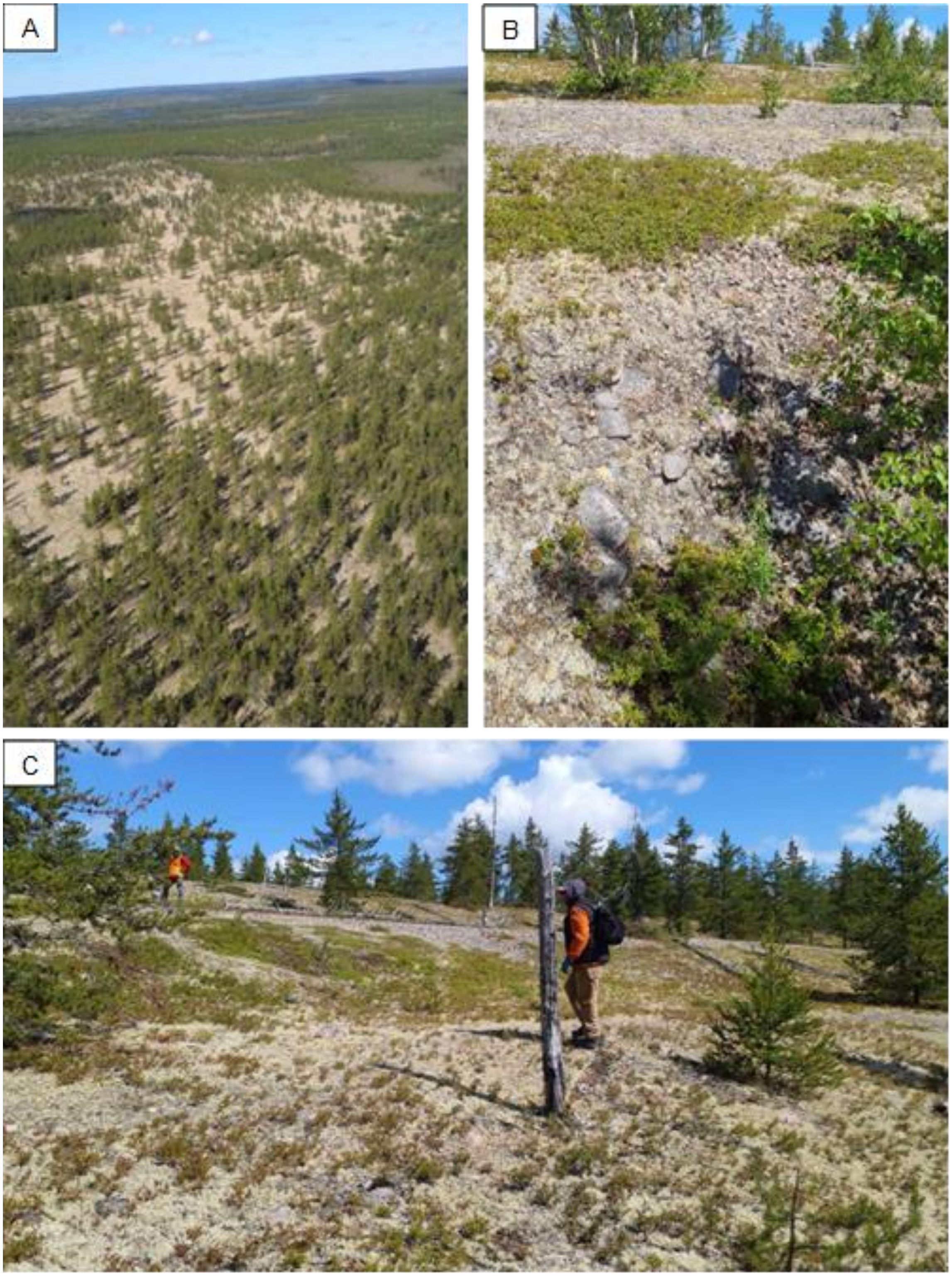


Figure 8-1 (A) Overall View to the SW of Borrow Pit D-061. (B) and (C) View to the East of Overlying Sediment Beaches with Boulders and Pebbles on the Surface.

GLACIOMARINE SEDIMENT PITS (SAND, GRAVEL, SILT AND CLAY)

During deglaciation, the Tyrrell Sea invaded the study area, resulting in the deposition of fine-textured sediments (silts and clays) in the deeper areas of the sea, and coarser sediments (sand and gravel) in the shallower areas. Some deposits were also reworked during the marine transgression, resulting in the leaching of the fine grains (clays and silts) and leaving the coarser grains (sand, gravel, pebbles and boulders) in place.

Deepwater, nearshore, and prelittoral fine glaciomarine sediments intersect the proposed road primarily at the northern and central portions of the area. Borrow pits B-110, B-119, B-146, D-164, and D 181A, D-192, D-201B were all deposited in areas of glaciomarine sediments.

Deposits B-110 and B-119 (sample B-119-02 only) are composed of silty sand with some gravel. Since these deposits have a high proportion of fine particles, 27% and 28% respectively, they have a lower potential as granular materials. Note that sample B-119-01 is composed of gravelly sand with traces of silt. A portion of pit B-119 is therefore suitable for mining.

Deposits B-146, D-164 and D-181A are characterized by sand with occasional traces of gravel and silt. These deposits could therefore be exploited and possibly amended with material from nearby quarries. However, it should be noted that rock was identified at the surface in some places on pits B-146 and D-164, while pit D-181A is located directly at the end of a rocky mound. The proximity of the bedrock is therefore an important consideration, as it could significantly reduce the exploitable thickness of these deposits.

Finally, deposit D-201B is composed of sand and gravel with traces of silt and therefore constitutes an excellent potential material for road construction. However, it must be considered that the pit forms a flat area between two rocky mounds, which could complicate its exploitation.

8.2.2 POTENTIAL QUARRY SITES

Of the 23 potential quarry sites previously identified, seven sites were not selected for site visits since quarry sites of higher exploitation potential were identified nearby. In addition, site R-140 was not investigated, but was replaced in the field by the additional site R-140B, located nearby, which appeared to be more favorable for exploitation. In the end, 16 potentials quarry sites were characterized during the reconnaissance visit.

The observations from the reconnaissance visit to the potential quarries are summarized in the tables below. These tables present the lithology encountered and other relevant observations. Maps of each of the quarries investigated are presented in Appendix E-1. Appendix E-4 presents a summary table of the visual description from the laboratory with supporting photos.

Table 8-3 Characteristics of Potential Quarries Investigated

Site	Coordinates		Approximative area (m²)	Exploitable Depth	Volume (m³)	Shortest distance to road (m)	Environments in the Vicinity		Access to the Road Alignment	Apparent lithology	Structure			Alteration	Weatherization		Outcrop Shape	Planned Clearing	Additional Information
	X	Y					Wetland	Water			Type	Direction	Hanging		Type	Intensity			
2393	-77.44619653	53.83013887	109,531	10	1,095,310	917	No	No	Easy	Granite	Dyke intrusion	342	70	N/A	N/A	Very Low	Rock wall	Yes	Coarse grained granite, little structure, some porphyritic felsic rock dykes. Exploitable on both walls, with platform in between.
R-010	-77.42499076	53.8763815	100,879	12	1,210,548	224	No	Yes	Easy from the south	Granite	Intrusion of pegmatites with irregular planes	45	90	N/A	N/A	N/A	N/A	N/A	N/A
R-025	-77.43148075	53.9835315	109,704	3	329,112	466	No	Yes	Simple to medium	Granite / Granitic gneiss	Foliation	7	70	N/A	N/A	Very Low	Rocky mound	Yes	Low thickness and interest
R-033	-77.40273693	54.06022459	113,991	6	683,946	201	No	Yes	N/A	Granitic gneiss	Foliation	20	55	N/A	N/A	N/A	Rocky mound	Yes	Local banding
R-046	-77.37690973	54.16146892	163,300	6	979,800	0	No	No	Easy	Granite	N/A	N/A	N/A	N/A	N/A	Very Low	Rocky mound	Yes	N/A
R-054C	-77.36727388	54.21795431	348,243	8	2,785,944	0	No	Yes	Easy	Granite	Quartz veins with porphyritic feldspar borders	N/A	N/A	N/A	Lichen	Very Low	Rocky mound	Yes	Clearing for access, low vegetation cover on the site. Granite with homogeneous enclaves of diorite and some cm to dm veins of quartz and porphyry feldspar. Slight foliation in places (aligned micas and slightly elongated quartz).
RV-096	-77.44605475	54.51860908	294,355	15	4,415,325	0	N/A	Yes	Easy from the SW, at the bottom of the rocky mound	Granitic gneiss	Foliation	270	80	N/A	Lichen	High	Rocky mound	Yes	Slight clearing required. Little vegetation covers on the rocky mounds. Medium to coarse grained granitic gneiss. Foliated and homogeneous. Little fractured. Several rocky mounds in the vicinity.

Site	Coordinates		Approximative area (m^2)	Exploitable Depth	Volume (m^3)	Shortest distance to road (m)	Environments in the Vicinity		Access to the Road Alignment	Apparent lithology	Structure			Alteration	Weatherization		Outcrop Shape	Planned Clearing	Additional Information
	X	Y					Wetland	Water			Type	Direction	Hanging		Type	Intensity			
R-110	-77.54158705	54.61935657	342,081	16	5,473,296	0	No	Yes	Large lake to the south. Alignment on the rocky mound with moderate slope.	Granite	Intrusion of a pegmatite	N/A	N/A	N/A	Lichen	Moderate	Rocky mound	Yes	Pink granitoid with medium to coarse grains. Foliated in places, but generally slightly metamorphosed. Intrusion of a pegmatite, 20 cm wide, oriented NE-SW (no dip possible). Decimetric enclaves of diorite. Forms a rocky mound with a strong dip on the south side.
R-118	-77.62604211	54.68592858	609,588	15	9,143,820	0	No	No	Easy	Granitic gneiss	N/A	N/A	N/A	N/A	Lichen	Low	Rocky mound	Yes	Sporadic organic cover
R-129A	-77.66101134	54.76259591	224,455	17	3,815,735	0	No	No	Easy	Granitic gneiss	Foliation and quartz veins	322	60	yes, oxidized	Lichen	High	Rocky mound	Yes	Low to partial vegetation cover (conifers)
R-140B	-77.67485159	54.86319427	295,964	20	5,919,280	614	Yes	Yes	Easy, alignment at about 1 km	Monzodiorite	N/A	N/A	N/A	Yes	N/A	Low	Rocky mound	No	N/A
R-147	-77.69443656	54.90635734	495,170	20	9,903,400	0	Yes	Yes	Easy	Monzodiorite	N/A	N/A	N/A	yes, oxidized	Lichen	Low	Rocky mound	No	N/A
R-165	-77.6851274	55.05870794	166,243	20	3,324,860	504	Yes	Yes	Easy, but many lakes and wetlands	Granite	Joints	N/A	N/A	N/A	N/A	Very Low	Rocky mound	No	Fairly open, surrounded by wetlands, thus difficult work area. The joints are oriented approximately east-west.
R-181A	-77.62219568	55.18198118	205,873	15	3,088,095	86	Yes	No	Easy	Granite	Joints	N/A	N/A	N/A	N/A	N/A	Rocky mound	No	Small wetlands in depressions above. Sporadic organic soil
R-192	-77.57975004	55.26898107	984,348	36	35,436,528	0	Yes	Yes	N/A	Granodiorite	Joints	N/A	N/A	N/A	Lichen	Very Low	Rocky mound	Little	Minimal clearing
R-202A	-77.65702604	55.31886158	373,919	30	11,217,570	0	No	Yes	Easy	Granitic gneiss	Joints	N/A	N/A	N/A	Lichen	Low	Rocky mound	No	N/A

Table 8-4 Characteristics of the Samples Taken from the Potential Quarry Sites Investigated

Site	Sample No	Coordinates		Lithology	Alteration		Texture	Color	Grain Size	Main Minerals
		X	Y		Type	Intensity				
2393	2393-01	-77.44631861	53.83027028	Granite	N/A	N/A	Grained	Pinkish grey	Coarse	Plagioclase, feldspar K, quartz, mafic (<10%)
R-010	R-010-01	-77.42500226	53.8763971	Granite	N/A	N/A	Grained	Pinkish grey	Coarse	Quartz, feldspar K, plagioclase, biotite
	R-010-02	-77.42489106	53.87590615	Granite	N/A	N/A	Grained	Pinkish grey	Coarse	Quartz, biotite, plagioclase
R-025	R-025-01	-77.4313525	53.99225069	Granite	N/A	N/A	Grained	Light grey	Medium	Quartz, plagioclase, biotite, other mafic
R-033	R-033-01	-77.40273985	54.06022589	Granitic gneiss	N/A	N/A	Grained	Pinkish grey	Coarse	Quartz, feldspar k, plagioclase, biotite
R-046	R-046-01	-77.37721478	54.16145314	Granite	N/A	N/A	Grained	White grey	Coarse	Quartz, feldspar k, plagioclase, biotite
	R-046-02	-77.37803472	54.16135621	Granite	N/A	N/A	Grained	White grey	Coarse	Plagioclase, quartz, biotite, feldspar k
R-054C	R-054C-01	-77.36733682	54.21781437	Granite	N/A	N/A	Grained	Pinkish grey	Coarse	Plagioclase, feldspar K, quartz, mafic (<10%)
RV-096	RV-096-01	-77.446139	54.51867828	Granitic gneiss	N/A	N/A	Foliate	Grey and pinkish white	Medium	Feldspar, quartz, biotite, other mafic
	RV-096-02	-77.44823583	54.5190569	Granitic gneiss	N/A	N/A	Grained	Greyish pink	Medium	Feldspar K, plagioclase, quartz, mafic (15%)
R-110	R-110-01	-77.55883498	54.61451458	Granite	N/A	N/A	Grained	Pink	Medium	Feldspar K, plagioclase, quartz, mafic (<10%)
R-118	R-018-01	-77.62581145	54.68613181	Granitic gneiss (weakly metamorphosed almost granite)	N/A	N/A	Grained	Pink, white, black (speckled)	Medium	Quartz, feldspar K, biotite
R-129A	R-129A-01	-77.66214335	54.7631088	Granitic gneiss	N/A	N/A	Grained	Light grey	Coarse	Plagioclase, feldspar K, quartz, mafic (10%)
R-140B	R-140B-01	-77.67530506	54.86334232	Monzodiorite	Oxidation and lichen	Moderate	Grained	Grey	Medium	Quartz, plagioclase, biotite
R-147	R-147-01	-77.69442278	54.90619082	Monzodiorite	Oxidation	Low	Grained	Grey	Medium	Plagioclase, quartz, biotite
	R-147-02	-77.69425973	54.90628625	Granite / granitic gneiss	N/A	N/A	Grained	Pinkish grey	Medium	N/A
	R-147-03	-77.70320449	54.90653663	Granite	N/A	N/A	Grained	Pink	Medium	N/A
R-165	R-165-01	-77.68569135	55.05859332	Granite	Oxidation	Low	Grained	Pinkish grey	Medium	Biotite, quartz, feldspar k, plagioclase
	R-165-02	-77.68667469	55.05881013	Granite	Oxidation	Low	Massive	Pinkish grey	Medium	Quartz, plagioclase, biotite feldspar K
R-181A	R-181A-01	-77.62247669	55.18214937	Granite	Lichen	Low	Grained	Greyish pink	Medium	Quartz, feldspar K, biotite
	R-181A-2	-77.62091075	55.18087893	Granite	N/A	N/A	Grained	Pinkish grey	Medium	N/A
R-192	R-192-01	-77.5725	55.26722222	Granodiorite	N/A	N/A	Grained	White grey	Medium	N/A
	R-192-02	-77.58527778	55.27083333	Granitic gneiss	N/A	N/A	Grained	Pinkish grey	Medium	N/A
R-202A	R-202A-01	-77.65952065	55.31621073	Granite / granitic gneiss	N/A	N/A	Grained	Pinkish grey	Medium	Feldspar K, quartz, biotite
	R-202A-02	-77.65948175	55.31614967	Granitic gneiss	N/A	N/A	Grained	Pinkish grey	Medium	N/A
	R-202A-03	-77.65699433	55.31885195	Granitic gneiss	N/A	N/A	Grained	Pink	Medium	Quartz, feldspar K, plagioclase

Following the field work, a multi-criteria analysis for the selection and justification of drilling sites was carried out by the geotechnical team according to the following:

- Proximity and quality of the borrow pit;
- Lithology;
- Potential exploitable volume;
- Availability of a work area;
- Accessibility in relation to the alignment;
- Clearing required;
- Observed elevation drop.

Each criterion having a weighting according to its importance (in qualitative terms: to be considered, important, very important), a score of the appreciation of the criterion was attributed to each site (in qualitative terms: very weak, weak, neutral, strong, very strong). Among the potential quarry sites, seven sites have been identified as being less favorable (R-025, R-033, R-046, R-118, R-129A and R-140B), two sites have been identified as being moderately favorable (R-054C and RV-096) and seven sites have been identified as the most favorable: R-010, R-110, R-147, R-165, R-181A, R-192 and R -202A. In addition to this analysis, it was necessary to consider the spatial distribution along the road so that the distance between the sites would be in the order of 50 km. Considering this additional criterion, six sites were selected for the drilling campaign as followed: R-010, R-054C, R-110, R-147, R-165 and R-192. Two boreholes per site were carried out. However, it should be noted that during the field work, for the purpose of distributing the length of the route, it was decided to carry out one borehole in the site named R-054C and one borehole on the site named R-054D which were located very close to each other. The drilling campaign was carried out from August to September 2022.

8.3 INVESTIGATION OF POTENTION QUARRY SITES BY DRILLING

8.3.1 METHODOLOGY

Following the geotechnical survey, seven sites of the highest potential were selected for drilling, including R-010, R-054C, R-054D, R-110, R-147, R-165 et R-192. Two boreholes per site were carried out to a depth of approximately 15 m within the rock, excepted for the sites R-054C et R-054D where only one borehole each were carried out since it is relatively the same outcrop. The objective was to describe the lithology of the rock as well as to define its nature and quality in view of its exploitation within the framework of the implementation of road infrastructures for the future road corridor.

8.3.2 SUMMARY OF DRILLING WORK AND ENCOUNTERED LITHOLOGY

Drilling was carried out using a Duralite 250B helicopter-borne drilling rig, operated by Downing's drilling staff under the constant supervision of WSP's technical staff.

The following photographs were taken on site and provide an overview of the equipment used on site.

Figure 8-2 Overview of Drilling Machine and Equipment

The rock was cored with a "BTW" diamond-core drill with an internal diameter of 42 mm for lengths ranging from 15.29 m to 16.16 m. The rock cores were described by a member of WSP's technical team, and the Rock Quality Designation (RQD) was recorded for each run sampled. The rock description and measured RQD values are presented on the borehole logs included in Appendix E-2.

Rock cores collected during the drilling campaign were sent to our laboratory and subjected to further visual examination by an experienced geologist.

Detailed descriptions are presented on the borehole logs in Appendix E-2. The photographic report of the rock cores is presented in Appendix E-5.

The rock samples collected during drilling works show a rock of igneous origin whose composition varies from a diorite (low proportion of alkaline feldspars) to a syenite (higher proportion of alkaline feldspars).

Rock coring recoveries in the boreholes are generally 100%. The RQD values obtained in the boreholes vary, but are mostly above 80%, indicating good to excellent rock quality.

8.3.3 ROCK CORE SAMPLES DESCRIPTION

The drilling campaign was carried out on seven sites, strategically selected along the route of the proposed road. The boreholes distributed in pairs are in three distinct geological zones, namely the Pluton de Radisson in the extreme south of the route, the Orthogneiss de Bienville in the center representing the majority of the route, and the boreholes and the zone of Archean rocks in the northern portion of the proposed road. All lithological identifications were made macroscopically with the naked eye according to the Streckeisen diagram of classification of igneous rocks, no verification using a magnifying binocular, or a microscope was carried out. The main lithologies identified were described as granitoids, with variable proportions of feldspar and plagioclase, a low percentage of quartz and very variable proportions of mafic minerals. The rocks are locally showing a more or less apparent foliation, they are sometimes cut by pegmatitic intrusions or contains mafic enclaves of variable sizes. The rocks generally show shallow and poorly developed oxidation and a low to inexistant ~~by~~ weathering. Fine pyrite in traces or in low percentage occur locally in some boreholes and seems to be associated with metamorphism. The following table describes the main characteristics of the lithologies encountered near the boreholes.

Table 8-5 Boreholes lithological descriptions summary

Borehole	Depth (m)	Main Lithologies	Textures and Structures	Geologic Zone (MERN)
R-010-F1	16.06	Quartz Syenite and quartz Monzonite	Very slight diffused foliation	Radisson Pluton 1
R-010-F2	15.36	Quartz Syenite and pegmatitic intrusions Fine pyrite traces (localy 1-4%)	Slightly foliated	Radisson Pluton 1
R-054C-F1	15.89	Quartz Syenite, quartz Monzonite and mafic enclaves	Massive	Bienville Orthogneiss 1
R-054D-F2	16.02	Quartz Syenite and mafic enclaves	Massive	Bienville Orthogneiss 1
R-110-F1	15.70	Quartz Syenite and quartz Monzonite Fine pyrite traces (localy 1-2%)	Slightly foliated	Bienville Orthogneiss 2
R-110-F2B	16.16	Quartz Syenite, pegmatitic intrusions and mafic enclaves	Massive	Bienville Orthogneiss 2
R-147-F1	15.84	Monzonite, Diorite, Monzodiorite and mafic enclaves	Slightly foliated	Bienville Orthogneiss 2
R-147-F2B	16.00	Monzonite, Monzodiorite, mafic and granitic enclaves	Slightly foliated	Bienville Orthogneiss 2
R-165-F1	15.49	Quartz Syenite	Massive	Bienville Orthogneiss 2
R-165-F2	15.29	Quartz Syenite	Massive	Bienville Orthogneiss 2
R-192-F1	15.84	Quartz Monzonite-Monzodiorite and mafic enclaves Fine pyrite traces	Slightly foliated	Archean
R-192-F2	15.57	Monzonite, quartz Monzonite and quartz Monzodiorite	Slightly foliated	Archean

During rock core logging, it was noted that boreholes corresponding to the geological zone of the Bienville Orthogneiss (boreholes R-054C, R-054D, R-110, R-147 and R-165), were mainly composed of granitic to tonalitic orthogneiss (MERN, 2022c), in which several lithological units have been described as slightly banded (foliated) granitoids. Generally, the foliation is slightly developed, therefore the rocks were not logged as metamorphic on macroscopic identification, but it is likely that some rocks identified as granitoids have undergone a certain degree of metamorphism and would therefore be orthogneisses, such as described by the MERN. Orthogneisses are rocks of igneous origin (e.g. granitoids) accompanied by mineralogical assemblage and texture modifications due to metamorphism, including a more or less developed or apparent foliation or banding. A more precise petrographic microscopic study would therefore be useful to determine more precisely the lithologies, a step that may be necessary if a complete and more detailed characterization is needed.

During the lithological description of the rock core in laboratory, two samples were chosen from each of the 12 boreholes to carry out preliminary physical tests, to verify certain intrinsic characteristics of the rocks in the form of aggregates. The sample selection was made in a way to obtain the most representative lithologies along the boreholes.

8.4 PROGRAM AND LABORATORY RESULTS

8.4.1 LABORATORY PROGRAM

8.4.1.1 *OVERBURDEN SAMPLES*

The following physical tests were performed at the WSP laboratory on representative samples of granular-appearing soils collected during the reconnaissance visit to evaluate the inherent properties of these materials.

At this stage of feasibility, grain size distribution analysis and tests to determine the inherent properties of the sampled materials (abrasion test and friability coefficient) were considered sufficient. Following some of the obtained grain size distribution analyses results, hydrometer and methylene blue value determination tests were added to the program.

The following table shows the type and number of tests performed on the loose deposit samples.

Table 8-6 Laboratory Program - Overburden Samples

TESTS	STANDARD	NUMBER OF TESTS
Grain size distribution analyses by sieving and washing with 80 µm sieve	BNQ 2501-025	21
Hydrometer analyses	BNQ 2501-025	6
Determination of the water content	BNQ 2501-170	21
Micro-Deval abrasion test, fine aggregate	LC 21-101	21
Friability coefficient, fine aggregate	LC 21-080	21
Methylene blue	LC 21-255	6

8.4.1.2 *ROCK CORE SAMPLES*

The following physical tests were performed at the WSP laboratory on rock samples collected during the drilling works in the vicinity of potential quarry sites for coarse materials.

The following table shows the type and number of tests anticipated on the rock core samples.

Table 8-7 Laboratory Program - Rock Core Samples

TESTS	STANDARD	NUMBER OF TESTS
Micro-Deval abrasion tests (grade F)	LC 21-070	24
Los Angeles abrasion test (grade B)	LC 21-400	24

8.4.2 LABORATORY TEST RESULTS

8.4.2.1 *OVERBURDEN SOIL SAMPLES*

PHYSICAL TESTS (FINE AGGREGATES)

Tables bellow presents the results of the grain size distribution analyses by sieving and hydrometer performed on the granular materials samples from the potential borrow pits. Detailed results are presented in Appendix E-3.

Table 8-8 Results of Grain Size Distribution Analyses by Sieving on Samples Taken from Potential Borrow Pits

BORROW PIT NO	SAMPLE NO	DEPTH (M)	WATER CONTENT (%)	GRAVEL > 5 mm (%)	SAND < 5 mm and >80 µM (%)	FINE PARTICLES < 80 µM (%)	DESCRIPTION
D-025A	D-025A-01	0,10-0,45	4.8	19.6	70.5	9.6	Sand, some gravel, traces of silt
B-034	B-034-02	0,20-0,60	7.1	20.7	54.8	25.0	Silty and gravelly sand
D-046	D-046-01	0,15-0,55	6.1	24.6	69.8	5.7	Gravelly sand, traces of silt
D-061	D-061-01	0,10-0,50	3.4	0	99.1	0.9	Sand, traces of silt
	D-061-02	0,10-0,50	0.8	42.4	56.9	0.3	Sand and gravel
	D-061-03	0,05-0,50	3.1	21.8	76.7	1.5	Gravelly sand, traces of silt
BV-089	BV-089-01	0,10-0,45	5.7	33.3	42.3	15.4	Gravelly sand, some silt. Presence of pebbles (about 9 %)
B-119	B-119-01	0,05-0,40	2.0	28.0	70.4	1.6	Gravelly sand, traces of silt
B-146	B-146-01	ND	3.6	8.3	91.1	0.7	Sand, traces of gravel and silt
D-164	D-164-01	0,00-0,70	2.0	3.4	95.2	1.4	Sand, traces of gravel and silt
D-181A	D-181A-01	0,00-0,90	3.1	3.9	96.0	0.1	Sand, traces of gravel
D-192	D-192-01	0,10-0,95	4.3	0.1	97.0	2.9	Sand, traces of silt
	D-192-02	0,10-0,60	4.3	0.1	96.4	3.5	Sand, traces of silt
D-201B	D-201B-01	0,10-0,50	3.3	44.9	54.3	0.8	Sand and gravel, traces of silt
95882	95882-01	0,00-0,35	21.1	3.5	96.5	0	Sand, traces of gravel

Table 8-9 Results of Grain Size Distribution Analyses by Sieving and hydrometer analysis on Samples Taken from Potentials Borrow Pits

BORROW PIT NO	SAMPLE NO	DEPTH (m)	WATER CONTENT (%)	GRAVEL > 5 mm (%)	SAND < 5 mm and >80 µM (%)	FINE PARTICLES < 80 µM and >2 µM (SILT) (%)	FINE PARTICLES < 2 µM (CLAY) (%)	DESCRIPTION
D-010	D-010-01	0,15-0,30	6,3	23,2	52,3	19,8	0,8	Gravelly and silty sand, traces of clay Presence of pebbles (around 4%)
B-017	B-017-01	0,00-0,60	6,5	17,7	50,4	29,9	2,0	Silty sand, some gravel, traces of clay
D-025A	D-025A-02	0,15-0,70	4,8	25,4	57,3	15,8	1,3	Gravelly sand, some silt, traces of clay
B-034	B-034-01	0,13-0,70	6,6	17,6	47,4	33,3	1,7	Silty sand, some gravel, traces of clay
B-110	B-110-01	0,20-0,80	7,5	17,1	43,4	25,4	1,2	Silty sand, some gravel, traces of clay Presence of pebbles (around 14%)
B-119	B-119-02	0,10-0,50	8,0	14,5	57,8	26,1	1,7	Silty sand, some gravel, traces of clay

Also, methylene blue tests were performed on some representative samples with a finer grain size. The results are presented in the table below and are compared to the requirements of the table II-4 of BNQ 2560-114 *« Travaux de génie civil – Granulats »*.

Table 8-10 Test results compared to the requirements of the table II-4 *Caractéristiques complémentaires des granulats pour matériaux de fondation, de sous fondation, de couche de roulement granulaire et d'accotement*

BORROW PIT NO	SAMPLE	TEST VALUE	REQUIREMENT
D-010	D-010-01	0,02	
B-017	B-017-01	0,12	≤ 0,20
D-025A	D-025A-02	0,03	
B-034	B-034-01	0,06	
B-110	B-110-01	0,01	
B-119	B-119-02	0,02	

All the results of the methylene blue test comply with the requirements of the BNQ 2560-114 standard. In fact, none of the results exceeded the maximum allowable value of 0.20.

The following table, taken from Table I-3 of BNQ Standard 2560-114, presents the test standards and requirements of the different intrinsic categories for fine aggregates typically used as sub-base materials in pavements. These requirements are expressed in terms of the percentage of resistance to wear of the fine aggregate using the Micro-Deval apparatus (LC 21-101) and the percentage of friability of fine aggregate (LC-080) of a granular subbase material. To join one of these categories, it requires simultaneous compliance with both specifications listed in the table below.

Table 8-11 Extract from Table I-3 Catégories de Granulats Fins selon leurs Caractéristiques Intrinsèques

INTRINSIC CHARACTERISTIC	TEST METHOD	CATEGORIES OF FINE AGGREGATES		
		1	2	3
Micro-Deval (MD), in %	LC 21-101	≤ 30	≤ 35	≤ 35
Friability, in %	LC 21-080	≤ 40	≤ 40	N/A
N/A means that there are no requirements for this characteristic				

The following Table 8-12 presents the results of the Micro-Deval abrasion and friability coefficient tests. The measured values correspond to the percentage loss of the material when subjected to physical tests. These results were then compared with the BNQ 2560-114 standard specifications shown on the previous Table 8-11.

Table 8-12 Results of Abrasion Tests (Micro-Deval) and Friability Coefficients

PIT NO	SAMPLE	MICRO-DEVAL (MD (%)	FRIABILITY (%)	CATEGORIES
D-010	D-010-01	25	18	1
B-017	B-017-01	20	20	1
D-025A	D-025A-01	20	16	1
	D-025A-02	22	16	1
B-034	B-034-01	24	24	1
	B-034-02	22	18	1
D-046	D-046-01	20	18	1
D-061	D-061-01	12	12	1
	D-061-02	8[1]	15	1
	D-061-03	46[2]	16	no categories
BV-089	BV-089-01	23[1]	20	1
B-110	B-110-01	13	19	1
B-119	B-119-01	18	15	1
	B-119-02	16	20	1
B-146	B-146-01	20	15	1
D-164	D-164-01	14	14	1
D-181A	D-181A-01	13	14	1
D-192	D-192-01	19	7	1
	D-192-02	19	14	1
D-201B	D-201B-01	13	17	1
95882	95882-01	18	13	1

[1]: According to test method LC 21-070 due to the larger portion of coarse particles.
[2]: Value of the abrasion test result, Micro-Deval, exceeds the maximum acceptable value for all categories of aggregates

All the tests results comply with the specifications of the BNQ 2560-114 standard for all categories of f aggregates except for sample D-061-03 where the value of the abrasion test result, Micro-Deval, exceeds the maximum acceptable value for all categories of aggregates.

8.4.2.2 *ROCK CORE SAMPLES*

The rock will be mined as quarries to obtain crushed stone of granular base course, granular wearing course and road shoulder materials. It will be crushed to obtain fill materials of the MG 20, MG 20B or MG-56 type or equivalent during the construction of the various road infrastructures. To carry out the physical tests (Micro-Deval and Los Angeles), the collected rock cores were first crushed. The samples were then prepared according to the target grade that is closest to the particle size of the aggregate intended for the planned work. In this case, the target grade for the Micro-Deval and Los Angeles trials was “F” and “B” respectively.

PHYSICAL TESTS (COARSE AGGREGATES)

As an indication, the following table presents the specifications of the BNQ 2560-114 standard concerning the requirements for the coarse aggregates categories, typically referring to granular base course, granular wearing course, and road shoulder materials. The categories of coarse aggregates are established in Table 8-13 according to their intrinsic characteristics of resistance to wear [micro-Deval (MD) test] according to the test method LC 21-070 and resistance to abrasion [Los Angeles (LA) test] per LC 21-400 test method. Belonging to a category requires simultaneously satisfying the three specifications MD, LA and MD + LA. The LC 21-070 method corresponds to aggregates ranging in size from 5 to 20 mm, while the LC 21-400 method applies to aggregates ranging in size from 2.5 to 80 mm, depending on the grade targeted. Detailed results are presented in Appendix E-3.

Table 8-13 Extract from Table I-1 Categories of coarse aggregates according to their intrinsic characteristics

INTRINSIC CHARACTERISTIC	TEST METHOD	COARSE AGGREGATES CATEGORIES					
		1	2	3	4	5	6
Micro-Deval (MD), in %	LC 21-070	≤ 15	≤ 20	≤ 25	≤ 30	≤ 35	≤ 40
Los Angeles (LA), in %	LC 21-400	≤ 35	≤ 45	≤ 50	≤ 50	≤ 50	≤ 50
Micro-Deval and Los Angeles (MD+LA), in %	LC 21-070 & LC 21-400	≤ 40	≤ 55	≤ 70	≤ 75	≤ 80	≤ 85

The following table presents the results of the Micro-Deval and Los-Angeles tests. These results were then compared with the BNQ 2560-114 standard specifications listed in Table 8-13, presenting the categorie for which these materials are eligible. The measured values correspond to the percentage loss of the material when subjected to physical tests.

Table 8-14 Micro-Deval and Los Angeles tests results, and eligible categories

NO.	SAMPLE	MICRO-DEVAL (MD) %	LOS ANGELES (LA) %	MICRO-DEVAL (MD) & LOS ANGELES (LA) %	ELIGIBLE CATEGORIE
R-010	R-010-F1-ECH-01	11	32	42	2
	R-010-F1-ECH-02	10	31	41	2
	R-010-F2-ECH-01	11	32	43	2
	R-010-F2-ECH-02	11	31	42	2
R-054C	R-054C-F1-ECH-01	10	28	38	1
	R-054C-F1-ECH-02	9	24	33	1
R-054D	R-054D-F2-ECH-01	10	30	40	1

NO.	SAMPLE	MICRO-DEVAL (MD) %	LOS ANGELES (LA) %	MICRO-DEVAL (MD) & LOS ANGELES (LA) %	ELIGIBLE CATEGORIE
	R-054D-F2-ECH-02	10	29	40	1
R-110	R-110-F1-ECH-01	11	31	42	2
	R-110-F1-ECH-02	9	31	42	1
	R-110-F2B-ECH-01	8	30	38	1
	R-110-F2B-ECH-02	10	32	42	2
R-147	R-147-F1-ECH-01	6	22	28	1
	R-147-F1-ECH-02	7	21	28	1
	R-147-F2B-ECH-01	8	17	25	1
	R-147-F2B-ECH-02	10	23	33	1
R-165	R-165-F1-ECH-01	7	23	30	1
	R-165-F1-ECH-02	6	25	31	1
	R-165-F2-ECH-01	6	24	30	1
	R-165-F2-ECH-02	8	25	32	1
R-192	R-192-F1-ECH-01	8	27	35	1
	R-192-F1-ECH-02	8	28	36	1
	R-192-F2-ECH-01	9	24	32	1
	R-192-F2-ECH-02	8	25	33	1

8.5 RESULTS DISCUSSION

8.5.1 MATERIALS FROM POTENTIAL GRANULAR BORRORW PITS

The following table summarizes the results obtained from the observations made during the reconnaissance visit and the laboratory test results. The pits in red represent the sites deemed unexploitable, while the pits in blue have a proportion of fine particles deeming these sites less favourable for exploitation of granular sub-base material.

The results of the grain size analysis by sedimentation revealed that only traces of clay, less than 2%, are present in the soils of the benches identified as being the least favorable. The results of the methylene blue values show the same observation, i.e. the absence (or almost) of clay in the soil samples. Nevertheless, according to the results of sieve analyses, the soils from the benches identified in blue contain a percentage of particles passing the 80 µm sieve (silt and clay) exceeding 10%. Therefore, these soils must be considered as susceptible to frost. Problems related to frost heave could occur if no amendments are made to this type of material. Under certain conditions, frost heave can cause damage to the intended pavement structure.

Moreover, according to the Unified Soil Classification System (USCS), the great majority of the materials composing the most favorable borrow pits can be classified as "SP". This type of material has favorable characteristics as a sub-base material, including good drainage, no or very low frost susceptibility, very low compressibility or swelling, and ease of compaction. In comparison with this type of material, the soils from the borrow pits identified in blue are mostly classified as "SM". Contrary to the characteristics of the soils classified as "SP", they present a lesser drainage capacity and a greater frostiness due to the greater proportion of fine particles.

Also, several of the most favourable borrow pits have samples that already meet (or nearly meet) the requirements of BNQ standard 2560-114 for MG 112 or equivalent material from a grading point of view, which may be interesting since the amendment process could be rather minimal. The borrow pits with material most similar to MG 112 are B-119, B-146, D-201B, D-061 and D-181A. The materials in borrow pit D-201B also meet (or nearly meet) the requirements of a MG 20 or equivalent material.

As for the Micro-Deval tests, they made it possible to characterize the resistance to attrition of the aggregates, while the Los Angeles tests made it possible to assess the resistance of the aggregates to fragmentation in comparison with the requirements of the BNQ 2560-114 standard. In fact, the soils comply with the specifications of the BNQ 2560-114 standard for all categories of fine aggregates except for sample D-061-03 where the value of the abrasion test result, Micro-Deval, exceeds the maximum admissible value for all categories of aggregates. Accordingly, there is primarily no constraint on the intended use of these materials within the pavement structure. However, special attention should be paid to the soils of bench D-061 since one sample out of three does not meet the specifications of the BNQ 2560-114 standard.

Finally, according to the requirements of Table II-4 of the BNQ 2560-114 standard, the quantity of organic matter must be less than or equal to 0.8% (≤ 0.8%). Although no test was carried out in the laboratory to verify the quantity of organic matter, a visual assessment was carried out on site and the organic matter content seems negligible. Of course, the organic soils found on the surface, the vegetation cover, must be removed before the exploitation of the underlying soils. The soils that will be exploited must also be free of all organic matter or follow the standard mentioned above.

Table 8-15 Summary of Potential Supply Results for the Potential Borrow Pits Investigated

BORROW PIT NO	SAMPE	TYPE OF DEPOSIT	STRATIGRAPHIC DESCRIPTION	ESTIMATED VOLUME (m^3)	QUALITATIVE POTENTIAL
D-010	D-010-01	Glacial materials	Gravelly and silty sand, traces of clay. Presence of pebbles	718,233	Medium

BORROW PIT NO	SAMPE	TYPE OF DEPOSIT	STRATIGRAPHIC DESCRIPTION	ESTIMATED VOLUME (m^3)	QUALITATIVE POTENTIAL
B-017	B-017-01	Glacial materials	Silty sand, some gravel, traces of clay.	414,108	Medium
D-025A	D-025A-01	Glacial materials	Sand, some gravel, traces of silt	945,477	Good
	D-025A-02		Gravelly sand, some silt, traces of clay.		Good
B-034	B-034-01	Glacial materials	Silty sand, some gravel, traces of clay	820,206	Medium
	B-034-02		Silty and gravelly sand		Medium
D-046	D-046-01	Glacial materials	Gravelly sand, traces of silt	1,441,590	Good
D-061	D-061-01	Fluvioglacial materials	Sand, traces of silt	53,273,565	Excellent
	D-061-02		Sand and gravel		
	D-061-03		Gravelly sand, traces of silt		Low
BV-082	-	Glacial materials	Till: Silty fine sand matrix	1,267,090	Low
BV-089	BV-089-01	Glacial materials	Gravelly sand, some silt. Presence of pebbles.	394,692	Good
B-110	B-110-01	Glaciomarine sediments	Silty sand, some gravel, traces of clay. Presence of pebbles	940,054	Medium
B-119	B-119-01	Glaciomarine sediments	Gravelly sand, traces of silt	256,510	Excellent
	B-119-02	Glaciomarine sediments	Silty sand, some gravel, traces of clay.		Medium
B-125	-	-	Bedrock seems in surface	-	Low
B-140	-	-	Bedrock seems in surface	-	Low
B-146	B-146-01	Glaciomarine sediments	Sand, traces of gravel and silt	590,331	Excellent
D-164	D-164-01	Glaciomarine sediments	Sand, traces of gravel and silt	4,366,776	Good
D-181A	D-181A-01	Glaciomarine sediments	Sand, traces of gravel	301,224	Excellent
D-192	D-192-01	Glaciomarine sediments	Sand, traces of silt	5,261,144	Good
	D-192-02		Sand, traces of silt		Good
D-198	-	-	Bedrock seems in surface	-	Low
D-201B	D-201B-01	Glaciomarine sediments	Sand and gravel, traces of silt	182,618	Excellent
D-205	-	Glaciomarine sediments	Presence of indigenous camp on site	-	-

BORROW PIT NO	SAMPE	TYPE OF DEPOSIT	STRATIGRAPHIC DESCRIPTION	ESTIMATED VOLUME (m^3)	QUALITATIVE POTENTIAL
98882	98882-01	Glaciomarine sediments	Sand, traces of gravel. Water table < 1 m deep.	-	-

8.5.2 MATERIALS FROM POTENTIAL QUARRY SITES

The requirements for the coarse aggregate category (BNQ 2560-114 standard) typically refer to granular base course, granular wearing course, and road shoulder materials. The categories of coarse aggregates have been established using Table 8-13 according to their intrinsic wear resistance characteristics [micro-Deval test (MD)] according to the LC 21-070 test method and abrasion resistance [Los Angeles (LA) test] according to test method LC 21-400. Belonging to a category requires satisfying simultaneously the three specifications MD, LA and MD + LA.

According to the results of the laboratory tests, in general, all the potential quarry sites for which a more detailed sampling was carried out by means of drilling would have good exploitation potential. Indeed, all the samples meet the minimum requirements for a category 2 material. Among the potential quarry sites that were analyzed, five quarries did not reveal any restrictions to the future use of the aggregates, i.e. the sites identified by the numbers R - 054C, R-054D, R-147, R-165 and R-192 have the best operating potential. The rock samples taken from these potential quarry sites meet the requirements for all categories of aggregates.

In addition to the laboratory tests, according to the detailed geological descriptions carried out in the WSP laboratory by an experienced geologist, the encountered rock is of igneous origin or occasionally slightly metamorphosed. This type of rock is generally considered very hard to extremely hard rock according to Table 3.5 of the Canadian Foundation Engineering Manual (MCIF, 2013) and has a good resistance to abrasion, which was also confirmed by the laboratory results.

According to the tests carried out and the results obtained, the samples generally demonstrate good mechanical properties. However, some lithologies were judged to be less suitable for aggregate quarrying, like mafic enclaves as the presence of sulphides was noted in these boreholes during the visual examination. The mafic minerals are less resistant to weathering, especially to freeze-thaw cycles and to the presence of water (chemical transformation): these minerals are generally more sensitive to these phenomena and thus are less interesting in terms of aggregate optics. Therefore, depending on the percentage of mafic minerals and sulphides present at the scale of the rock mass, some sites could potentially be less exploitable than what the lab results present,

8.5.3 OVERVIEW OF AVAILABLE MATERIAL QUANTITIES

8.5.3.1 CALCULATION OF SURPLUS AND DEFICIT OF AVAILABLE MATERIALS

Table 8-16 lists the main characteristics of the sites visited (quality, volume, etc.) as well as the material requirements of the proposed road. The area and thickness of the pits and quarries were identified by photointerpretation of satellite images via ArcGIS Pro software, using contour lines and, when available, digital LiDAR models. No surveying was done in the field. The boundaries of each site were then revised to take into account environmental constraints, such as the presence of wetlands and water bodies. In fact, a distance of at least 30 m from wetlands and water bodies was maintained around the sites, in accordance with article 121 of the guide to the application of the regulation respecting the sustainable development of forests in the domain of the State (MFFP, 2022).

For each site, the volume of exploitable material was calculated by multiplying the area by the estimated average thickness of the site. The site descriptions refer to the results of the grain size distribution (borrow pit) and macroscopic (quarry) after fieldwork.

The road engineering team defined the quantities of material required for the proposed road construction. For this purpose, the proposed alignment (alternative 2) was divided into 20 segments of 10 km. For each section, the estimated volume of the investigated quarry sites and borrow pits was compared to the granular material requirement (Appendix E-1, Map 6). It should be noted that rock cuttings will also be used for road construction and were considered in the net granular material requirement calculation (V fill required - V rock cuttings). The 2nd class cuttings constitute the soft deposit layer resting on the bedrock. Although a certain proportion of this material may be used for road construction, it has not been considered in the material surplus/deficit calculations, as further investigations will be required to assess its quality for use as granular material (granular base material and/or granular sub-base material). Finally, the material surplus/deficit for road construction was calculated (V pits + V quarries – V net requirement). Generally, 5 segments out of 20 are found to have a granular material deficit of about 70,000 m3 to 500,000 m3. These segments are located in the northern portion of the proposed alignment, i.e. in the last two-thirds of the alignment north of the major borrow pit encountered near km 61. Surplus material is estimated for the other 15 segments and can be used in segments where a potential shortage is anticipated.

Table 8-16 Comparison of Estimated Material Volumes and Road Construction Requirements

Segment No	Characteristics of the visited sites					Characteristics of the proposed road				
	Potential Quarry No	Potential Pit No	Sample No	Preliminary Description	Estimated Volume (m^3)	Backfill required (m^3)	Excavation 2nd Class	Rock Excavation	Net Requirement (m^3)	Material Surplus/Deficit (m^3)
TR_01	2393		2393-01	Quartz monzonite	1,095,310	752,124	14,505	232,650	519,474	**1,786,384**
	R-010		R-010-01	Quartz monzonite	1,210,548					
			R-010-02	Quartz monzonite						
TR_02		D-010	D-010-01	Gravelly and silty sand. Presence of pebbles	718,233	493,227	59,807	177,961	315,266	**817,075**
		B-017	B-017-01	Silty sand, some gravel	414,108					
TR_03	R-025		R-025-01	Granodiorite	329,112	305,758	55,816	39,800	265,958	**1,008,631**
		D-025A	D-025A-01	Sand, some gravel, traces of silt	945,477					
			D-025A-02	Gravelly sand, some silt						
TR_04	R-033		R-033-01	Granitic gneiss	683,946	341,191	27,042	7,020	334,171	**1,169,981**
		B-034	B-034-01	Silt, some gravel	820,206					
			B-034-02	Silty and gravelly sand						
TR_05	R-046		R-046-01	Granite	979,800	551,497	26,408	28,662	522,835	**1,898,555**
			R-046-02	Granitic pegmatite						
		D-046	D-046-01	Gravelly sand, traces of silt	1,441,590					
TR_06	R-054C		R-054C-01	Pegmatitic quartz syenite	2,785,944	256,032	41,749	115,698	140,334	**18,700,320**
	R-054D		R-054D-02	Pegmatitic quartz syenite	16,054,710					
Var_02_TR_01		D-061	D-061-01	Sand, traces of silt	53,273,565	101,543	65,468	7,272	94,271	**53,179,294**
			D-061-02	Sand and gravel						
			D-061-03	Gravelly sand, traces of silt						
Var_02_TR_02						102,770	86,570	23,772	78,998	**(78,998)**
Var_02_TR_03		BV-082	-	Till: Silty fine sand matrix	1 267 090	168,837	49,243	9,902	158,935	**235,757**
		BV-089	BV-089-01	Gravelly sand, some silt. Presence of pebbles.	394,692					
Var_02_TR_04	RV-096		RV-096-01	Granitic gneiss	4,415,325	122,331	80,874	37,473	84,858	**4,330,467**
			RV-096-02	Granitic gneiss						
Var_03_TR_01						198,966	86,218	84,178	114,788	**(114,788)**
Var_03_TR_02	R-110		R-110-01	Granite	5,473,296	407,809	97,550	34,660	373,149	**15,440,531**
	R-118		R-118-01	Monzonite to Quartz syenite	9,143,820					
		B-110	B-110-01	Silty sand, some gravel. Presence of pebbles	940,054					
		B-119	B-119-01	Gravelly sand, traces of silt	256,510					
			B-119-02	Silty sand, some gravel						
TR_13	R-129A		R-129A-01	Granitic gneiss	3,815,735	254,316	72,301	76,977	177,339	**3,638,396**
		B-125	-	Bedrock seems in surface						
TR_14		B-140	-	Bedrock seems in surface		452,083	101,528	80,302	371,781	**(371,781)**

Segment No	Characteristics of the visited sites					Characteristics of the proposed road				
	Potential Quarry No	Potential Pit No	Sample No	Preliminary Description	Estimated Volume (m^3)	Backfill required (m^3)	Excavation 2nd Class	Rock Excavation	Net Requirement (m^3)	Material Surplus/Deficit (m^3)
TR_15	R-140B		R-140B-01	Quartz diorite	5,919,280	275,462	83,629	106,041	169,421	**16,243,590**
	R-147		R-147-01	Quartz diorite	9,903,400					
			R-147-02	Monzodiorite						
			R-147-03	Quartz monzonite						
		B-146	B-146-01	Sand, traces of gravel and silt	590,331					
TR_16						216,677	34,902	143,277	73,400	**(73,400)**
TR_17	R-165		R-165-01	Quartz syenite	3,324,860	303,476	15,497	10,403	293,073	**7,398,563**
			R-165-02	Quartz syenite						
		D-164	D-164-01	Sand, traces of gravel and silt	4,366,776					
TR_18						535,472	8,314	20,332	515,140	**(515,140)**
TR_19	R-181A		R-181A-01	Quartz syenite	3,088,095	447,038	15,323	8,795	438,243	**2,951,076**
			R-181A-02	Quartz monzonite						
		D-181A	D-181A-01	Sand, traces of gravel	301,224					
TR_20	R-192		R-192-01	Quartz diorite to Tonalite	35,436,528	2,051,826	4,800	183,755	1,868,071	**50,229,789**
			R-192-02	Quartz monzonite						
	R-202A		R-202A-01	Granitic gneiss	11,217,570					
			R-202A-02	Granitic gneiss						
			R-202A-03	Quartz syenite						
		D-192	D-192-01	Sand, traces of silt	5,261,144					
			D-192-02	Sand, traces of silt						
		D-198	-	Bedrock seems in surface						
		D-201B	D-201B-01	Sand and gravel, traces of silt	182,618					
		D-205	-	Aboriginal camp on site						
		98882	98882-01	Sand, traces of gravel. Water table < 1m deep.						
TOTAL					**184,783,807**	**8,338,435**	**1,027,544**	**1,428,929**	**6,909,506**	**176,983,181**
Surplus										
Deficit										

8.6 RECOMMENDATIONS AND NEXT STEPS

If the proposed infrastructures (all or separately) are deemed valuable by the communities, there is still a good amount of work to be carried out before construction works take place; this study is only the beginning of all the steps required to complete a project of this scale and this nature. Detailed analyses, alignment optimization and further site data collection should be carried out in coordination with other preparatory studies that will feed the conceptual design, and further detailed engineering and construction works. More specifically, the further development of geotechnical studies will involve a more detailed field campaign with different type of survey (boreholes, in situ tests) and additional investigations to:

- Evaluate the bearing capacity of soils and bedrock at the location of the proposed infrastructures;
- Evaluate the nature and properties of infrastructure soils or bedrock if encoutered along the proposed route.

Regarding the granular materials, the investigation of potential borrow pits, the rock masses, and the carried-out laboratory tests are considered preliminary and have several limitations. During subsequent studies, more boreholes and more detailled characterization of potential aggregate quarries, as well as a potential borrow pits, will be necessary for the completion of the various proposed road works, in order to comply with the characteristics and evaluation criteria of the various current standards. According to government standards, a non-exhaustive list of subsequent investigation works, is listed in the sub-sections below.

8.6.1 SUBBASE GRANULAR MATERIALS

For sub-base granular materials, additional tests to confirm the characteristics of these materials should be carried out. Not limited to, these characteristics are:

- Intrinsic characteristics: degradation of fine aggregate due to attrition according to LC 21-101 standard and percentage of friability according to LC 21-080 standard,
- Grain size distribution analysis by sieving according to LC 21-040 standard,
- Complementary characteristics such as percentage of organic matter according to LC 31-228 standard and methylene blue value according to LC 21-255.

8.6.2 BASE GRANULAR MATERIALS

For base granular materials, additional tests to confirm the characteristics of these materials should be carried out. Not limited to, these characteristics are :

- Intrinsic characteristics: degradation of coarse aggregate due to attrition according to LC 21-070 standard and degradation of coarse aggregate due to abrasion according to LC 21-400 standard;
- Manufacturing characteristics: Grain size distribution analysis by sieving according to LC 21-040 standard, flat and elongated particles according to LC 21-265;
- Complementary characteristics (only for materials from sand pits or gravel pits) such as percentage of organic matter according to LC 31-228 standard and methylene blue value according to LC 21-255.

8.6.3 AGGREGATES FOR CONCRETE OF BRIDGES AND CULVERTS

The construction of the road will require the construction of bridges and culverts. Concrete for these bridges and culverts should meet the requirements of the CSA A23.1:19 standard. The aggregates to be used in the mix to obtain the concretes should meet the requirements of Table 12 of the CSA.1:19 standard. In addition to all the requirements of Table 12 of the CSA.1:19 standard, granular materials should meet the following requirements:

- Macroscopic petrographic analysis (CSA A23.2-15A standard);
- Petrographic analysis in thin sections, in order to identify the different mineralogical phases in transmitted light and in reflected light (CSA A23.2-15A standard);
- Chemical analyses (4 elements), to determine the total of sulfur and sulphates, in order to evaluate the potential of chemical reactivity (CSA A23.2-15A standard);
- Classification of petrographic number (PN), to determine the petrographic quality coefficient of each type of rock (BNQ 2560-114 standard);
- Los Angeles: CSA A23.2-16A and 17A standards;
- Micro-Deval: CSA A23.2-23A and 17A standards;
- Unconfined Freeze-Thaw Loss: CSA A23.2-24A standards.

9 CONCLUSION

If the proposed infrastructures (all or separately) are deemed valuable by the communities, there is still a good amount of work to be carried out before construction works take place; this study is only the beginning of all the steps required to complete a project of this scale and this nature. Detailed analyses, alignment optimization and further site data collection should be carried out in coordination with other preparatory studies that will feed the conceptual design, and further detailed engineering and construction works. More specifically, the further development of geotechnical studies will involve characterizing the deposits and obtaining the soil geotechnical parameters for each infrastructure, to identify any features or critical areas, and to locate all potential borrow sites.

9.1 PRE-FEASIBILITY INFRASTRUCTURE COMPONENTS

9.1.1 RAILWAY: RUPERT TO LA GRANDE (PHASE II)

Area SA1 involves the study of a rail corridor along the existing Billy-Diamond Highway. Overall, the distribution of unconsolidated deposits in the rail corridor (1 km buffer on either side of the proposed alignment) approximately consists of :

- 40% granular soil (sand, gravel and till);
- 25% organic soils;
- 20% rock;
- 15% cohesive soils (silt and clay).

Constraints to the railway line crossing have been identified within the corridor including the planned railroad line and 200 m on either side, which include:

- Fine deep-water glaciomarine sediments (clay deposits) that are mainly found in the northern part of the alignment;
- Three areas of moderate slopes (B-478, B-461 and B-408 in the GIS database) and three areas of steep slopes (B-394, B-412 and B-473) intersecting the central portion of the alignment;
- 8 water bodies intersected by the rail corridor, including the main watercourses of the Pontax, Eastmain and Beaver rivers;
- 16 heavily developed peatlands intersecting the alignment, including five in the center and 11 in the north;
- Five power lines intersected by the alignment (B-393, B-473, B-525, B-544 and B-610 in the GIS database), three of which are in the northern part of the area and the two others are in the center.

Based on the type of deposits identified on the proposed alignment and their corresponding proportions, the geotechnical issues to be addressed are primarily the following:

- Low bearting capacity if it consists of loose granular deposits (sand, gravel, or till) or soft cohesive deposits (silt or clay);
- Over-excavation of low bearing capacity soils requiring the use of controlled backfill;
- Susceptibility to freezing (freeze-thaw cycle) (fine soils);
- Long-term settlements (consolidation settlements in cohesive deposits);
- The risks of cracking caused by swelling/drying cycles of clay soils;
- Drainage problems during excavation work, hence the need to install a drainage system in the short and/or long term;

- Liquefaction potential if granular soils are loose, saturated and if the granulometry is tight (mostly composed of same particle size): soil improvement techniques can be anticipated (costly);
- Excavation challenges are to be considered if the till deposit includes a significant proportion of boulders (boulder till), hence the need to use backfill;
- The need for rock excavation by drilling or blasting, which will depend on the road profile and bedrock topography at outcropping rock locations along the alignment;

Potential sources of granular material identified along the proposed railway are as follows:

- Various gravel and crushed stone operations in the southern portion and northern end of the study area (GESTIM data);
- Some sand mining and moraine deposits in the southern portion and northern end of the study area (GESTIM data);
- Fluvioglacial sediments recorded in the northern and central portions of the study area (SIGEOM);
- Reworked till recorded southeast of the study area (SIGEOM).

The quality and quantity of materials available at these sites will need to be investigated in the next stages of the project.

9.1.2 ROADWAY & RAILWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASES II & III)

Area SA2 involves the study of a road corridor and a rail corridor along the proposed road corridor, as well as the study of the development of a sea harbour near Kuujjuarapik. Overall, the overburden layout along the proposed road corridor (Alternative 1 and Alternative 2 combined; 1 km buffer on either side of the proposed alignments) consists of approximately:

- Slightly more than 50% till and sand and gravel deposits;
- About 25% of rock;
- About 20 % of clay soils (silt and clay) and organic soils.

Constraints to the crossing of the proposed structures have been identified within the corridor comprising the proposed road and railway and 200 m on either side, which incude:

- Fine deep-water glaciomarine sediments (clay deposits) located mainly in the central and northern parts of the transect;
- Three rocky areas of moderate slope (km 48, km 70 and km 197), two of which are located in the south-central part of the corridor and the third at the northern end;
- 22 and 19 water bodies intersected by road and rail corridors respectively, including the main watercourses of the Piagochioui River to the south and the Great Whale River to the north;
- Two heavily developed and recorded peatlands in the center of the corridor (km 87 and km 129.5);
- A power line intersected by the alignment at the southern end of the section.

Based on the type of deposits identified on the proposed alignment and their corresponding proportions, the geotechnical issues to be addressed are primarily the following:

- Low bearing capacity if it consists of loose granular deposits (sand, gravel, or till) or soft cohesive deposits (silt or clay);
- Over-excavation of low bearing capacity soils requiring the use of controlled backfill;
- Susceptibility to freezing (freeze-thaw cycle) (fine soils);
- Long-term settlements (consolidation settlements in cohesive deposits);

- The risks of cracking caused by the swelling/drying of clay soils;
- Drainage issues during excavation work, hence the need to install a drainage system in the short and/or long term;
- Liquefaction potential if granular soils are loose, saturated and if the granulometry is tight (mostly composed of same particle size): soil improvement techniques can be anticipated (costly);
- Excavation challenges are to be considered if the till deposit includes a significant proportion of boulders (boulder till), hence the need to use backfill;
- The need for rock excavation by drilling or blasting will depend on the road profile and bedrock topography at outcropping rock locations along the alignment;

Potential sources of granular materials identified along the proposed railway are the following:

- Two sand and gravel deposits of more than 500,000 m³ and 2.5 M m³ in the southern portion of the transect, near Lake Awahagats (Poly-Géo inc., 2013);
- Several sand and gravel deposits between 50,000 and 500,000 m³ in the northern portion of the road, near Benoît and Mach lakes (Poly-Géo inc., 2013);
- A sand and gravel deposit of more than 500,000 m³ located on the south shore of the Great Whale River, at the northern end of the road (Poly-Géo inc., 2013);
- Several till deposits are located throughout the transect and may fill in areas where granular material sources are more limited, i.e. in the southern and central portions of the proposed road;
- 13 granular deposit sites, consisting of five existing sand pits, two existing quarries, and six potential quarries identified at the northern end of the area near the village of Kuujjuarapik (WSP, 2017);
- Some areas of fluvioglacial sediments, mainly on the west side of the proposed road (SIGEOM).
- Several borrow pits and quarries with high potential for exploitation along the proposed road alignment (Alternative 2) investigated during the field campaign conducted by the WSP team in summer 2022.

9.1.3 ROUTE 167: UPGRADE & EXTENSION TO TRANS-TAIGA (PHASE II)

Area SA3 includes the extension of Route 167 to the Trans-Taiga Highway. Overall, the distribution of unconsolidated deposits in the proposed road corridor (1 km buffer on either side of the proposed alignment) approximately consists of :

- About 100% till deposit and to a lesser extent sand and gravel;
- Less than 1% organic soil and rock.

Constraints to the crossing of the proposed road have been identified within the corridor comprising the proposed road and 200 m on either side, which include:

- Six rocky areas of moderate slopes and four areas of steep slopes scattered throughout the corridor understudy;
- 20 major rivers or water bodies crossed by the road corridor;
- Eight more heavily developed peatlands scattered throughout the territory.

Since most of the road alignment is covered by till deposits with less than 1% of organic soils and rock, the geotechnical issues in this area should be limited to the following:

— Low bearing capacity issues in the case of recession till whose matrix is composed mainly of silt and/or clay);
— Reworking of excavation surfaces if the till deposit includes a certain proportion of fine particles (silt and clay), hence the need to protect the bottom of the excavation (by a granular layer or by a layer of lean concrete);
— Liquefaction potential if soils are loose, saturated and if the granulometry is tight (mostly composed of same particle size): soil improvement techniques can be anticipated (costly);
— Excavation challenges are to be considered if the till deposit includes a significant proportion of boulders (boulder till), hence the need to use backfill.

Potential sources of granular material identified along the proposed railroad are as follows:

— 21 gravel borrow pits at the southern end of the alignment (GESTIM);
— Five borrow pits, including two gravel pits, two sand pits and one crushed stone pit at the north end of the alignment (GESTIM);
— Several fluvioglacial deposits located on either side of the proposed road, primarily at the southern end and in the central and northern portions of the study area (SIGEOM);
— Several till deposits cover most of the study area and may fill in areas where granular material sources are more limited.

9.2 FEASIBILITY INFRASTRUCTURE COMPONENT

9.2.1 ROADWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK (PHASE II)

The purpose of the geotechnical characterization in the feasibility phase was to investigate the potential quantity and quality of the exploitable materials that make up the potential borrow pits and potential quarry sites that could be used for the road construction.

A preliminary reconnaissance visit was made to sample the soils of the previously selected borrow pits for laboratory analyses and to evaluate their exploitation potential. This visit also allowed for the examination of potential quarries and the collection of hand samples of rock for the selection of sites with the highest exploitation potential.

A more detailed investigation was carried out a few weeks later by means of a drilling campaign in order to sample sufficient rock cores for laboratory tests to evaluate their intrinsic properties.

The analysis of the results identified a potential surplus of materials on the majority of the proposed road (15 sections out of 20, each 10 km long). However, five sections are characterized by a deficit in granular materials in the central and northern portions of the alignment. This lack of material is explained by the fact that no borrow pits or potential quarry sites were investigated in this area or, in the case of segment 14, the pit visited (B-140 at km 140) proved to be non-exploitable. Surplus materials from the neighbouring sections could easily cover the deficits of the 5 segments. However, an increase in production costs will be required due to the travel distance required for transporting these materials.

It should be noted that a large proportion of the material requirements will be met by quarry sites, which are distributed along the entire road alignment and offer significant volumes of exploitable materials. In fact, the main lithologies identified were described as being granitoids, with variable proportions of feldspar and plagioclase, a low percentage of quartz and very variable proportions of mafic minerals, which generally represents a good rock quality. The borrow pits are smaller in size and are often further apart along the proposed road.

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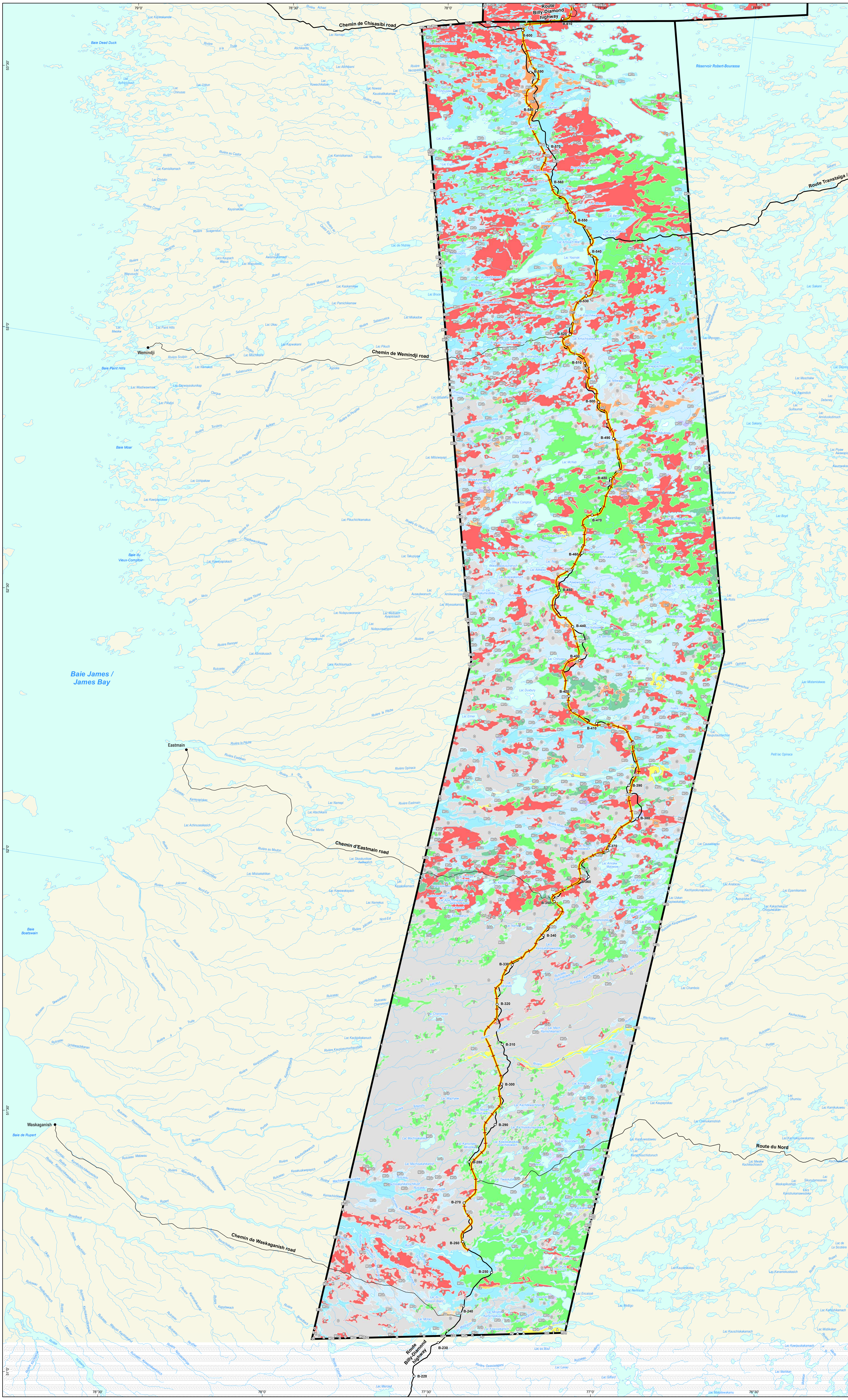
APPENDIX

A

MAPS OF MORPHO-SEDIMENTARY AREAS

APPENDIX

A-1 *MAP 1 – SA1*



Dépôts sédimentaires / Sedimentary Deposit

- A — Alluvion non différenciée / Alluvial deposit or alluvium (undifferentiated)
- Ap — Alluvion actuelle / Recent alluvial deposit
- C — Dépôt de versant non différencié / Undifferentiated slope deposit
- Ce — Dépôt d'éboulis / Rockfall deposit
- Ed — Sédiment éolien / Eolian sediment
- Go — Sédiment d'épandage proglaciaire subaérien / Subaerial outwash sediment
- Gs — Sédiment d'épandage proglaciaire subaquatique / Subaquatic outwash sediment
- Gx — Sédiment juxtaglaciaire / Ice-proximal sediment
- GxT — Sédiment de la moraine frontale / Frontal moraine sediment
- H — Dépôt anthropogénique / Antropogenic deposit
- LGa — Sédiment glaciolacustre fin d'eau profonde / Deep-water fine-grained glaciolacustrine sediment
- LGb — Sédiment glaciolacustre littoral et prélittoral / Coastal and pre-coastal glaciolacustrine sediment
- LGd — Sédiment glaciolacustre deltaïque/prodeltaïque / Deltaic and prodeltaic glaciolacustrine sediment
- MGa — Sédiment glaciomarin fin d'eau profonde / Deep-water fine-grained glaciomarine sediment
- MGb — Sédiment glaciomarin littoral et prélittoral / Coastal and pre-coastal glaciomarine sediment
- MGd — Sédiment glaciomarin deltaïque et prodeltaïque / Deltaic and prodeltaic glaciomarine sediment
- O — Sédiment organique non différencié / Undifferentiated organic sediment
- R — Roche en place non différenciée / Undifferentiated bedrock
- T — Till non différencié / Undifferentiated till
- Tf — Till de fusion ou d'ablation / Melt-out or ablation till

Limite / Limit

Zone d'étude / Study area

Infrastructure / Infrastructure

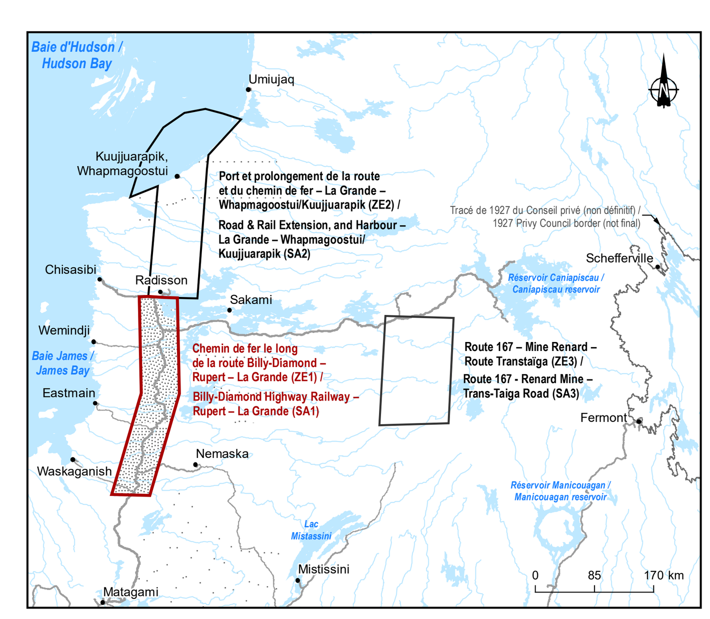
B-610 — Route Billy-Diamond et borne kilométrique / Billy-Diamond highway and kilometre point

Composante projet / Project Component

Chemin de fer projeté / Proposed railway

Note: Les alignements proposés ne sont pas finaux / The proposed alignments are not final

La précision des limites et les mesures montrées sur ce document ne doivent pas servir à des fins d'ingénierie ou de délimitation foncière. Aucune analyse foncière n'a été effectuée par un arpenteur-géomètre. / The accuracy of the limits and the measurements shown in this document should not be used for engineering purposes or land delimitation. No property analysis was carried out by a land surveyor.



LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 1 - ZE1 Zones morpho-sédimentaires

MAP 1 - SA1 Morpho-sedimentary Zones

Sources :
Adresse Québec, MERN, 2020
BDTA, 1/250 000, MRN Québec, 2002
SIGEOM, Système d'information géominière, 2021

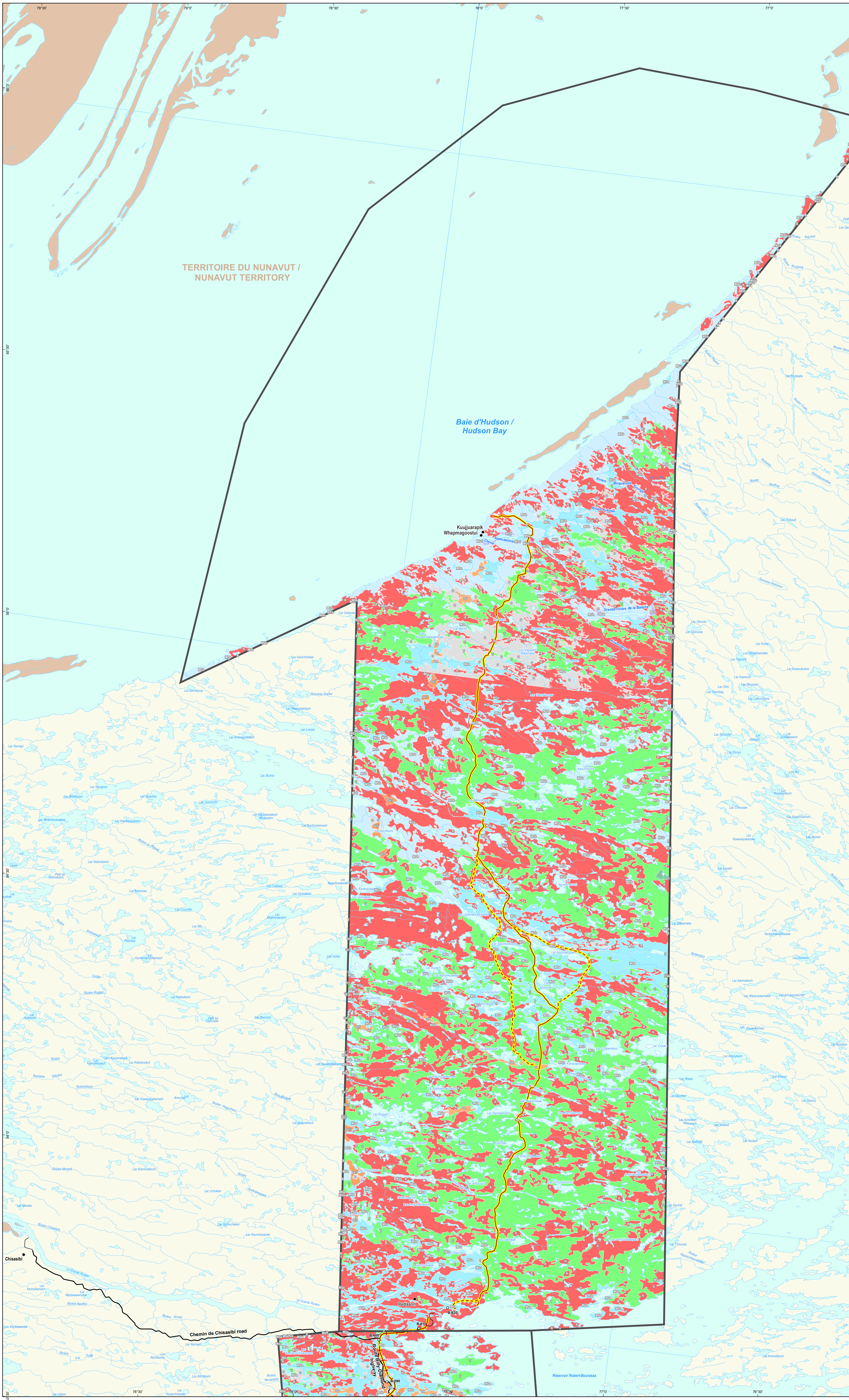
0 3,55 7,1 10,65 km
Lambert, NAD83

Février / February 2023

Préparation / Prepared by : C. Lefebvre-Fortier
Dessin / Drawn by : J.-M. Tremblay
Approbation / Approved by : G. Beauchamp
211_08415_00_NT10_aA_c1_ze1_depotsedim_230223.mxd

APPENDIX

A-2 *MAP 2 – SA2*



Dépôts sédimentaires / Sedimentary Deposit

A	Alluvion non différenciée / Alluvial deposit or alluvium (undifferentiated)
Ap	Alluvion actuelle / Recent alluvial deposit
C	Dépôt de versant non différencié / Undifferentiated slope deposit
Ce	Dépôt d'éboulis / Rockfall deposit
Ed	Sédiment éolien / Eolian sediment
Go	Sédiment d'épandage proglaciaire subaérien / Subaerial outwash sediment
Gs	Sédiment d'épandage proglaciaire subaquatique / Subaquatic outwash sediment
Gx	Sédiment juxtaglaciaire / Ice-proximal sediment
GxT	Sédiment de la moraine frontale / Frontal moraine sediment
H	Dépôt anthropogénique / Antropogenic deposit
LGa	Sédiment glaciolacustre fin d'eau profonde / Deep-water fine-grained glaciolacustrine sediment
LGb	Sédiment glaciolacustre littoral et prélittoral / Coastal and pre-coastal glaciolacustrine sediment
LGd	Sédiment glaciolacustre deltaïque/prodeltaïque / Deltaic and prodeltaic glaciolacustrine sediment
MGa	Sédiment glaciomarin fin d'eau profonde / Deep-water fine-grained glaciomarine sediment
MGb	Sédiment glaciomarin littoral et prélittoral / Coastal and pre-coastal glaciomarine sediment
MGd	Sédiment glaciomarin deltaïque et prodeltaïque / Deltaic and prodeltaic glaciomarine sediment
O	Sédiment organique non différencié / Undifferentiated organic sediment
R	Roche en place non différenciée / Undifferentiated bedrock
T	Till non différencié / Undifferentiated till
Tf	Till de fusion ou d'ablation / Melt-out or ablation till

Limite / Limit

Zone d'étude / Study area

Infrastructure / Infrastructure

B-610 Route Billy-Diamond et borne kilométrique / Billy-Diamond highway and kilometre point

Composante projet / Project Component

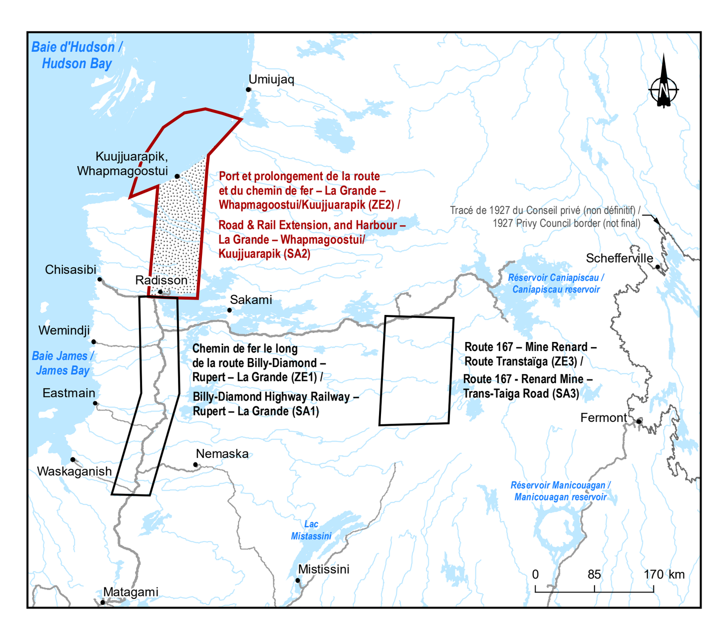
Route projetée / Proposed road

Variante de la route projetée / Proposed road alternative

Chemin de fer projeté / Proposed railway

Note: Les alignements proposés ne sont pas finaux / The proposed alignments are not final

La précision des limites et les mesures montrées sur ce document ne doivent pas servir à des fins d'ingénierie ou de délimitation foncière. Aucune analyse foncière n'a été effectuée par un arpenteur-géomètre. / The accuracy of the limits and the measurements shown in this document should not be used for engineering purposes or land delimitation. No property analysis was carried out by a land surveyor.



LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 2 - ZE2 Zones morpho-sédimentaires

MAP 2 - SA2 Morpho-sedimentary Zones

Sources :
Adresse Québec, MERN, 2020
BDTA, 1/250 000, MRN Québec, 2002
SIGEOM, Système d'information géominière, 2021

0 3,55 7,1 10,65 km
Lambert, NAD83

Février / February 2023

Préparation / Prepared by : C. Lefebvre-Fortier
Dessin / Drawn by : D. Gagné
Approbation / Approved by : G. Beauchamp
211_08415_00_NT10_aA_c2_ze2_depotsedim_230223.mxd

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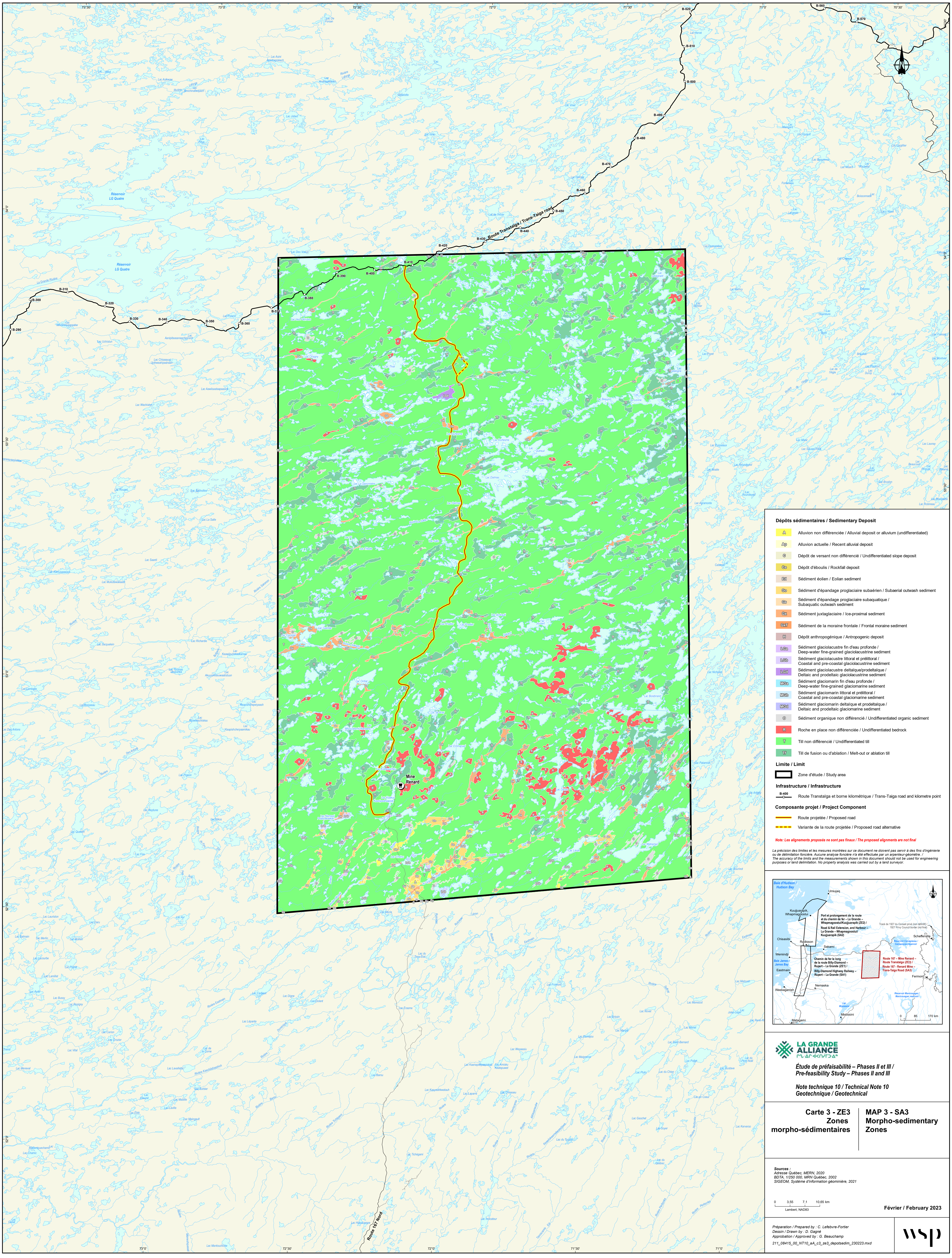
APPENDIX

A-3 *MAP 3 – SA3*

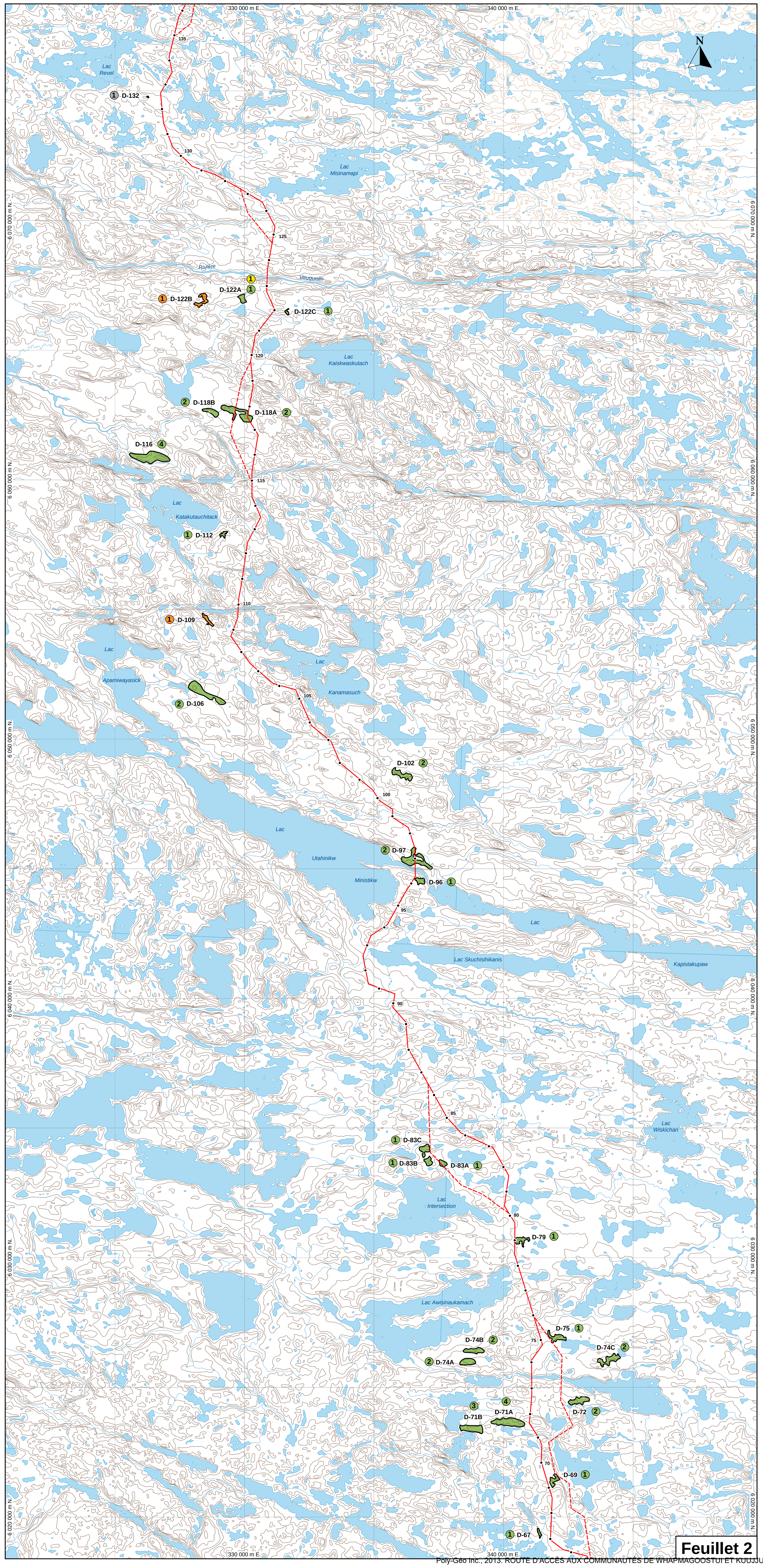


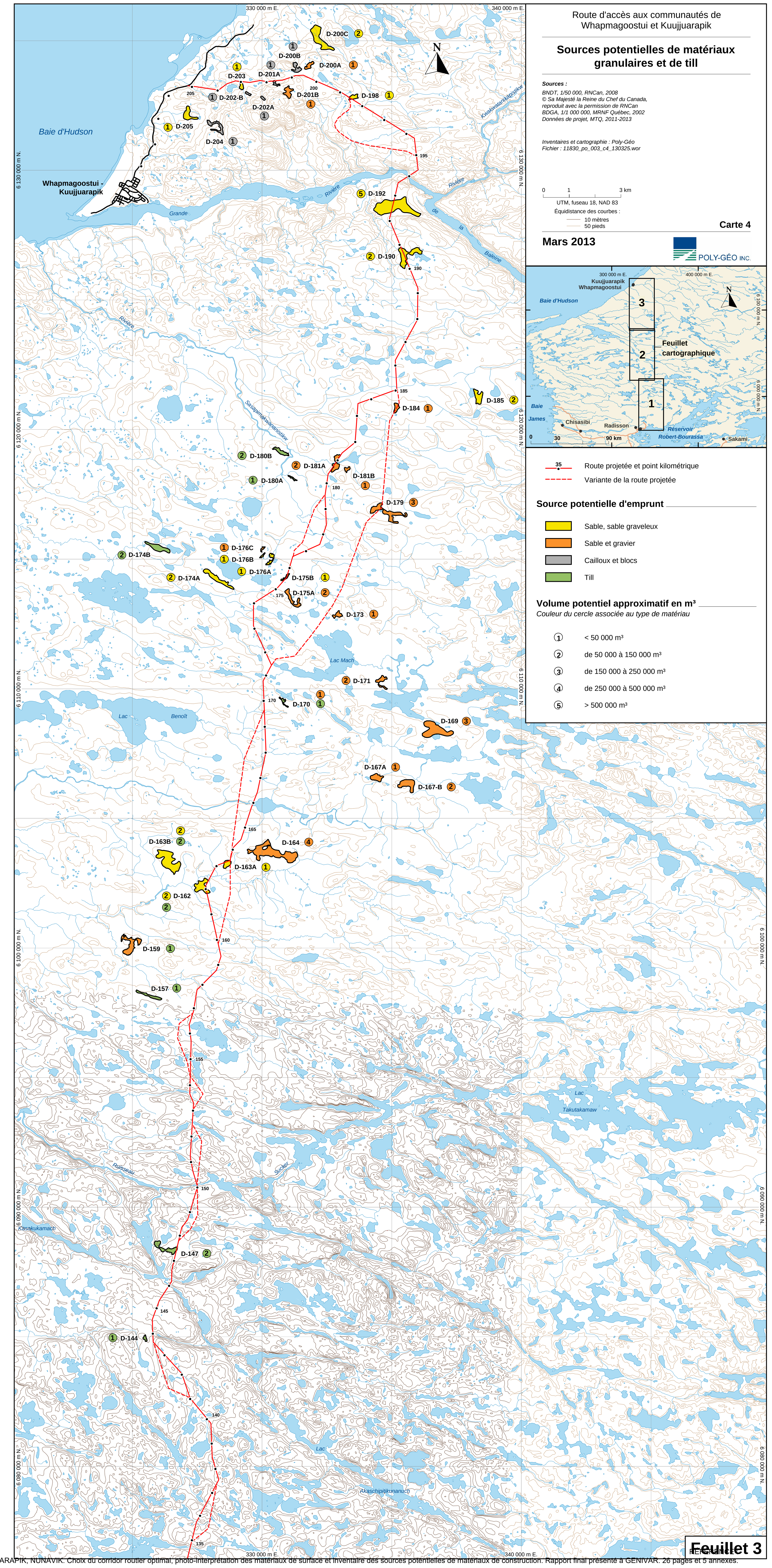
Route Transtaïga / Trans-Taiga road
Réservoir LG Quatre
Mine Renard
Route 167 Nord
Dépôts sédimentaires / Sedimentary Deposit
A Alluvion non différenciée / Alluvial deposit or alluvium (undifferentiated)
Ap Alluvion actuelle / Recent alluvial deposit
C Dépôt de versant non différencié / Undifferentiated slope deposit
Ce Dépôt d'éboulis / Rockfall deposit
Ed Sédiment éolien / Eolian sediment
Go Sédiment d'épandage proglaciaire subaérien / Subaerial outwash sediment
Gs Sédiment d'épandage proglaciaire subaquatique / Subaquatic outwash sediment
Gx Sédiment juxtaglaciaire / Ice-proximal sediment
GxT Sédiment de la moraine frontale / Frontal moraine sediment
H Dépôt anthropogénique / Antropogenic deposit
LGa Sédiment glaciolacustre fin d'eau profonde / Deep-water fine-grained glaciolacustrine sediment
LGb Sédiment glaciolacustre littoral et prélittoral / Coastal and pre-coastal glaciolacustrine sediment
LGd Sédiment glaciolacustre deltaïque/prodeltaïque / Deltaic and prodeltaic glaciolacustrine sediment
MGa Sédiment glaciomarin fin d'eau profonde / Deep-water fine-grained glaciomarine sediment
MGb Sédiment glaciomarin littoral et prélittoral / Coastal and pre-coastal glaciomarine sediment
MGd Sédiment glaciomarin deltaïque et prodeltaïque / Deltaic and prodeltaic glaciomarine sediment
O Sédiment organique non différencié / Undifferentiated organic sediment
R Roche en place non différenciée / Undifferentiated bedrock
T Till non différencié / Undifferentiated till
Tf Till de fusion ou d'ablation / Melt-out or ablation till
Limite / Limit
Zone d'étude / Study area
Infrastructure / Infrastructure
B-400
Route Transtaïga et borne kilométrique / Trans-Taiga road and kilometre point
Composante projet / Project Component
Route projetée / Proposed road
Variante de la route projetée / Proposed road alternative
Note: Les alignements proposés ne sont pas finaux / The proposed alignments are not final
La précision des limites et les mesures montrées sur ce document ne doivent pas servir à des fins d'ingénierie ou de délimitation foncière. Aucune analyse foncière n'a été effectuée par un arpenteur-géomètre. / The accuracy of the limits and the measurements shown in this document should not be used for engineering purposes or land delimitation. No property analysis was carried out by a land surveyor.
Baie d'Hudson / Hudson Bay
Baie James / James Bay
Route 167 - Renard Mine – Route Transtaïga (ZE3) / Route 167 - Renard Mine – Trans-Taiga Road (SA3)
Réservoir Manicouagan / Manicouagan reservoir
0 85 170 km
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Geotechnique / Geotechnical
Carte 3 - ZE3
Zones morpho-sédimentaires
MAP 3 - SA3
Morpho-sedimentary Zones
Sources :
Adresse Québec, MERN, 2020
BDTA, 1/250 000, MRN Québec, 2002
SIGEOM, Système d'information géominière, 2021
0 3,55 7,1 10,65 km
Lambert, NAD83
Février / February 2023
Préparation / Prepared by : C. Lefebvre-Fortier
Dessin / Drawn by : D. Gagné
Approbation / Approved by : G. Beauchamp
211_08415_00_NT10_aA_c3_ze3_depotsedim_230223.mxd

APPENDIX

B

SHEETS 1 TO 3 - POTENTIAL SOURCES OF GRANULAR MATERIAL AND TILL



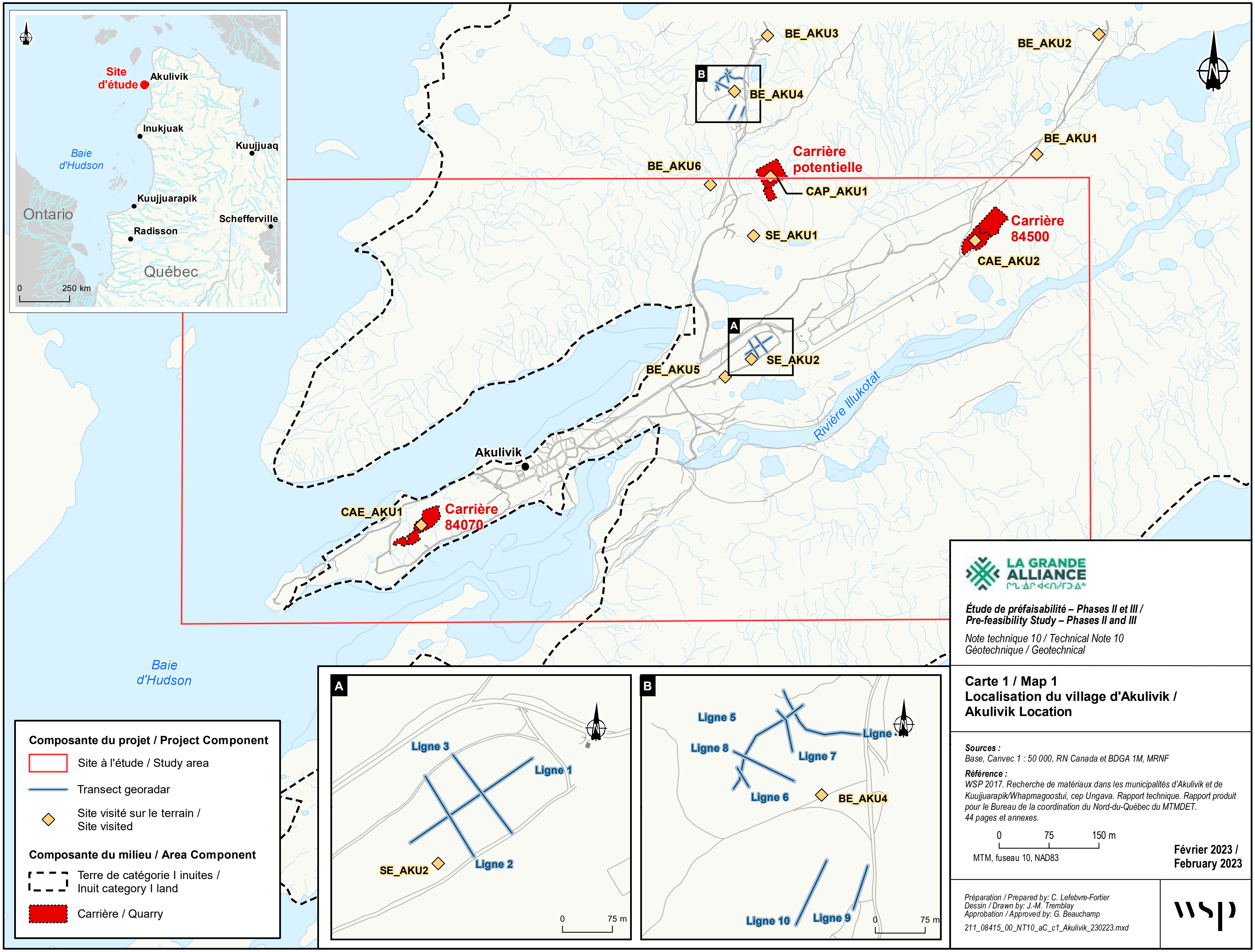


Poly-Géo Inc., 2013. ROUTE D'ACCÈS AUX COMMUNAUTÉS DE WHAPMAGOOSTUI ET KUUJJUARAPIK, NUNAVIK. Choix du corridor routier optimal, photo-interprétation des matériaux de surface et inventaire des sources potentielles de matériaux de construction. Rapport final présenté à GENIVAR. 26 pages et 5 annexes.

APPENDIX

C

POTENTIAL SOURCES OF GRANULAR DEPOSITS NEAR THE VILLAGE OF KUUJJUARAPIK


Site d'étude
Akulivik
Inukjuak
Kuujjuaq
Baie d'Hudson
Kuujjuarapik
Ontario
Schefferville
Radisson
Québec
0 250 km
BE_AKU3
BE_AKU2
B
BE_AKU4
BE_AKU1
Carrière potentielle
BE_AKU6
CAP_AKU1
Carrière 84500
SE_AKU1
CAE_AKU2
A
SE_AKU2
BE_AKU5
Rivière Illukotat
Akulivik
CAE_AKU1
Carrière 84070
Baie d'Hudson
Composante du projet / Project Component
Site à l'étude / Study area
Transect georadar
Site visité sur le terrain / Site visited
Composante du milieu / Area Component
Terre de catégorie I inuites / Inuit category I land
Carrière / Quarry
A
Ligne 3
Ligne 1
SE_AKU2
Ligne 2
0 75 m
B
Ligne 5
Ligne 8
Ligne 7
Ligne 4
Ligne 6
BE_AKU4
Ligne 10
Ligne 9
0 75 m
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Carte 1 / Map 1
Localisation du village d'Akulivik / Akulivik Location
Sources :
Base, Canvec 1 : 50 000, RN Canada et BDGA 1M, MRNF
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.
0 75 150 m
MTM, fuseau 10, NAD83
Février 2023 / February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_aC_c1_Akulivik_230223.mxd
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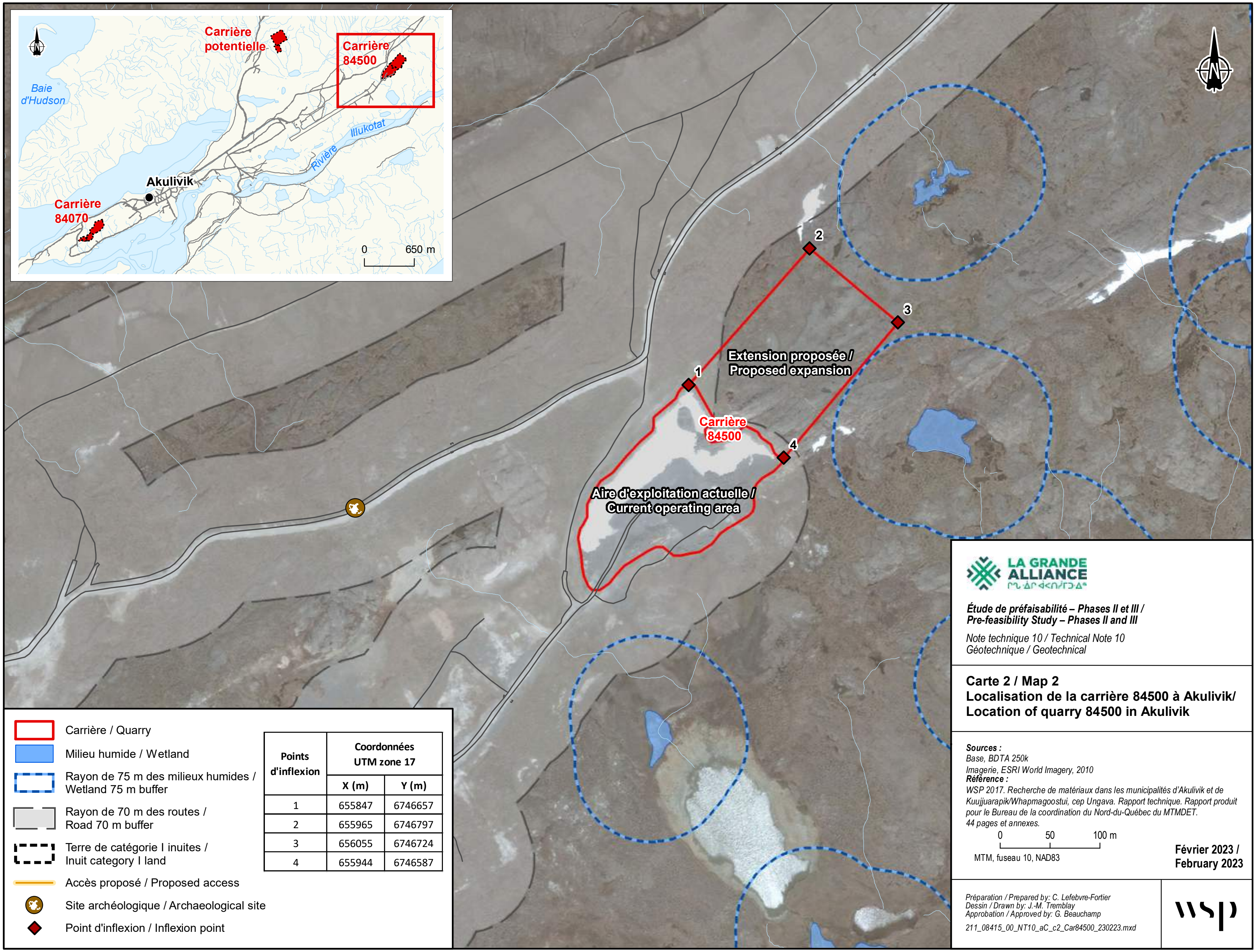

- Carrière / Quarry
- Milieu humide / Wetland
- Rayon de 75 m des milieux humides / Wetland 75 m buffer
- Rayon de 70 m des routes / Road 70 m buffer
- Terre de catégorie I inuites / Inuit category I land
- Accès proposé / Proposed access
- Site archéologique / Archaeological site
- Point d'inflexion / Inflexion point

Points d'inflexion	Coordonnées UTM zone 17	
	X (m)	Y (m)
1	655847	6746657
2	655965	6746797
3	656055	6746724
4	655944	6746587

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III /
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 2 / Map 2
Localisation de la carrière 84500 à Akulivik/
Location of quarry 84500 in Akulivik

Sources :
Base, BDTA 250k
Imagerie, ESRI World Imagery, 2010
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.

0 50 100 m
MTM, fuseau 10, NAD83

Février 2023 /
February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_aC_c2_Car84500_230223.mxd

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Carrière / Quarry
Milieu humide / Wetland
Rayon de 75 m des milieux humides / Wetland 75 m buffer
Rayon de 70 m des routes / Road 70 m buffer
Rayon de 600 m des zones commerciales et résidentielles / 600 m buffer from commercial and residential areas
Usage résidentiel / Residential use
Usage commercial / Commercial use
Terre de catégorie I inuites / Inuit category I land
Accès proposé / Proposed access
Site archéologique / Archaeological site
Point d'inflexion / Inflexion point

Points d'inflexion	Coordonnées UTM zone 17	
	X (m)	Y (m)
1	651983	6744360
2	651983	6744396
3	652036	6744448
4	652041	6744501
5	652125	6744535
6	652165	6744467
7	652116	6744395
8	652024	6744346

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 3 / Map 3
Localisation de la carrière 84070 à Akulivik/ Location of quarry 84070 in Akulivik

Sources :
Base, BDTA 250k
Imagerie, ESRI World Imagery, 2010
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.

0 50 100 m
MTM, fuseau 10, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
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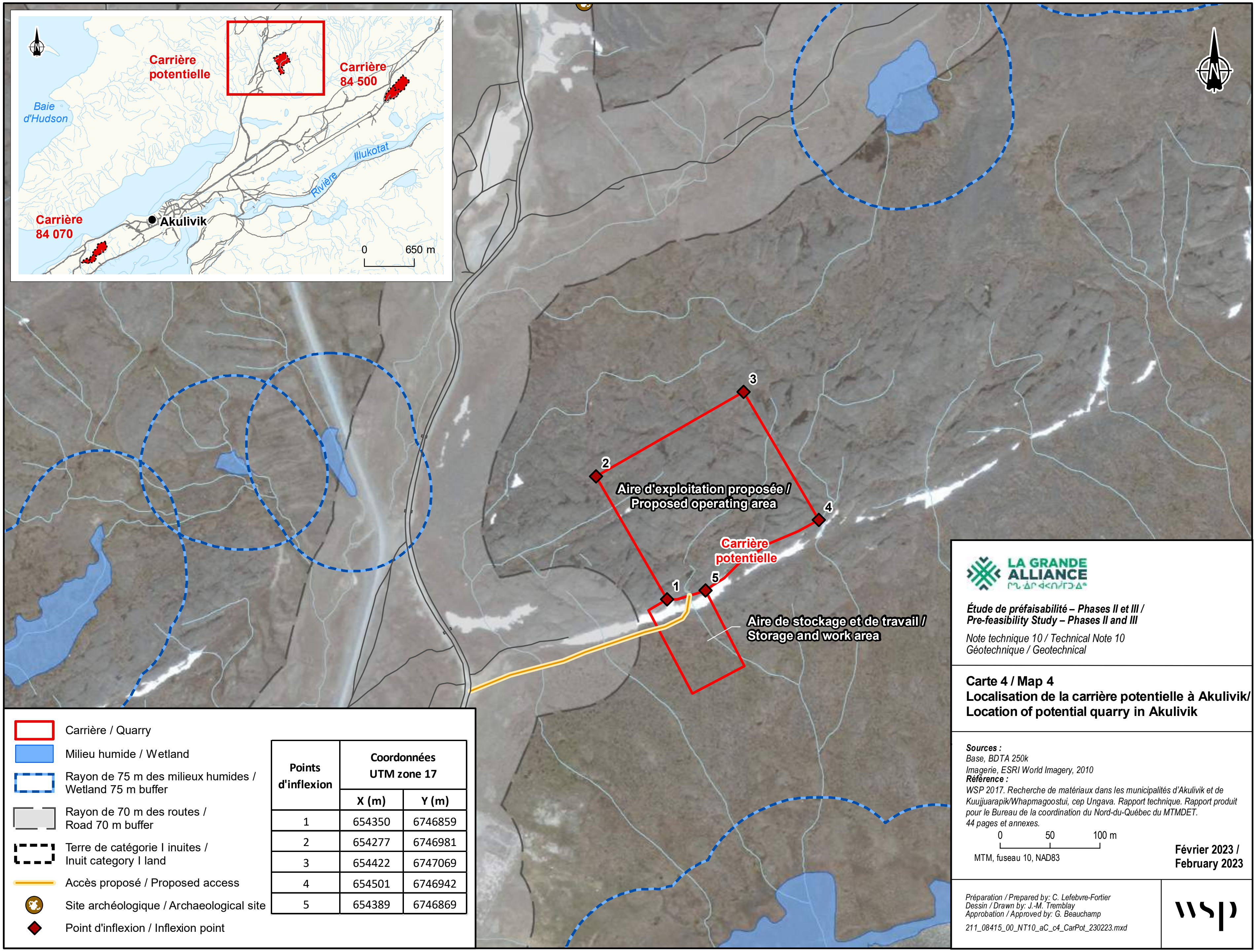
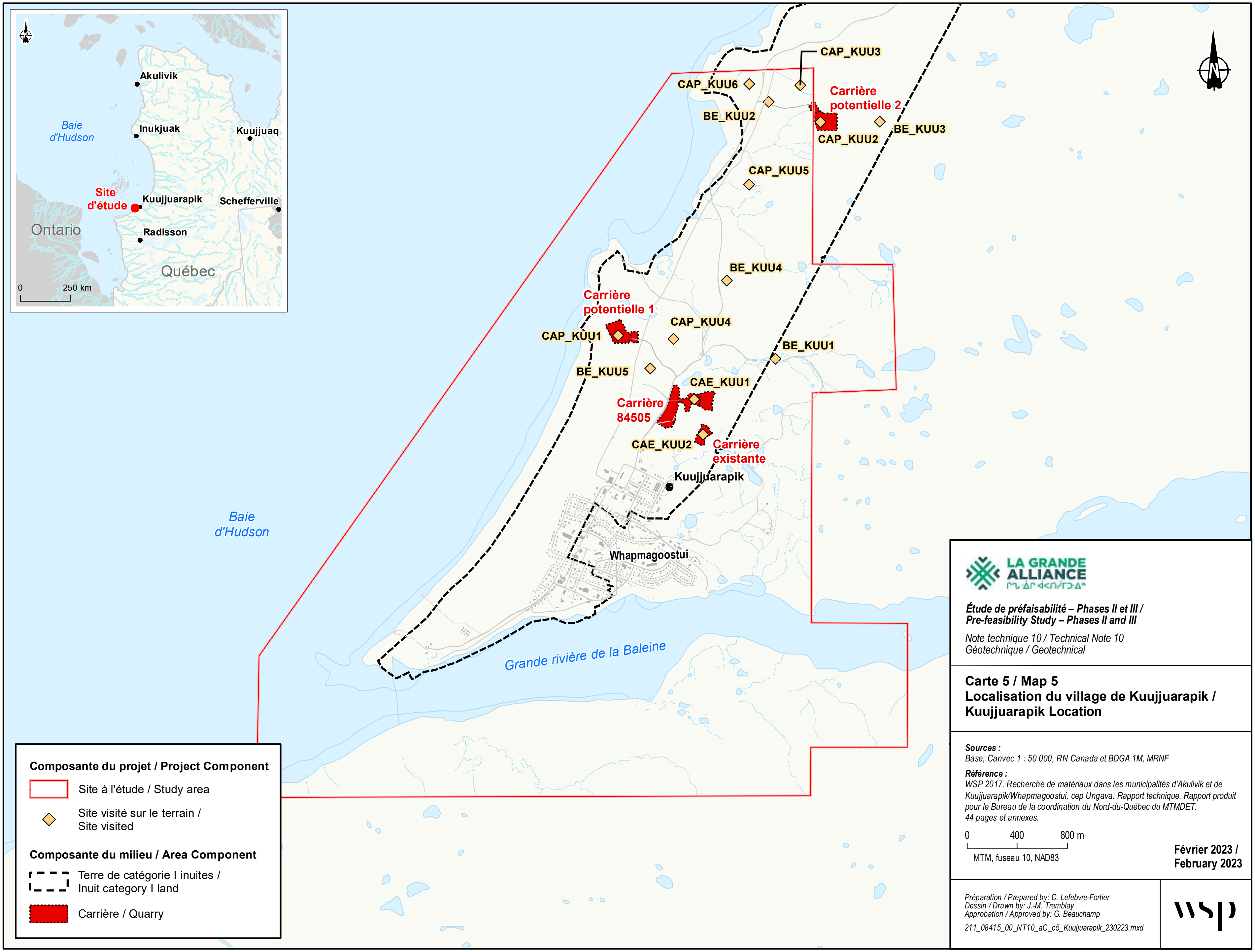
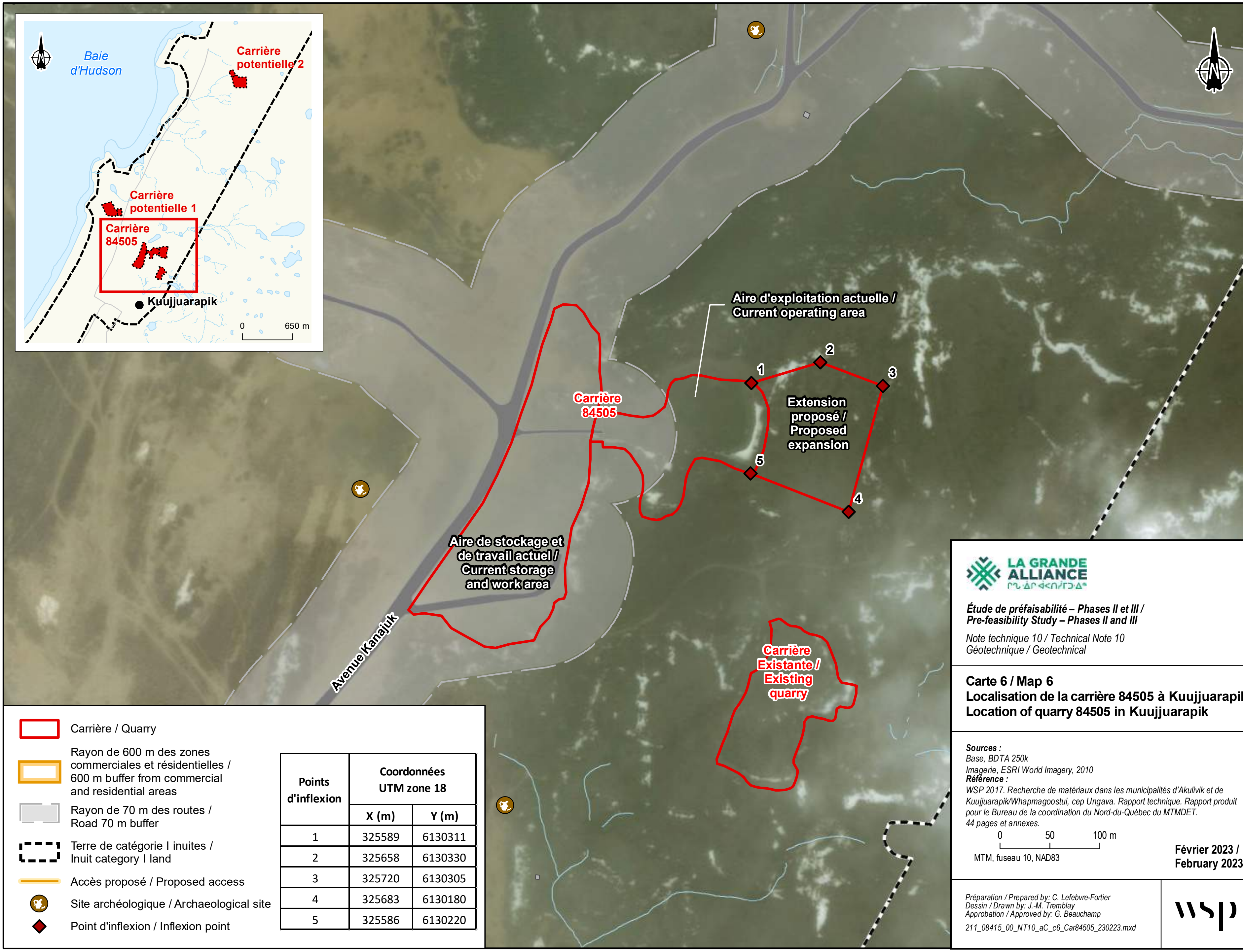


Points d'inflexion	Coordonnées UTM zone 17	
	X (m)	Y (m)
1	654350	6746859
2	654277	6746981
3	654422	6747069
4	654501	6746942
5	654389	6746869



Akulivik
Baie d'Hudson
Inukjuak
Kuujjuaq
Site d'étude
Kuujjuarapik
Schefferville
Ontario
Radisson
Québec
0 250 km
CAP_KUU3
CAP_KUU6
Carrière potentielle 2
BE_KUU2
BE_KUU3
CAP_KUU2
CAP_KUU5
BE_KUU4
Carrière potentielle 1
CAP_KUU4
CAP_KUU1
BE_KUU1
BE_KUU5
CAE_KUU1
Carrière 84505
CAE_KUU2
Carrière existante
Kuujjuarapik
Baie d'Hudson
Whapmagoostui
Grande rivière de la Baleine
Composante du projet / Project Component
Site à l'étude / Study area
Site visité sur le terrain / Site visited
Composante du milieu / Area Component
Terre de catégorie I inuites / Inuit category I land
Carrière / Quarry
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Carte 5 / Map 5
Localisation du village de Kuujjuarapik / Kuujjuarapik Location
Sources :
Base, Canvec 1 : 50 000, RN Canada et BDGA 1M, MRNF
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.
0 400 800 m
MTM, fuseau 10, NAD83
Février 2023 / February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_aC_c5_Kuujjuarapik_230223.mxd
wsp



Carrière / Quarry

Rayon de 600 m des zones commerciales et résidentielles / 600 m buffer from commercial and residential areas

Rayon de 70 m des routes / Road 70 m buffer

Terre de catégorie I inuites / Inuit category I land

Accès proposé / Proposed access

Site archéologique / Archaeological site

Point d'inflexion / Inflexion point

Points d'inflexion	Coordonnées UTM zone 18	
	X (m)	Y (m)
1	325589	6130311
2	325658	6130330
3	325720	6130305
4	325683	6130180
5	325586	6130220

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 6 / Map 6
Localisation de la carrière 84505 à Kuujjuarapik / Location of quarry 84505 in Kuujjuarapik

Sources :
Base, BDTA 250k
Imagerie, ESRI World Imagery, 2010
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.

0 50 100 m
MTM, fuseau 10, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp

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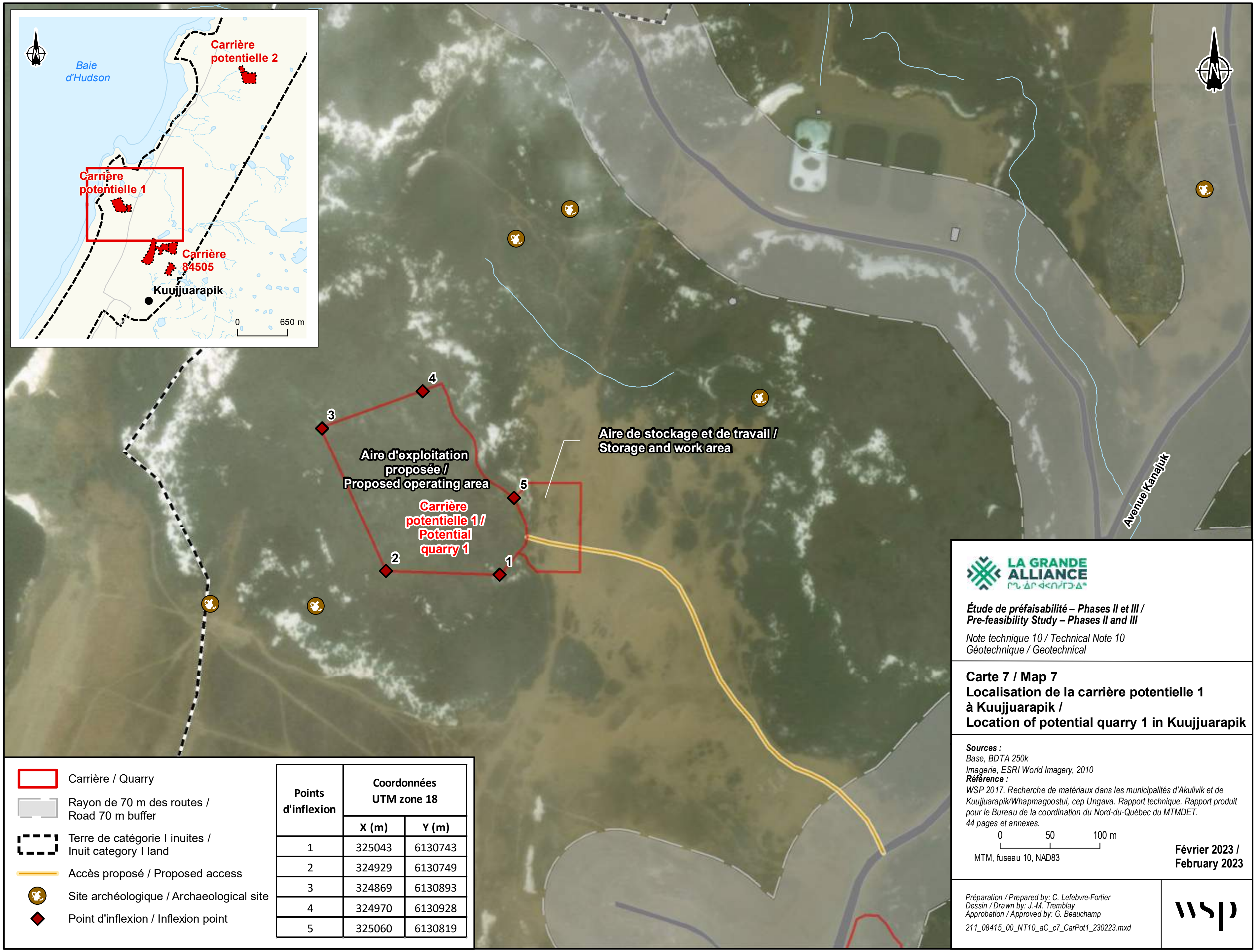


Carrière / Quarry
Rayon de 70 m des routes / Road 70 m buffer
Terre de catégorie I inuites / Inuit category I land
Accès proposé / Proposed access
Site archéologique / Archaeological site
Point d'inflexion / Inflexion point

Points d'inflexion	Coordonnées UTM zone 18	
	X (m)	Y (m)
1	325043	6130743
2	324929	6130749
3	324869	6130893
4	324970	6130928
5	325060	6130819

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

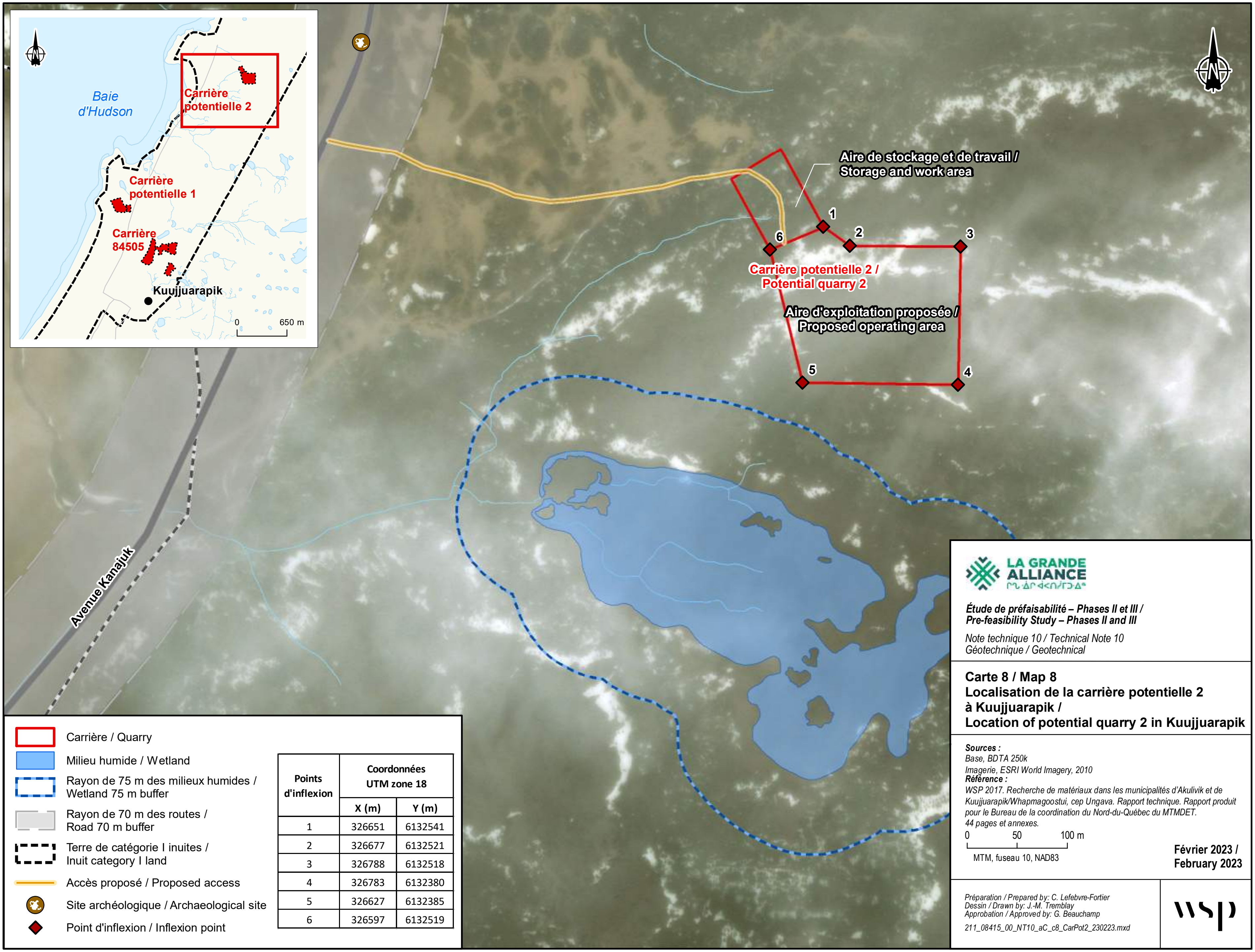
Carte 7 / Map 7
Localisation de la carrière potentielle 1 à Kuujjuarapik /
Location of potential quarry 1 in Kuujjuarapik

Sources :
Base, BDTA 250k
Imagerie, ESRI World Imagery, 2010
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.

0 50 100 m
MTM, fuseau 10, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_aC_c7_CarPot1_230223.mxd



Carrière / Quarry
Milieu humide / Wetland
Rayon de 75 m des milieux humides / Wetland 75 m buffer
Rayon de 70 m des routes / Road 70 m buffer
Terre de catégorie I inuites / Inuit category I land
Accès proposé / Proposed access
Site archéologique / Archaeological site
Point d'inflexion / Inflexion point

Points d'inflexion	Coordonnées UTM zone 18	
	X (m)	Y (m)
1	326651	6132541
2	326677	6132521
3	326788	6132518
4	326783	6132380
5	326627	6132385
6	326597	6132519

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 8 / Map 8
Localisation de la carrière potentielle 2 à Kuujjuarapik / Location of potential quarry 2 in Kuujjuarapik

Sources :
Base, BDTA 250k
Imagerie, ESRI World Imagery, 2010
Référence :
WSP 2017. Recherche de matériaux dans les municipalités d'Akulivik et de Kuujjuarapik/Whapmagoostui, cep Ungava. Rapport technique. Rapport produit pour le Bureau de la coordination du Nord-du-Québec du MTMDET. 44 pages et annexes.

0 50 100 m
MTM, fuseau 10, NAD83

Février 2023 / February 2023

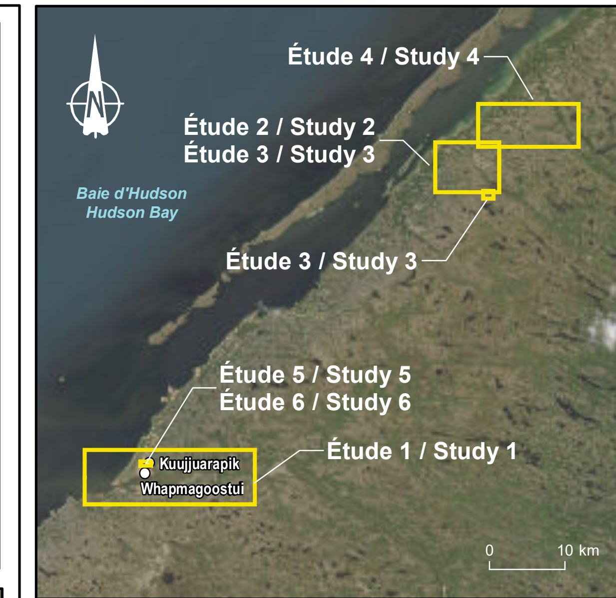
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_aC_c8_CarPot2_230223.mxd

wsp

APPENDIX

D

MAP OF EXISTING BOREHOLES IN THE SA2 AREA



Hydro-Québec (HQ)

	Sols pulvérulents / Granular soils	Sols argileux ou organiques / Clayey or organic soils
1976	●	●
1977	▲	
1978	■	■
1981	✕	✕

Ministère des Transports du Québec (MTQ)

	Sols pulvérulents / Granular soils
2012	★
2016	◆

LA GRANDE ALLIANCE
ᒋᔑ ᐧᐋᒋ ᐊᐸᑎᓰᒥᑐᐧᐃᓐ

Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Carte 4 / Map 4
Forages existants dans le secteur de Whapmagoostui/Kuujjuarapik / Existing boreholes in Whapmagoostui/Kuujjuarapik area

Sources :
Base : World Imagery

Février 2023 / February 2023

Préparation / Prepared by : Y. Obeid
Dessin / Drawn by : D. Gagné
Approbation / Approved by : G. Beauchamp
211_08415_00_NT10_c4_forages_230223.mxd

wsp

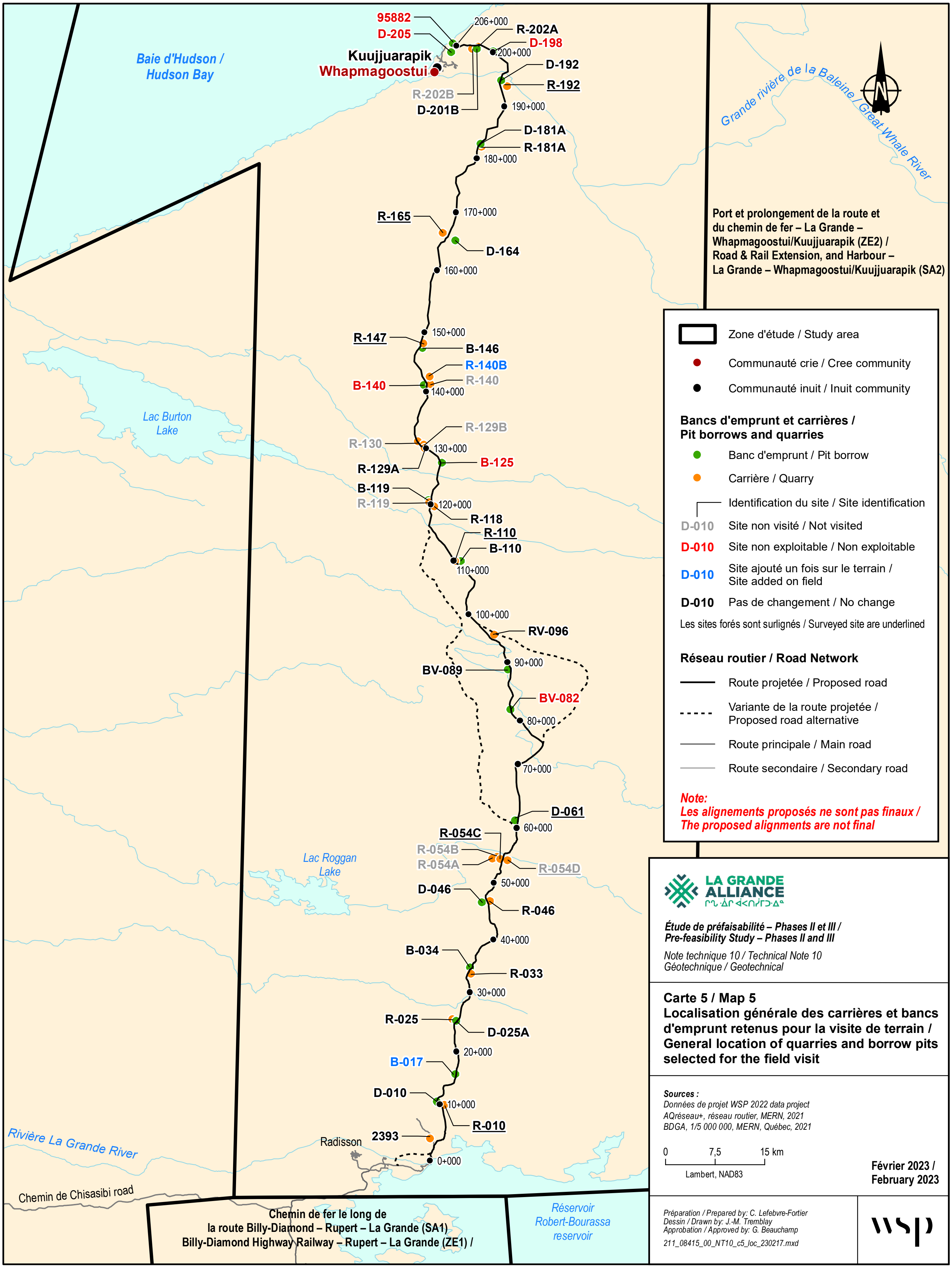
APPENDIX

E

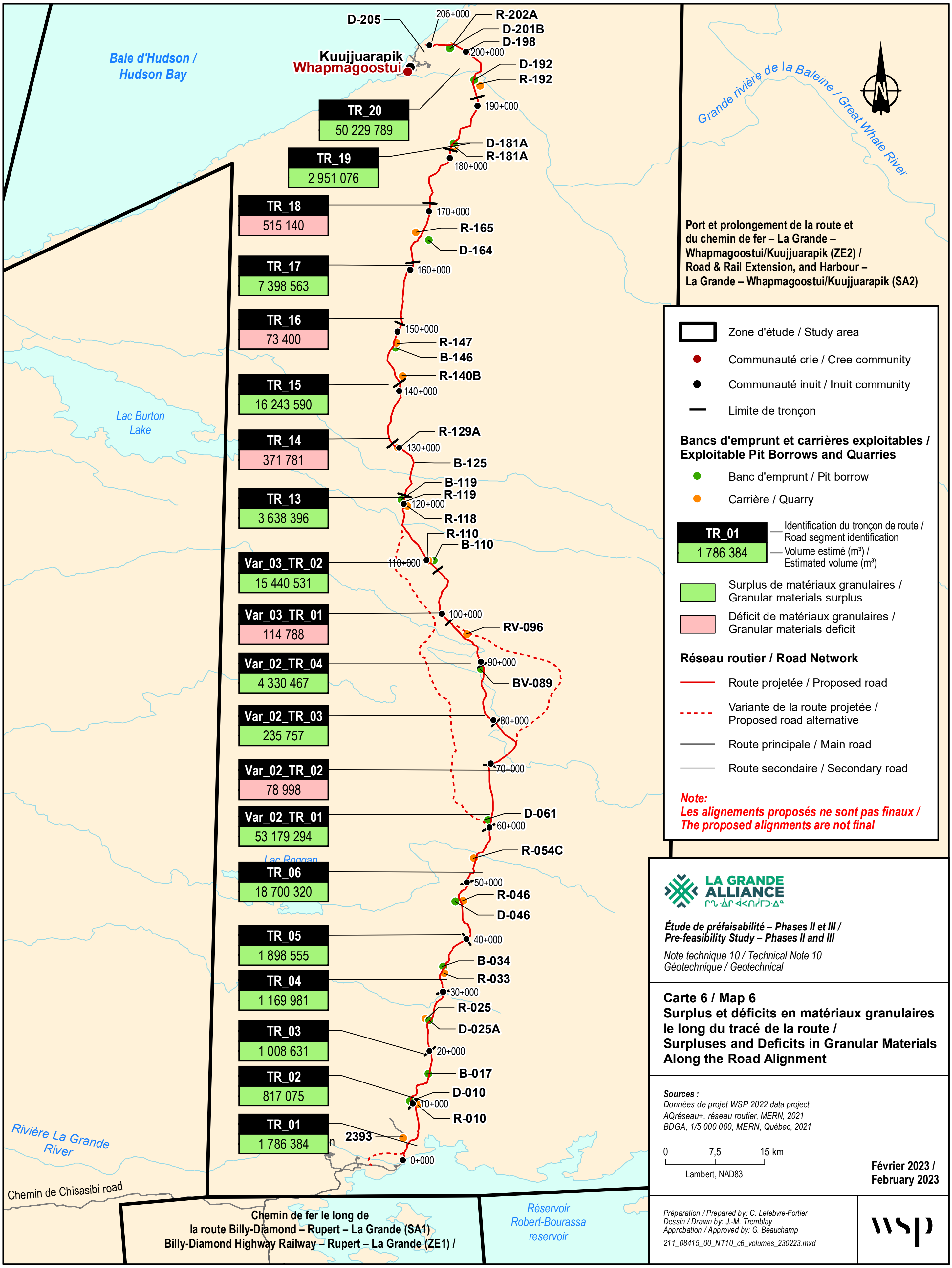
FEASIBILITY - APPENDICES

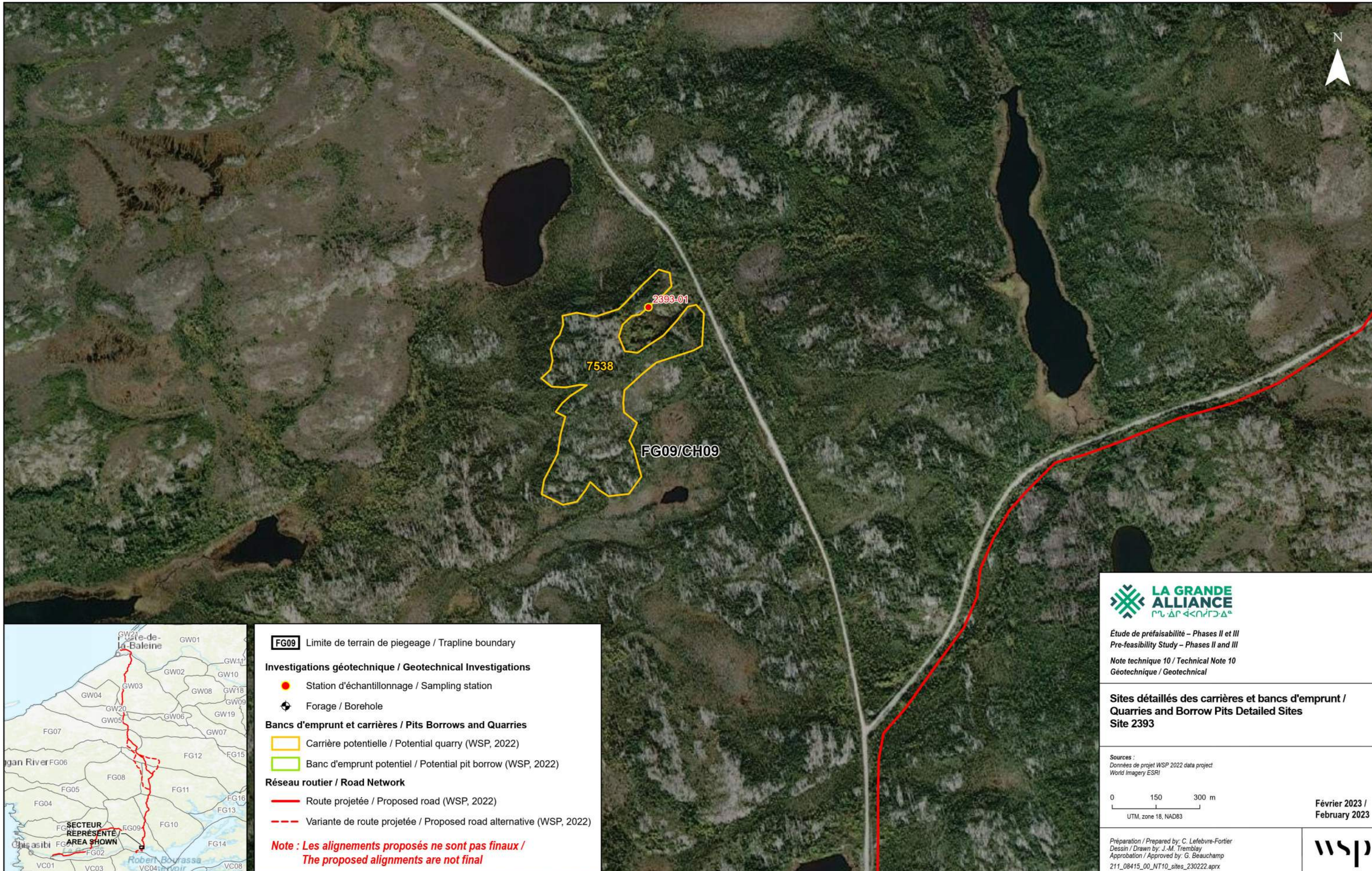
APPENDIX

E-1 *MAPS*



Baie d'Hudson / Hudson Bay
Kuujjuarapik
Whapmagoostui
95882
D-205
206+000
R-202A
D-198
200+000
D-192
R-192
R-202B
D-201B
190+000
D-181A
R-181A
180+000
R-165
170+000
D-164
160+000
R-147
150+000
B-146
R-140B
B-140
R-140
140+000
Lac Burton Lake
R-129B
R-130
130+000
R-129A
B-125
B-119
R-119
120+000
R-118
R-110
B-110
110+000
100+000
RV-096
90+000
BV-089
BV-082
80+000
70+000
D-061
60+000
R-054C
R-054B
R-054A
R-054D
Lac Roggan Lake
50+000
D-046
R-046
40+000
B-034
R-033
30+000
R-025
D-025A
20+000
B-017
D-010
10+000
R-010
2393
Radisson
0+000
Rivière La Grande River
Chemin de Chisasibi road
Chemin de fer le long de la route Billy-Diamond – Rupert – La Grande (SA1) Billy-Diamond Highway Railway – Rupert – La Grande (ZE1) /
Réservoir Robert-Bourassa reservoir
Grande rivière de la Baleine / Great Whale River
N
Port et prolongement de la route et du chemin de fer – La Grande – Whapmagoostui/Kuujjuarapik (ZE2) / Road & Rail Extension, and Harbour – La Grande – Whapmagoostui/Kuujjuarapik (SA2)
Zone d'étude / Study area
Communauté crie / Cree community
Communauté inuit / Inuit community
Bancs d'emprunt et carrières / Pit borrows and quarries
Banc d'emprunt / Pit borrow
Carrière / Quarry
Identification du site / Site identification
D-010 Site non visité / Not visited
D-010 Site non exploitable / Non exploitable
D-010 Site ajouté un fois sur le terrain / Site added on field
D-010 Pas de changement / No change
Les sites forés sont surlignés / Surveyed site are underlined
Réseau routier / Road Network
Route projetée / Proposed road
Variante de la route projetée / Proposed road alternative
Route principale / Main road
Route secondaire / Secondary road
Note:
Les alignements proposés ne sont pas finaux / The proposed alignments are not final
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III / Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Carte 5 / Map 5
Localisation générale des carrières et bancs d'emprunt retenus pour la visite de terrain / General location of quarries and borrow pits selected for the field visit
Sources :
Données de projet WSP 2022 data project
AQréseau+, réseau routier, MERN, 2021
BDGA, 1/5 000 000, MERN, Québec, 2021
0 7,5 15 km
Lambert, NAD83
Février 2023 / February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_c5_loc_230217.mxd
wsp


Baie d'Hudson / Hudson Bay
Kuujjuarapik
Whapmagoostui
D-205
206+000
R-202A
D-201B
D-198
200+000
D-192
R-192
190+000
D-181A
R-181A
180+000
170+000
R-165
D-164
160+000
150+000
R-147
B-146
R-140B
140+000
R-129A
130+000
B-125
B-119
R-119
120+000
R-118
R-110
B-110
110+000
100+000
RV-096
90+000
BV-089
80+000
70+000
D-061
60+000
R-054C
50+000
R-046
D-046
40+000
B-034
R-033
30+000
R-025
D-025A
20+000
B-017
D-010
10+000
R-010
2393
0+000
TR_20
50 229 789
TR_19
2 951 076
TR_18
515 140
TR_17
7 398 563
TR_16
73 400
TR_15
16 243 590
TR_14
371 781
TR_13
3 638 396
Var_03_TR_02
15 440 531
Var_03_TR_01
114 788
Var_02_TR_04
4 330 467
Var_02_TR_03
235 757
Var_02_TR_02
78 998
Var_02_TR_01
53 179 294
Lac Roggan
TR_06
18 700 320
TR_05
1 898 555
TR_04
1 169 981
TR_03
1 008 631
TR_02
817 075
TR_01
1 786 384
Lac Burton
Lake
Rivière La Grande
River
Chemin de Chisasibi road
Chemin de fer le long de
la route Billy-Diamond – Rupert – La Grande (SA1)
Billy-Diamond Highway Railway – Rupert – La Grande (ZE1) /
Réservoir
Robert-Bourassa
reservoir
Grande rivière de la Baleine / Great Whale River
N
Port et prolongement de la route et
du chemin de fer – La Grande –
Whapmagoostui/Kuujjuarapik (ZE2) /
Road & Rail Extension, and Harbour –
La Grande – Whapmagoostui/Kuujjuarapik (SA2)
Zone d'étude / Study area
Communauté crie / Cree community
Communauté inuit / Inuit community
Limite de tronçon
Bancs d'emprunt et carrières exploitables /
Exploitable Pit Borrows and Quarries
Banc d'emprunt / Pit borrow
Carrière / Quarry
TR_01
1 786 384
Identification du tronçon de route /
Road segment identification
Volume estimé (m³) /
Estimated volume (m³)
Surplus de matériaux granulaires /
Granular materials surplus
Déficit de matériaux granulaires /
Granular materials deficit
Réseau routier / Road Network
Route projetée / Proposed road
Variante de la route projetée /
Proposed road alternative
Route principale / Main road
Route secondaire / Secondary road
Note:
Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
LA GRANDE
ALLIANCE
Étude de préfaisabilité – Phases II et III /
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Carte 6 / Map 6
Surplus et déficits en matériaux granulaires
le long du tracé de la route /
Surpluses and Deficits in Granular Materials
Along the Road Alignment
Sources :
Données de projet WSP 2022 data project
AQréseau+, réseau routier, MERN, 2021
BDGA, 1/5 000 000, MERN, Québec, 2021
0
7,5
15 km
Lambert, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_c6_volumes_230223.mxd
wsp



FG09 Limite de terrain de piegeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE

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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites
Site 2393

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

0 150 300 m

UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP

N
D-010-01
D-010
FG09/CH09
R-010-F2
R-010
R-010-01
R-010-02
R-010-F1
Poste-de-la-Baleine
GW21
GW01
GW11
GW02
GW10
GW03
GW08
GW18
GW04
GW09
GW20
GW05
GW06
GW19
GW07
FG07
FG12
FG15
FG06
FG08
FG05
FG11
FG16
FG04
FG13
FG10
FG09
FG02
FG14
SECTEUR REPRÉSENTÉ / AREA SHOWN
Chisasibi
VC01
VC03
VC04
VC08
VC02
VC20
Robert-Bourassa
FG09 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site D-010 / R-010
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp

FG09 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE
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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites Site B-017

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

0 100 200 m
UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

wsp

FG09 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

Le site visité a été décalé au sud-ouest puisque le sédiment composant la moraine semblait d'épaisseur considérable et pourrait donc être une extension exploitable du site inital D-025A.

LA GRANDE ALLIANCE

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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites Site D-025A/R-025

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

0 150 300 m

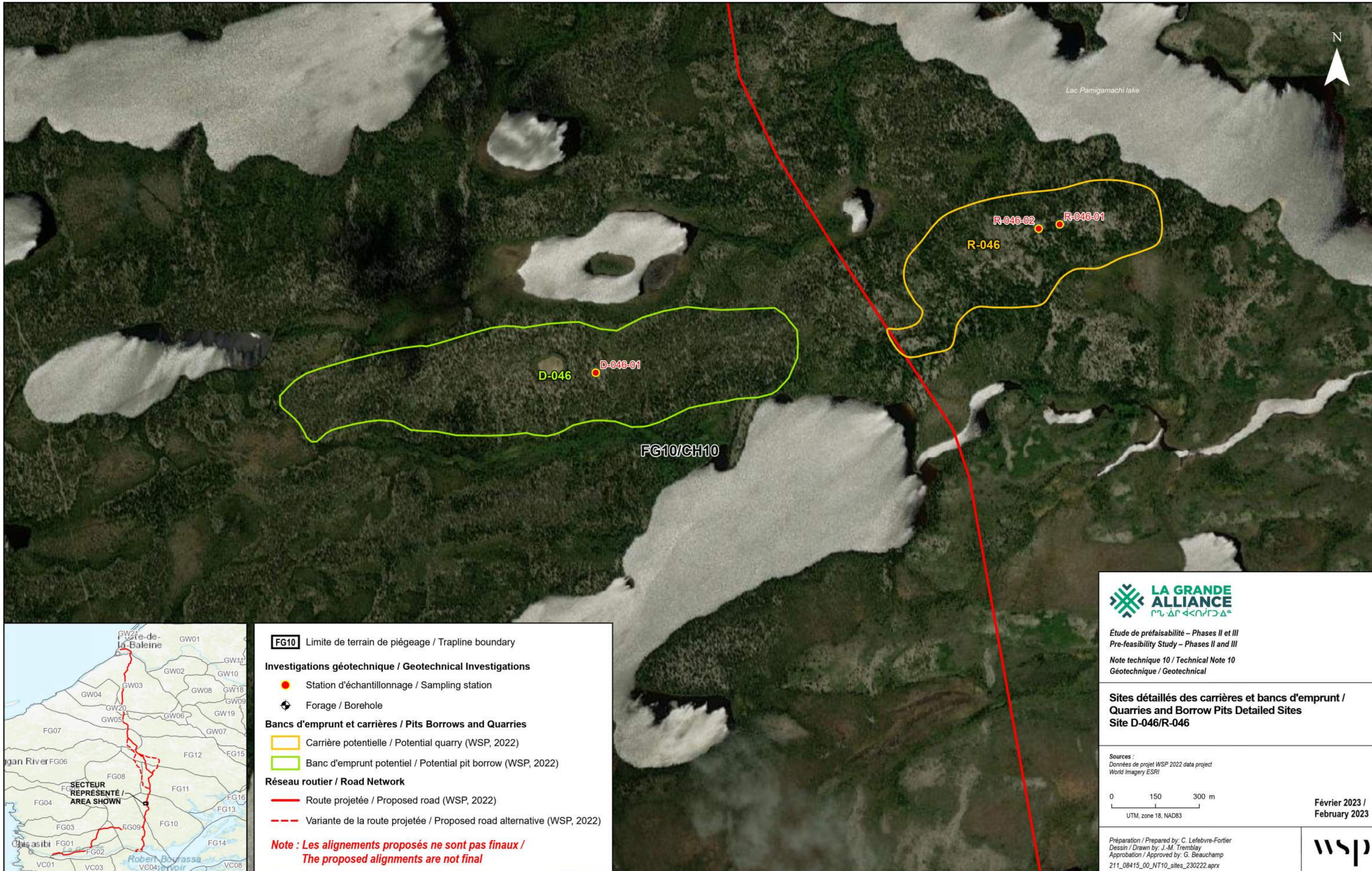
UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP


N
B-034-01
B-034-02
B-034
FG10/CH10
R-033-01
R-033
GW21
Poste-de-la-Baleine
GW01
GW11
GW02
GW10
GW03
GW08
GW18
GW04
GW09
GW20
GW19
GW05
GW06
FG07
GW07
FG12
FG15
gan River
FG06
FG08
FG11
FG05
FG16
FG04
SECTEUR REPRÉSENTÉ / AREA SHOWN
FG13
FG10
FG03
FG09
Chisasibi
FG01
FG02
FG14
Robert-Bourassa
VC01
VC03
VC04
VC08
VC02
VC20
FG10 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
Le site visité a été décalé au nord-est puisque le sédiment composant la moraine semblait d'épaisseur considérable et pourrait donc être une extension exploitable du site inital B-034
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site B-034/R-033
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx



Lac Pamigamachi lake
R-046-02
R-046-01
R-046
D-046-01
D-046
FG10/CH10
N
Poste-de-la-Baleine
GW01
GW21
GW11
GW02
GW10
GW03
GW08
GW18
GW04
GW09
GW20
GW19
GW05
GW06
GW07
FG07
FG15
FG12
gan River
FG06
FG08
SECTEUR REPRÉSENTÉ / AREA SHOWN
FG11
FG16
FG04
FG13
FG10
FG03
FG09
Chisasibi
FG01
FG14
FG02
Robert-Bourassa
VC01
VC03
VC04
VC08
VC02
VC20
FG10 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site D-046/R-046
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
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N
FG11/CH11
Rivière Roggan river
R-054A
R-054B
R-054C
R-054D
R-054C-F1
R-054D-F2
R-054C-01
FG10/CH10
GW01
GW02
GW03
GW04
GW05
GW06
GW07
GW08
GW09
GW10
GW18
GW19
GW20
GW21
FG01
FG02
FG03
FG04
FG06
FG07
FG08
FG09
FG10
FG11
FG12
FG13
FG14
FG15
FG16
VC01
VC02
VC03
VC04
VC08
VC20
SECTEUR REPRÉSENTÉ / AREA SHOWN
FG10 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site R-054A / R-054B / R-054C / R-054D
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp

FG11 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage destructif / Destructive drilling

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE
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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites Site D-061

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

0 150 300 m
UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP

FG11 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites
Site BV-082

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

0 150 300 m
UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

wsp

FG12 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE
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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites
Site BV-089

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

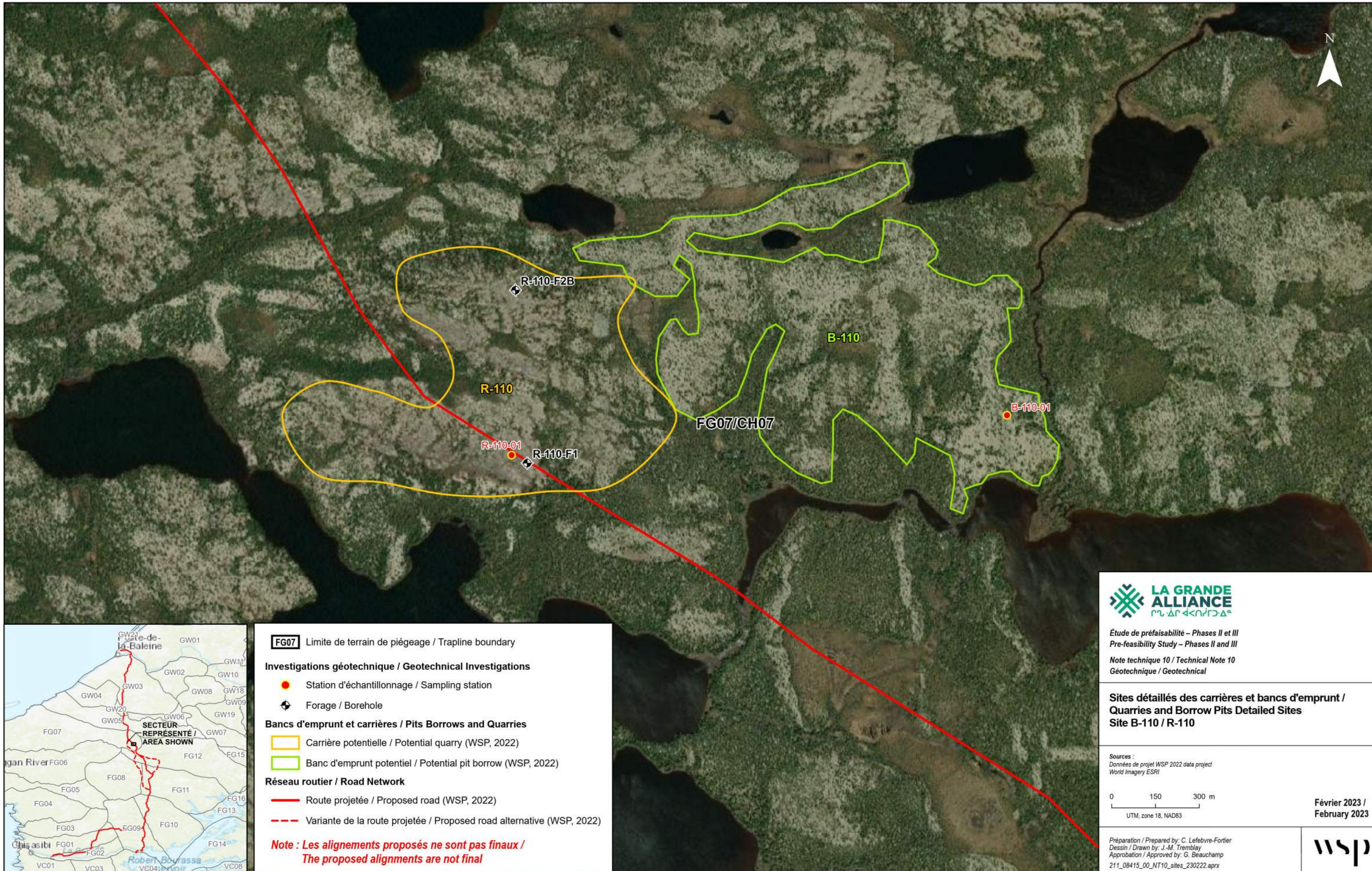
0 150 300 m
UTM, zone 18, NAD83

Février 2023 / February 2023

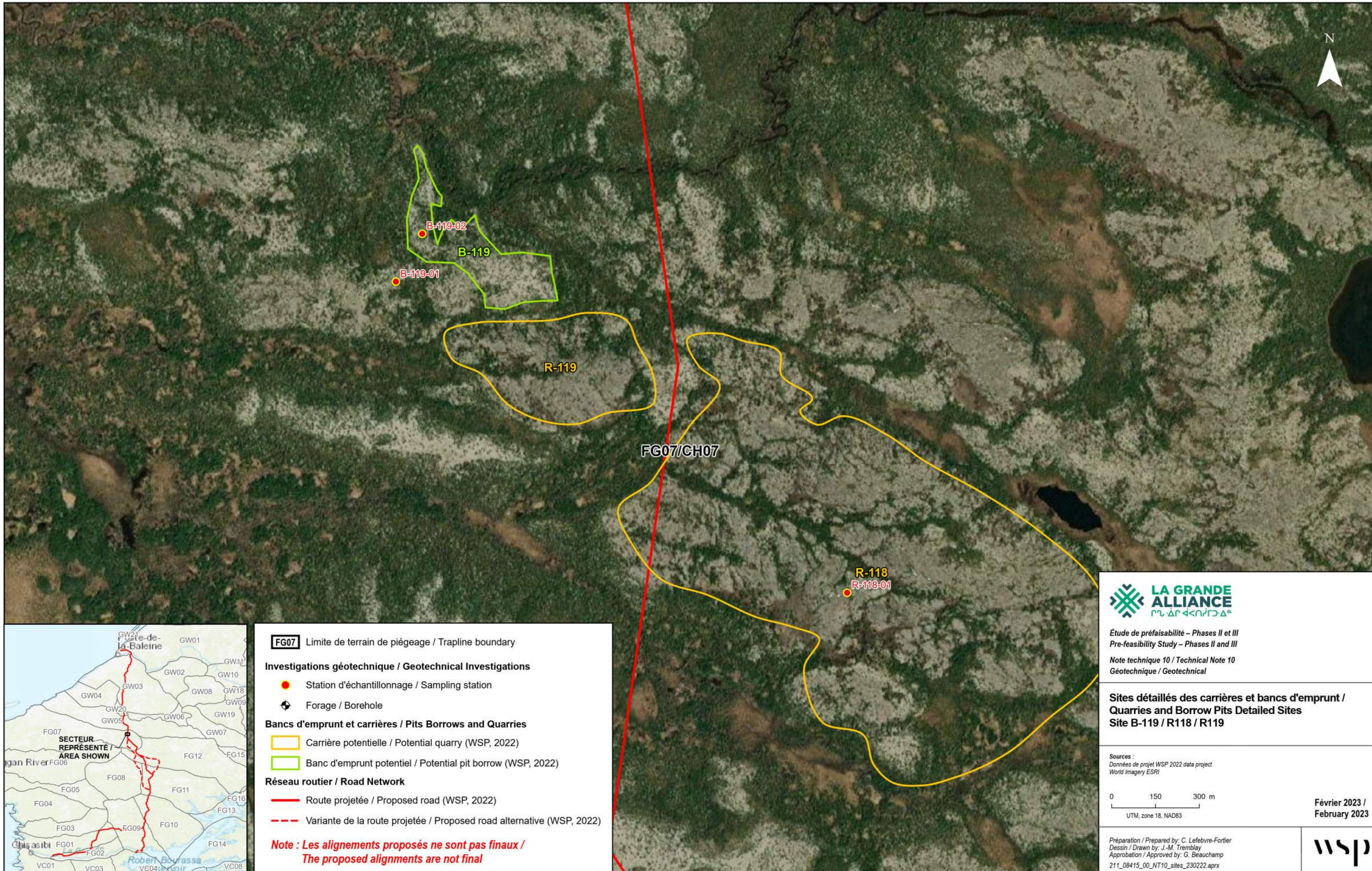
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP

N
RV-096
FG12/CH12
RV-096-02
RV-096-01
GW21
Poste-de-la-Baleine
GW01
GW11
GW02
GW10
GW03
GW08
GW18
GW04
GW09
GW20
GW06
GW19
GW05
GW07
FG07
SECTEUR REPRÉSENTÉ / AREA SHOWN
FG15
gan River
FG06
FG08
FG05
FG11
FG16
FG04
FG13
FG03
FG09
FG10
Chisasibi
FG01
FG02
FG14
Robert-Bourassa Réservoir
VC01
VC03
VC04
VC08
VC02
VC20
FG12 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
Il semble que le site a été décalé vers le sud puisque l'endroit était plus facile d'accès et proposait tout de même une bonne quantité de roc exploitable
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site RV-096
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp



R-110-F2B
R-110
R-110-01
R-110-F1
B-110
B-110-01
FG07/CH07
N
FG07 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
SECTEUR REPRÉSENTÉ / AREA SHOWN
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site B-110 / R-110
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
WSP


N
B-119-02
B-119
B-119-01
R-119
FG07/CH07
R-118
R-118-01
FG07 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
SECTEUR REPRÉSENTÉ / AREA SHOWN
GW01
GW02
GW03
GW04
GW05
GW06
GW07
GW08
GW10
GW18
GW19
GW20
FG01
FG02
FG03
FG04
FG05
FG06
FG07
FG08
FG09
FG10
FG11
FG12
FG13
FG14
FG15
FG16
VC01
VC03
VC04
VC08
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site B-119 / R118 / R119
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
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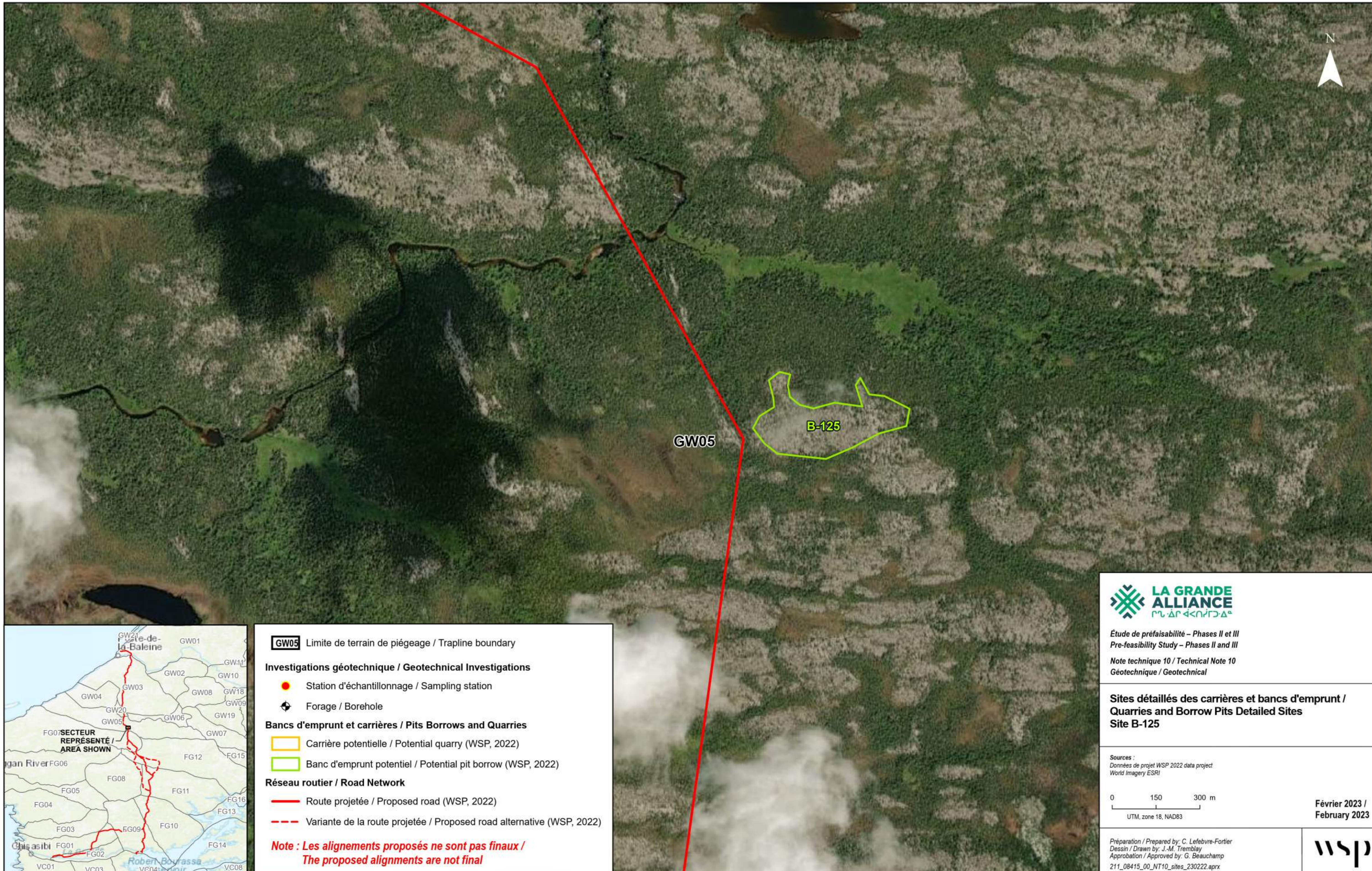
wsp



GW05 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE

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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites Site B-125

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

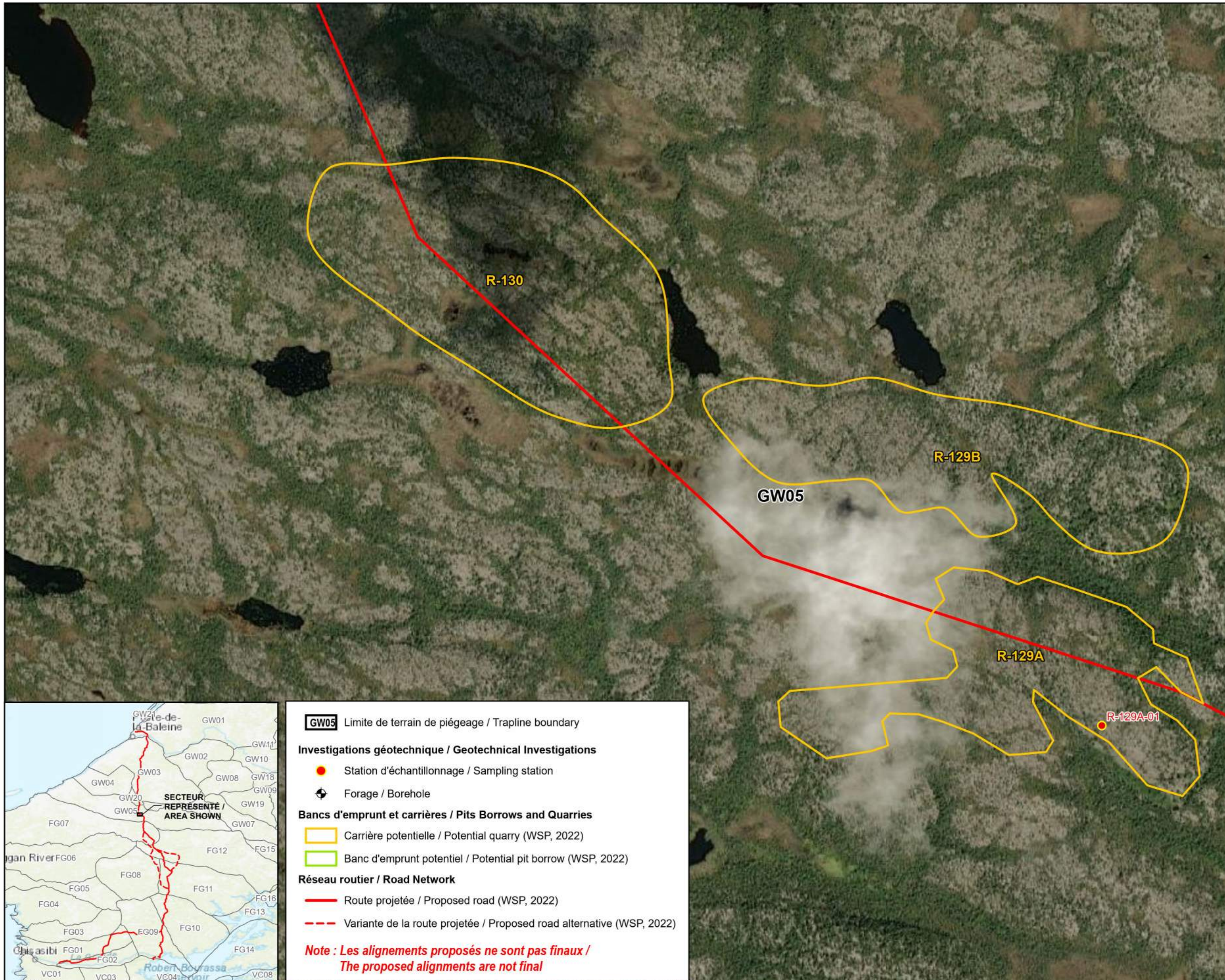
0 150 300 m

UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP



GW05 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE

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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites
Site R-129A / R-129B / R-130

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

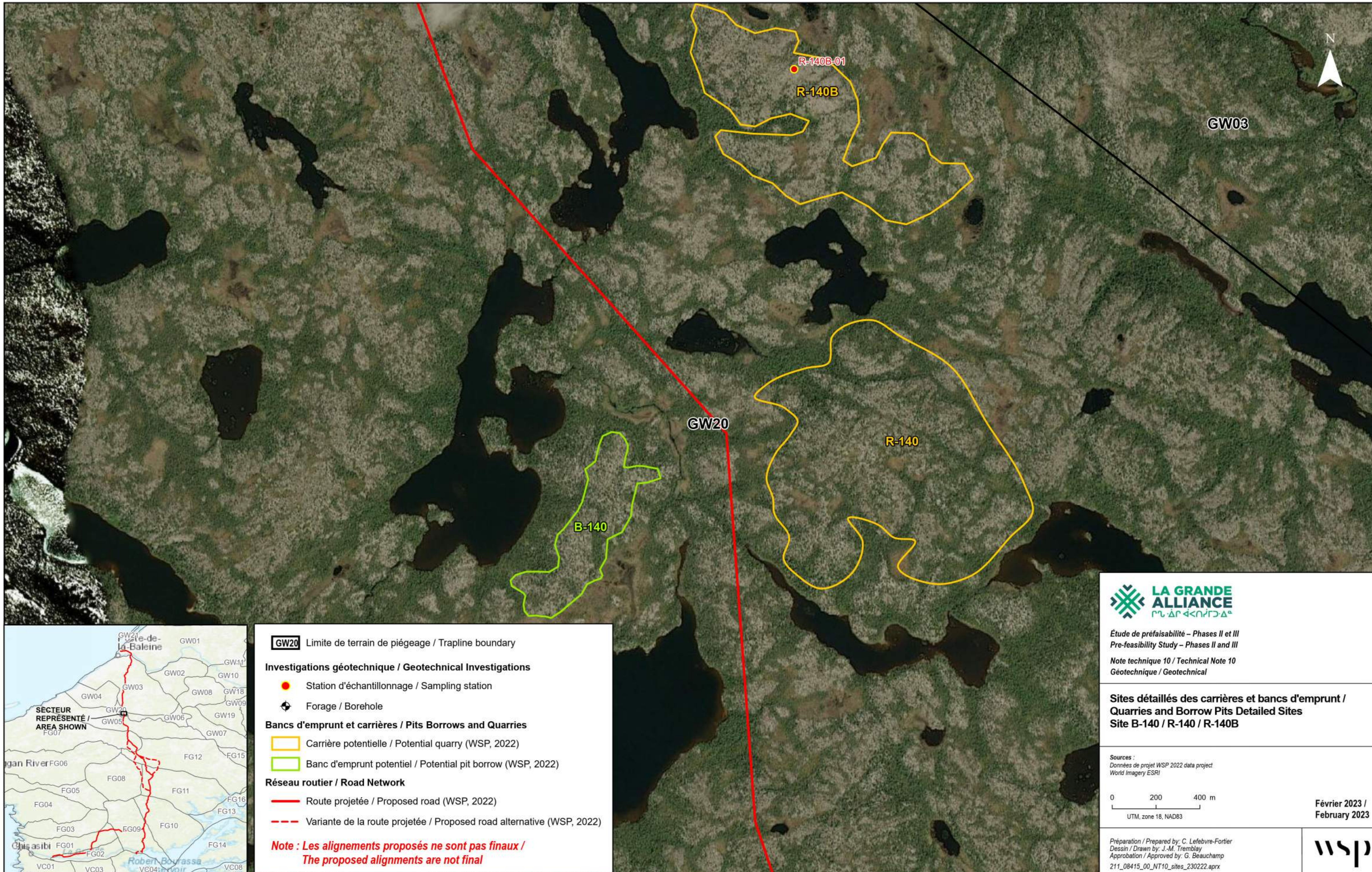
0 150 300 m

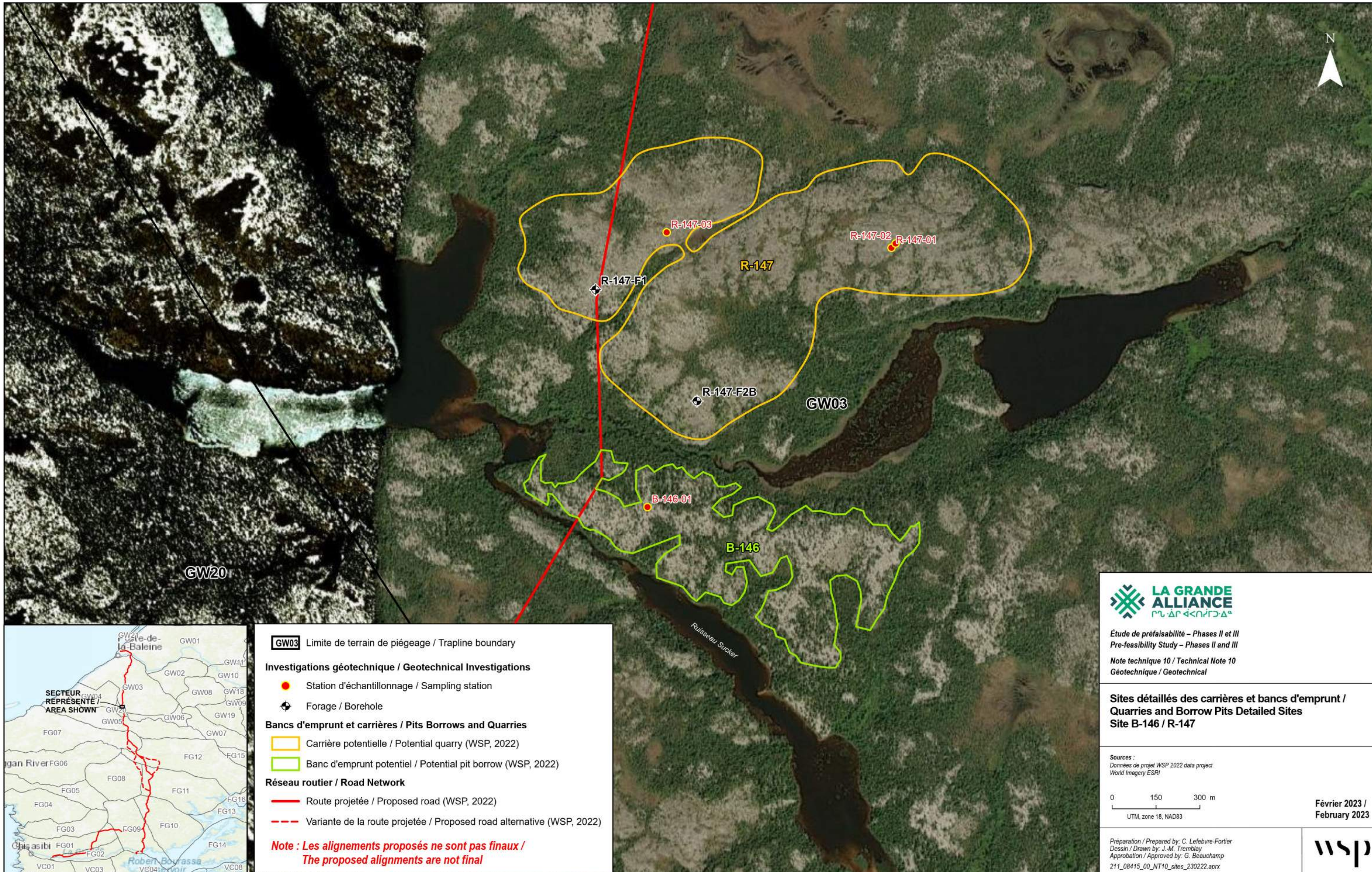
UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP


N
R-140B-01
R-140B
GW03
GW20
R-140
B-140
GW20 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
SECTEUR REPRÉSENTÉ / AREA SHOWN
Chisasibi
Robert-Bourassa
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site B-140 / R-140 / R-140B
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 200 400 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp



GW03 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

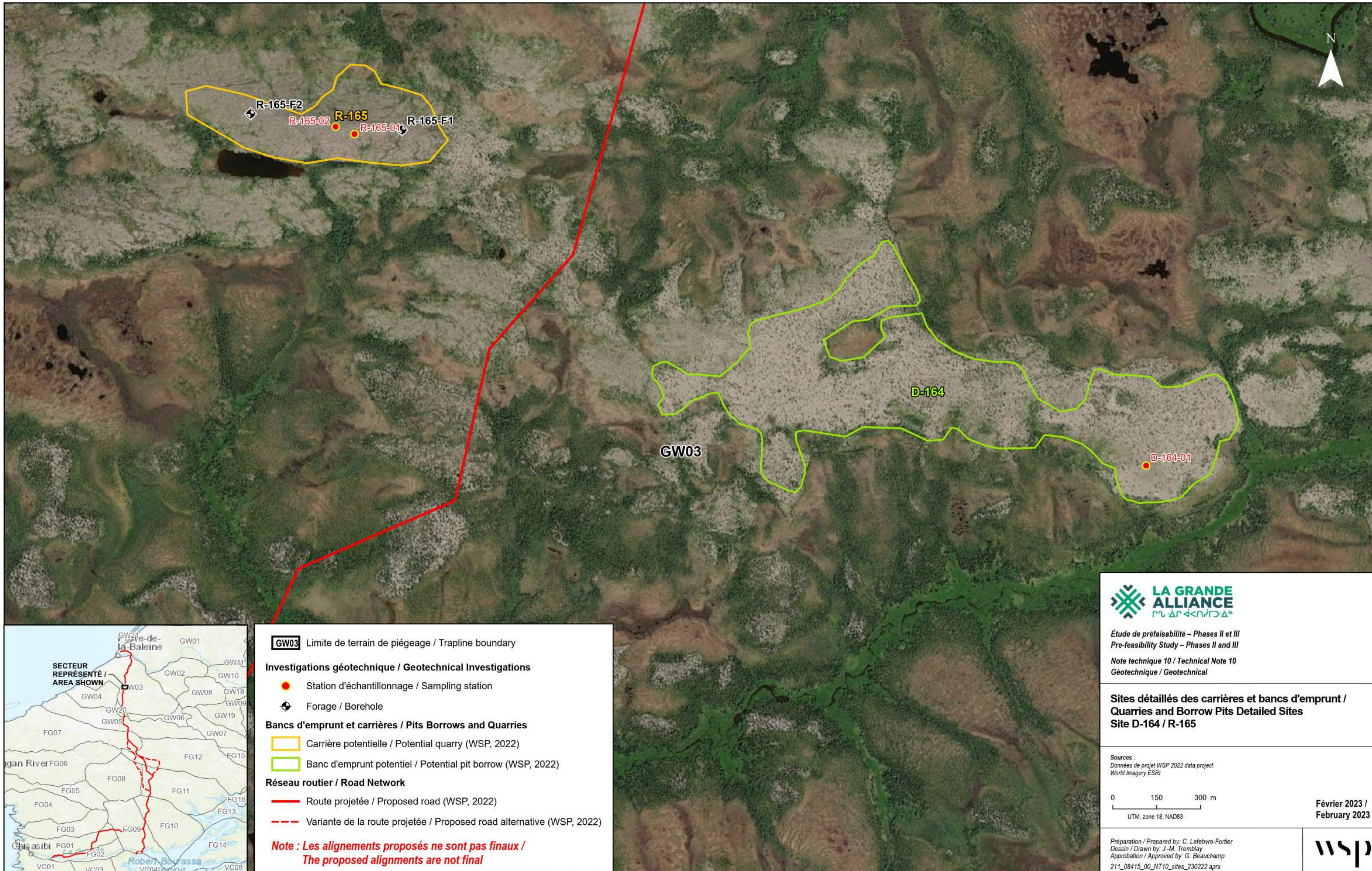
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site B-146 / R-147

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

0 150 300 m
UTM, zone 18, NAD83

Février 2023 /
February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx



GW03 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

- Station d'échantillonnage / Sampling station
- Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

- Carrière potentielle / Potential quarry (WSP, 2022)
- Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

- Route projetée / Proposed road (WSP, 2022)
- Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites
Site D-164 / R-165

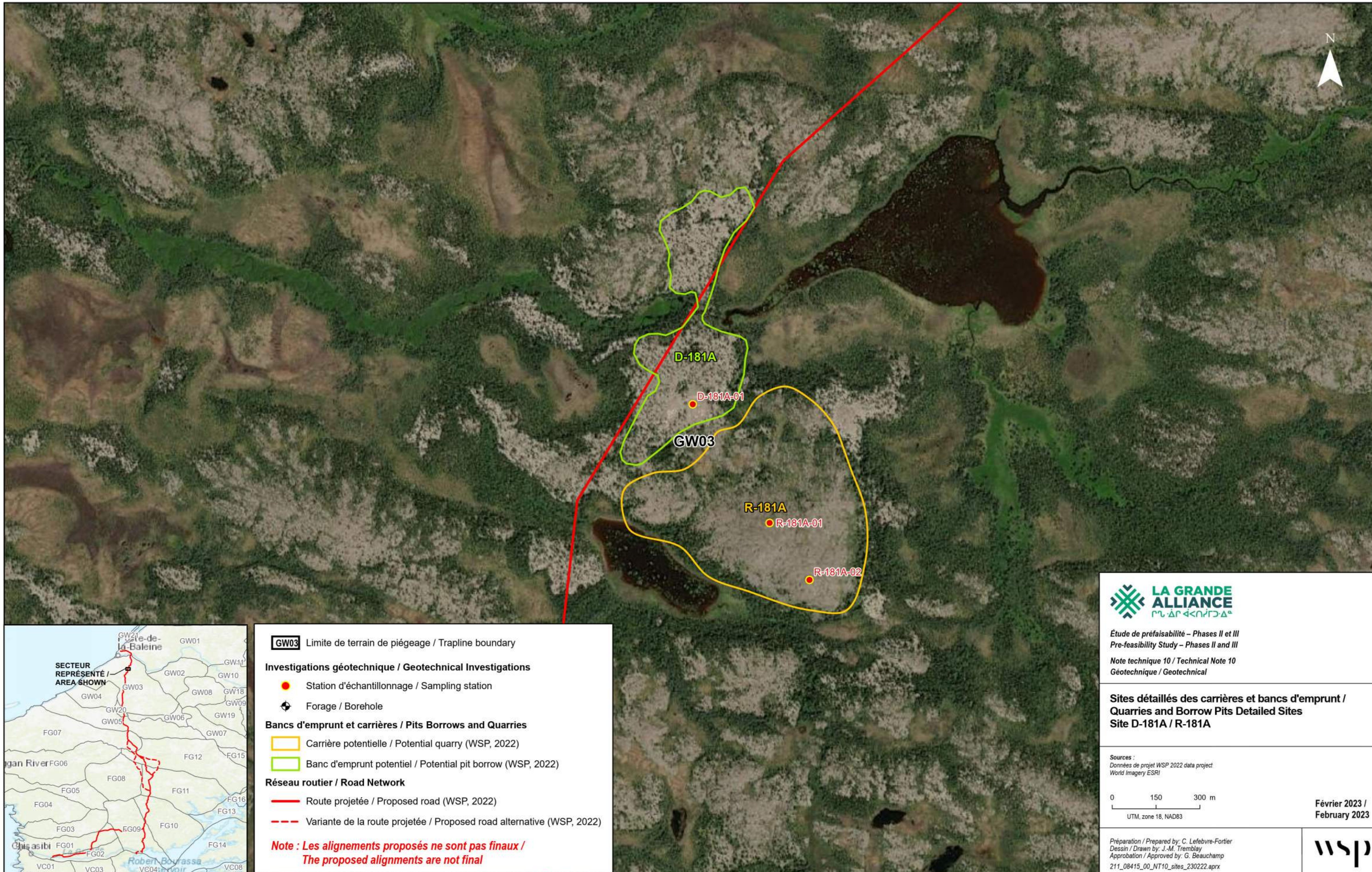
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

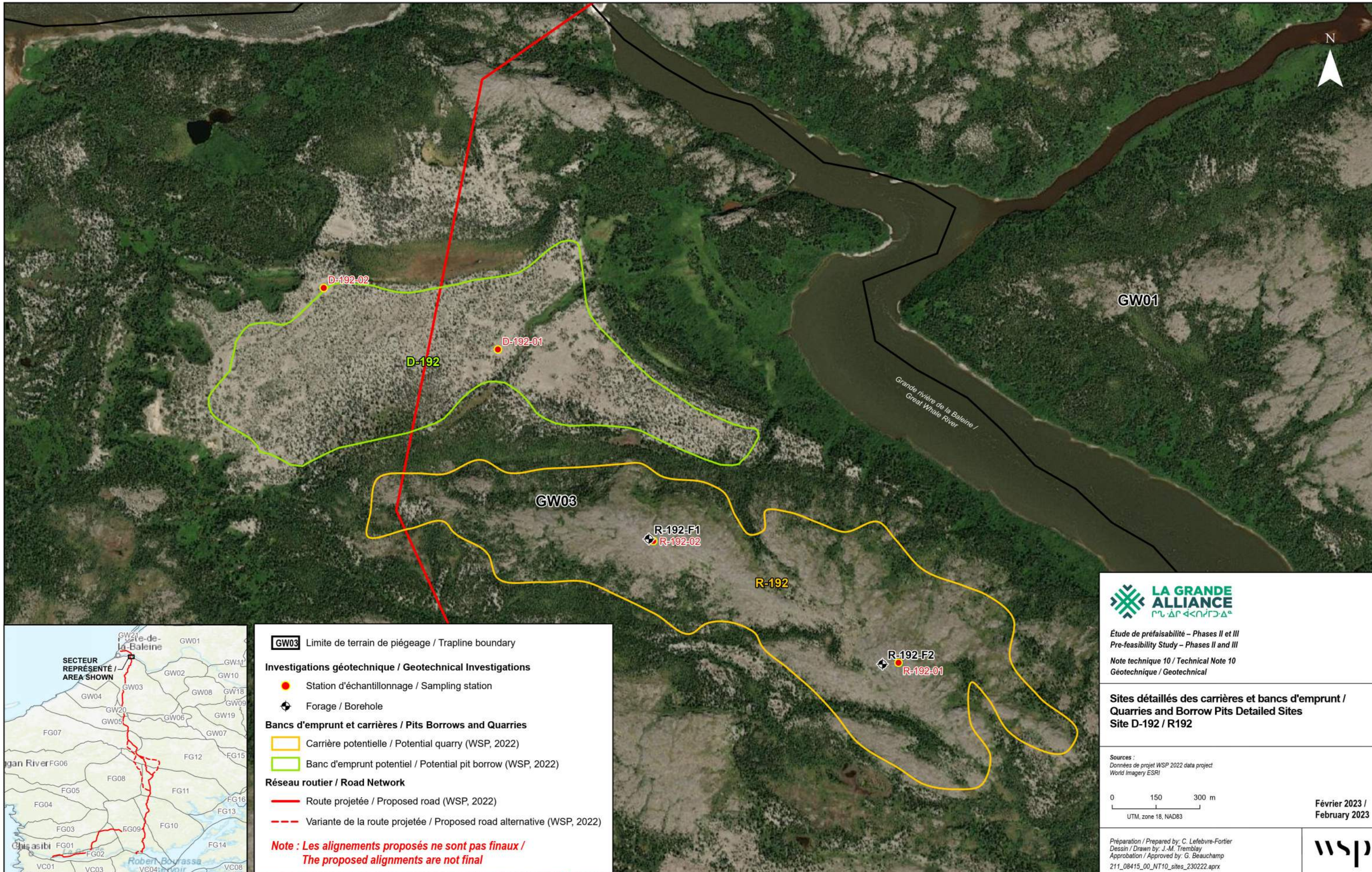
0 150 300 m
UTM, zone 18, NAD83

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP


N
D-181A
D-181A-01
GW03
R-181A
R-181A-01
R-181A-02
GW03 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
SECTEUR REPRÉSENTÉ / AREA SHOWN
Poste-de-la-Baleine
Chisasibi
Robert-Bourassa
GW01
GW02
GW03
GW04
GW05
GW06
GW07
GW08
GW10
GW11
GW18
GW19
GW20
GW21
FG01
FG02
FG03
FG04
FG05
FG06
FG07
FG08
FG09
FG10
FG11
FG12
FG13
FG14
FG15
FG16
VC01
VC02
VC03
VC04
VC08
VC20
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site D-181A / R-181A
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx



GW03 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

Station d'échantillonnage / Sampling station

Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

Carrière potentielle / Potential quarry (WSP, 2022)

Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

Route projetée / Proposed road (WSP, 2022)

Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final

LA GRANDE ALLIANCE

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Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

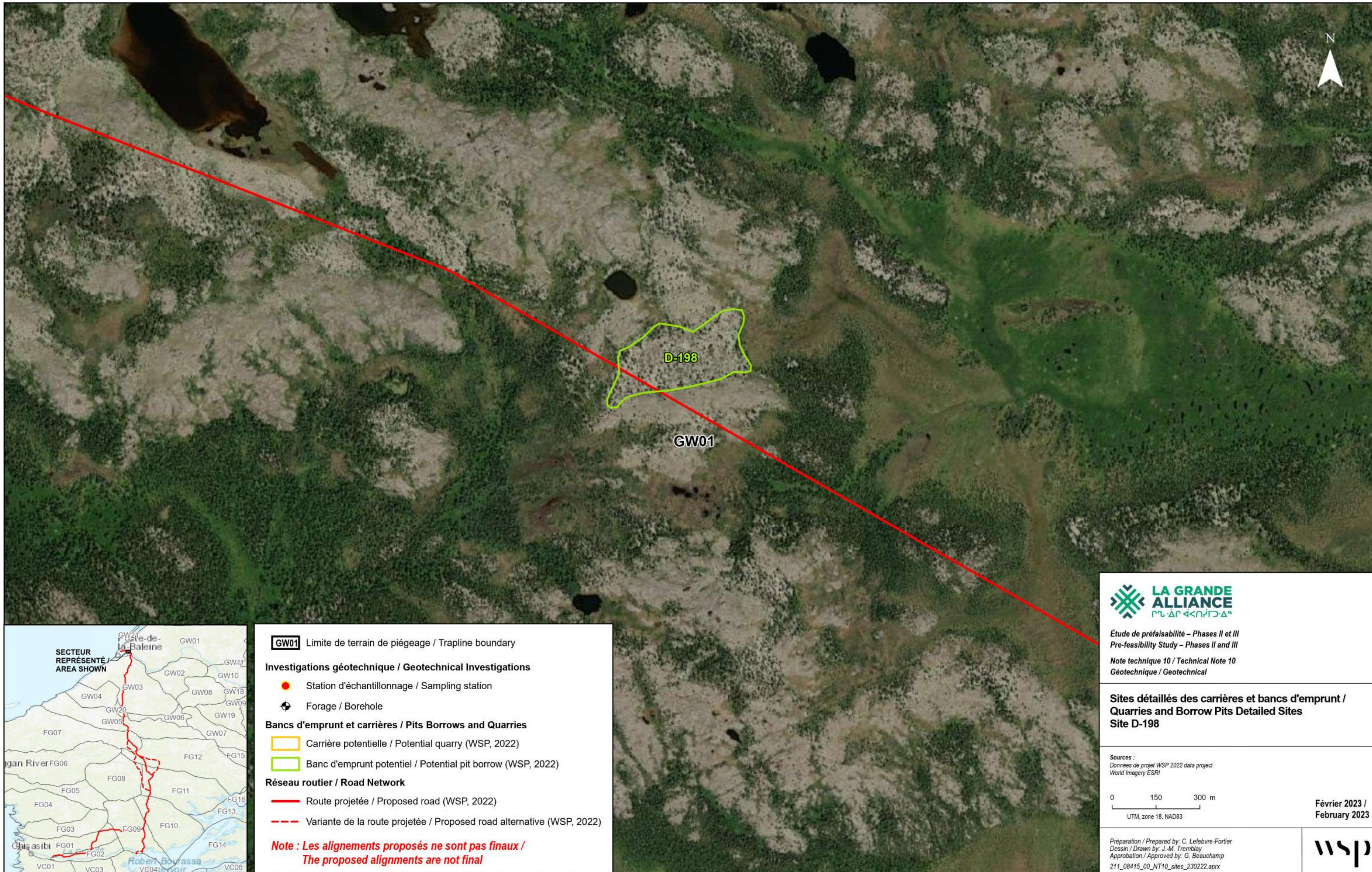
Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites Site D-192 / R192

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

Février 2023 / February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP


N
D-198
GW01
SECTEUR REPRÉSENTÉ / AREA SHOWN
Poste-de-la-Baleine
GW01
GW02
GW03
GW04
GW05
GW06
GW07
GW08
GW09
GW10
GW11
GW18
GW19
GW20
GW21
FG01
FG02
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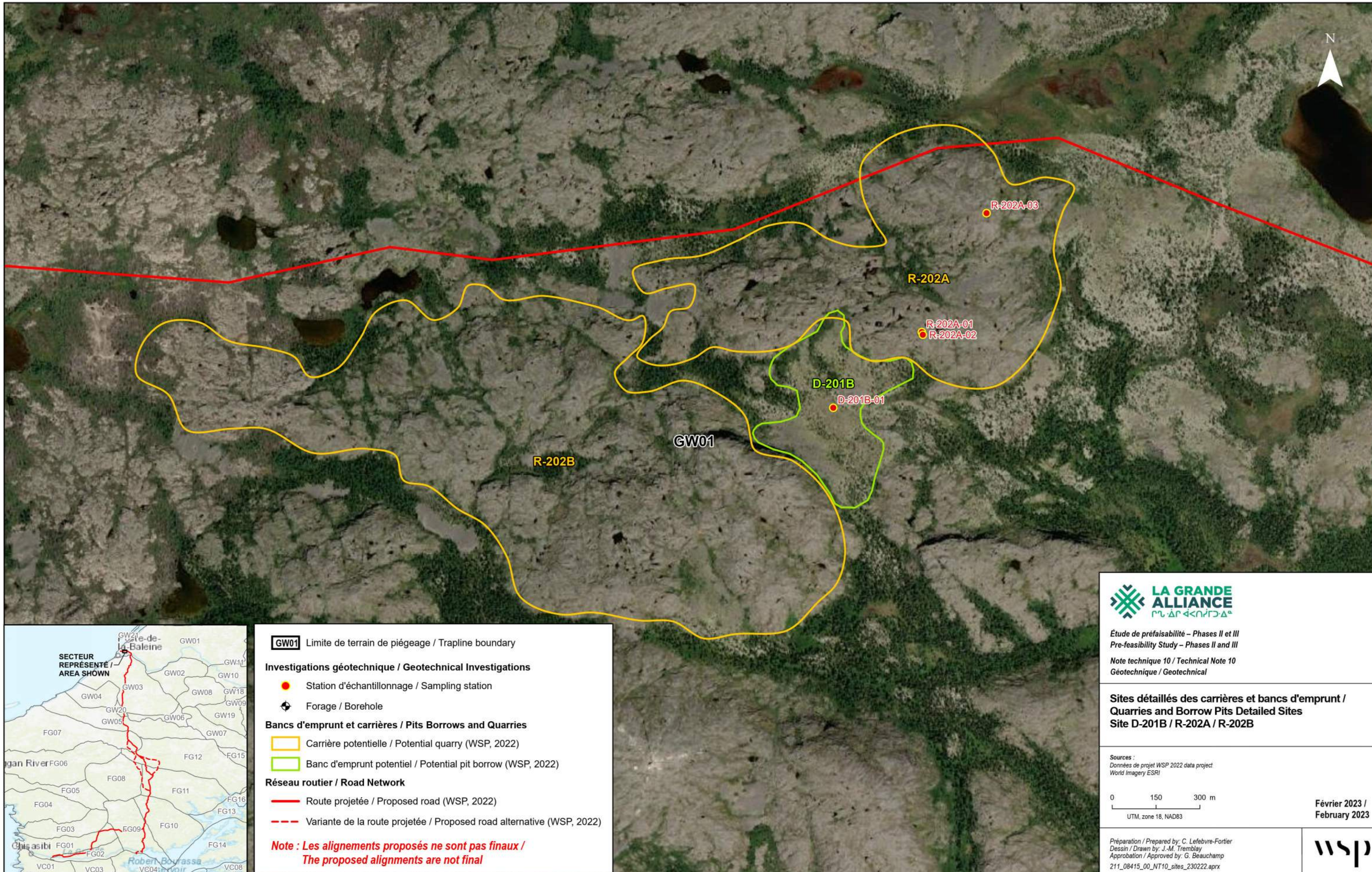
FG11
FG12
FG13
FG14
FG15
FG16
VC01
VC02
VC03
VC04
VC08
VC20
Chisasibi
gan River
Robert-Bourassa
GW01 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux / The proposed alignments are not final
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt / Quarries and Borrow Pits Detailed Sites
Site D-198
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0
150
300 m
UTM, zone 18, NAD83
Février 2023 / February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp



N
R-202A-03
R-202A
R-202A-01
R-202A-02
D-201B
D-201B-01
GW01
R-202B
SECTEUR REPRÉSENTÉ / AREA SHOWN
Chisasibi
Robert-Bourassa
GW01 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
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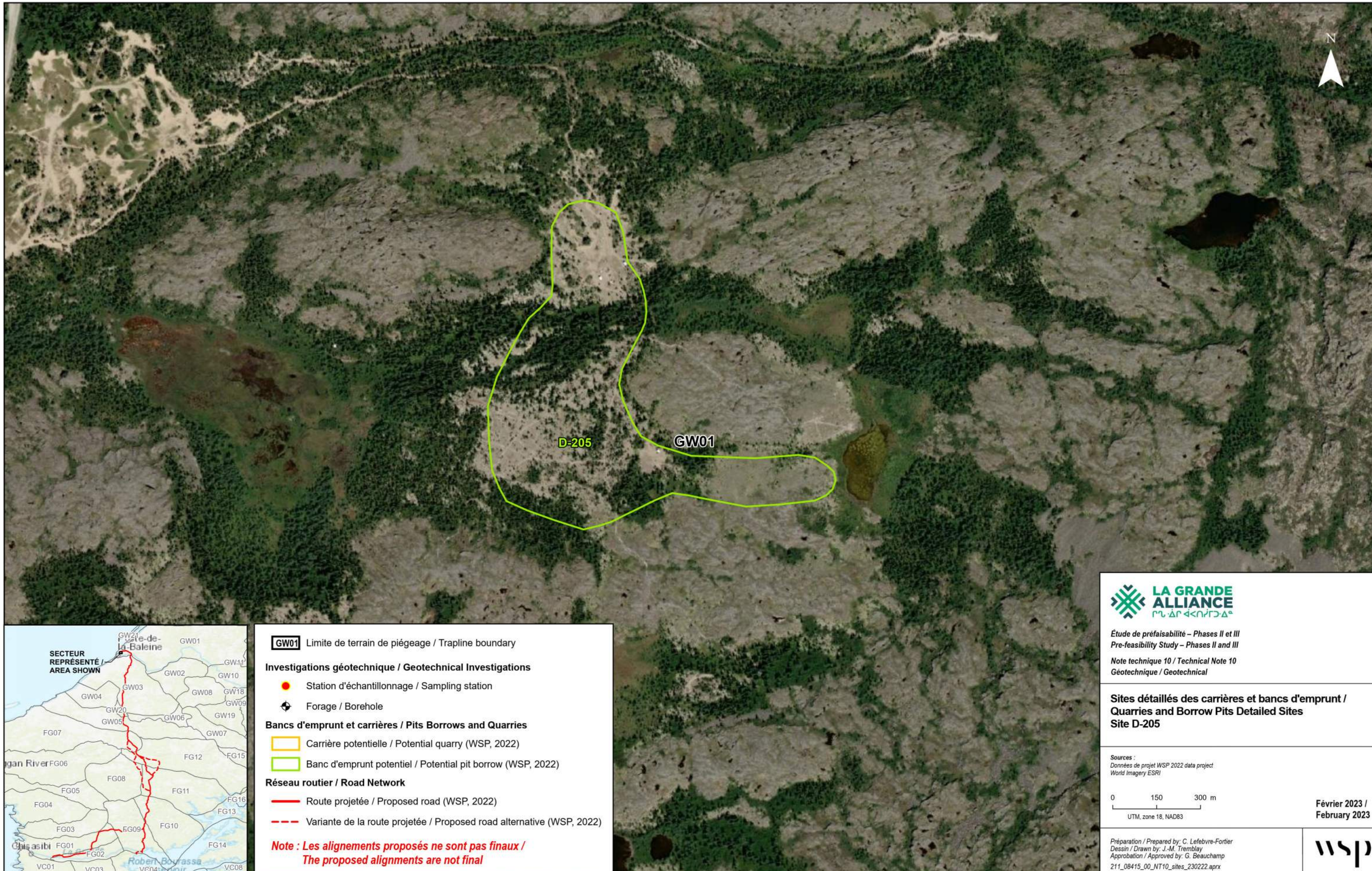
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site D-201B / R-202A / R-202B
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp



GW01 Limite de terrain de piégeage / Trapline boundary

Investigations géotechnique / Geotechnical Investigations

Station d'échantillonnage / Sampling station

Forage / Borehole

Bancs d'emprunt et carrières / Pits Borrows and Quarries

Carrière potentielle / Potential quarry (WSP, 2022)

Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)

Réseau routier / Road Network

Route projetée / Proposed road (WSP, 2022)

Variante de la route projetée / Proposed road alternative (WSP, 2022)

Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final

LA GRANDE ALLIANCE

Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III

Note technique 10 / Technical Note 10
Géotechnique / Geotechnical

Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site D-205

Sources :
Données de projet WSP 2022 data project
World Imagery ESRI

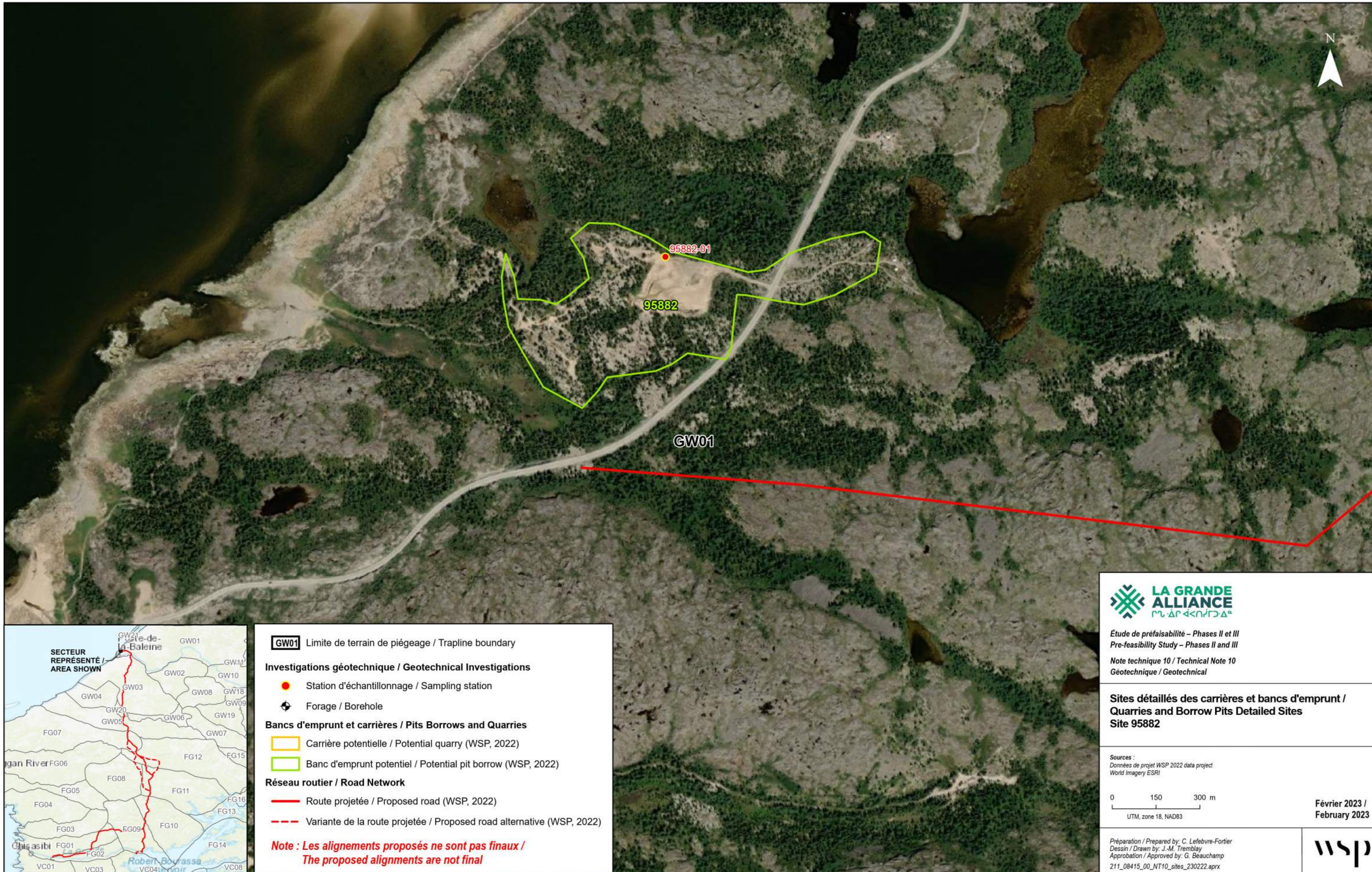
0 150 300 m

UTM, zone 18, NAD83

Février 2023 /
February 2023

Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx

WSP



95882-01
95882
GW01
N
SECTEUR REPRÉSENTÉ / AREA SHOWN
GW21
Poste-de-la-Baleine
GW01
GW11
GW02
GW10
GW03
GW08
GW18
GW04
GW09
GW20
GW19
GW05
GW06
FG07
GW07
FG12
FG15
FG06
FG08
FG05
FG11
FG16
FG04
FG13
FG10
FG03
FG09
FG01
FG02
FG14
Chisasibi
VC01
VC03
VC04
VC08
VC02
VC20
Robert-Bourassa
GW01 Limite de terrain de piégeage / Trapline boundary
Investigations géotechnique / Geotechnical Investigations
Station d'échantillonnage / Sampling station
Forage / Borehole
Bancs d'emprunt et carrières / Pits Borrows and Quarries
Carrière potentielle / Potential quarry (WSP, 2022)
Banc d'emprunt potentiel / Potential pit borrow (WSP, 2022)
Réseau routier / Road Network
Route projetée / Proposed road (WSP, 2022)
Variante de la route projetée / Proposed road alternative (WSP, 2022)
Note : Les alignements proposés ne sont pas finaux /
The proposed alignments are not final
LA GRANDE ALLIANCE
Étude de préfaisabilité – Phases II et III
Pre-feasibility Study – Phases II and III
Note technique 10 / Technical Note 10
Géotechnique / Geotechnical
Sites détaillés des carrières et bancs d'emprunt /
Quarries and Borrow Pits Detailed Sites
Site 95882
Sources :
Données de projet WSP 2022 data project
World Imagery ESRI
0 150 300 m
UTM, zone 18, NAD83
Février 2023 /
February 2023
Préparation / Prepared by: C. Lefebvre-Fortier
Dessin / Drawn by: J.-M. Tremblay
Approbation / Approved by: G. Beauchamp
211_08415_00_NT10_sites_230222.aprx
wsp

APPENDIX

E-2 BOREHOLE LOGS

NOTES EXPLICATIVES SUR LES RAPPORTS DE SONDAGE

PROFONDEUR : Distance par rapport à la surface du sol des différents contacts géologiques.

ÉLÉVATION : Référence à un point géodésique ou à un point arbitraire de l'emplacement vertical d'un sondage.

DESCRIPTION DES SOLS ET DU ROC

Classification des sols	Dimension des particules (mm)
Argile	< 0,002
Silt	0,002 à 0,080
Sable fin	0,080 à 0,4
Sable moyen	0,4 à 2
Sable grossier	2 à 5
Gravier fin	5 à 20
Gravier grossier	20 à 80
Cailloux	80 à 300
Blocs	> 300

Terminologie descriptive	Pourcentage
« Traces »	1 à 10 %
« Un peu »	10 à 20 %
Adjectif (ex., graveleux)	20 à 35 %
« Et »	35 à 50 %

Sols pulvérulents ou granulaires	Indice N de l'essai de pénétration standard (coups/300 mm)
Très lâche	0 - 4
Lâche	4 - 10
Compact	10 - 30
Dense	30 - 50
Très dense	> 50

Sols cohérents	Résistance au cisaillement non drainé (kPa)
Très mou	≤ 12
Mou	12 à 25
Ferme	25 à 50
Raide	50 à 100
Très raide	100 à 200
Dure	> 200

Classification du roc	Indice RQD
Très mauvaise qualité	< 25 %
Mauvaise qualité	25 à 50 %
Qualité moyenne	50 à 75 %
Bonne qualité	75 à 90 %
Excellente qualité	90 à 100 %

SYMBOLES

Roc	Gravier	Argile
Bloc	Sable	Remblai
Cailloux	Silt	Sol organique

ÉCHANTILLONS

TYPE ET NUMÉRO : Type d'échantillon conformément à la méthode d'échantillonnage utilisée et séquence numérique croissante correspondante à l'ordre d'échantillonnage.

SOUS-ÉCHANTILLON : S'applique lorsque plus d'une stratigraphie compose l'échantillon. La classification en sous-échantillon permet de différencier les stratigraphies pour les essais en laboratoire.

ÉTAT : Illustrer par un symbole défini dans l'entête du rapport de sondage. Permet de définir la condition de l'échantillon.

RÉCUPÉRATION : Rapport entre la longueur récupérée dans l'échantillonneur versus la longueur enfoncée de cet échantillonneur.

INDICE N : Obtenu par l'essai de pénétration standard, correspondant au nombre de coups d'un marteau de 63,5 kg tombant d'une hauteur de 760 mm nécessaire pour enfoncer un carottier fendu de 51 mm de diamètre sur une longueur de 300 mm.

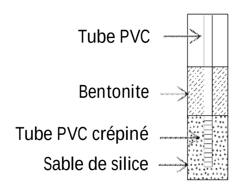
RQD : Rapport entre la sommation des morceaux plus longs que 100 mm de roc intact et la longueur forée d'une course.

GRAPHIQUE

Graphique permettant d'illustrer la résistance au cisaillement non drainé des sols cohérents, les essais de pénétration dynamique, les teneurs en eau et les limites d'Atterberg.

NIVEAU D'EAU

Cette colonne représente le niveau d'eau mesuré à la date indiquée. Le détail d'installation est illustré schématiquement.



ESSAIS

Cette section présente les résultats des essais effectués en chantier et au laboratoire. La définition des abréviations utilisées est indiquée dans l'entête du rapport de sondage.

Nom du consultant : WSP

Nom du client : Société de développement crie

RAPPORT DE FORAGE

Sondage N° R-010-F1

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **340 633,1**
	Y : **5 972 389,5**
	Z : **206,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-09-06**
Profondeur du sondage :	**16,06 m**

TYPE D'ÉCHANTILLON

- CF Cuillère fendue
- CR Échantillon par forage au diamant
- EM Manuel
- TA Tarière
- TT Tube transparent
- TS Tube shelby

ÉTAT DE L'ÉCHANTILLON

- Remanié
- Intact
- Perdu
- Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES

- N: Indice de pénétration standard
- R: Refus (N > 100)
- PM: Poids du marteau / 61 cm
- % RQD = $\frac{\sum \text{Carottes} > 4 \text{ po. (10 cm)}}{\text{Longueur forée}}$

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION

Piézo | Hauteur du PVC/Sol* (m)

** PVC hors sol : -*
PVC sous la surface du terrain : +

NIVEAUX D'EAU

Piézo | Date | Prof* (m) | Niveau (m)

** Prof. par rapport à la surface du terrain*

GRAPHIQUE

- × : N (pen. standard)
- + : Nc (pen. dynamique)
- ■ : Cu (laboratoire)
- □ : Cur (laboratoire)
- ▲ : Cu (chantier)
- △ : Cur (chantier)

Wp w Wl — 20 40 60 80

ESSAIS

- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U^p Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm	INSTALLATION	ESSAIS
206,00	Niveau								
0,00	Roc: Syénite à quartz et Monzonite à quartz, gris pâle rosé à gris foncé, grains moyens à grossiers, massif avec présence d'un léger rubannement diffus, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Moyenne jusqu'à 4,03 m, puis bonne à excellente par la suite.	CR-01		BTW	100	70			
		CR-02		BTW	100	71			
		CR-03		BTW	100	56			
		CR-04		BTW	100	100			
		CR-05		BTW	100	84			
		CR-06		BTW	100	93			
		CR-07		BTW	100	88			
		CR-08		BTW	100	98			
		CR-09		BTW	100	97			
		CR-10		BTW	100	98			
		CR-11		BTW	100	93			
189,94 16,06	Fin du forage.								

PROFONDEUR (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

PROFONDEUR (pi): 5 10 15 20 25 30 35 40 45 50 55

Remarque(s) :

Date de production : 2022-11-24

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Nom du consultant : WSP

Nom du client : Société de développement crie

RAPPORT DE FORAGE

Sondage N° **R-010-F2**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **340 600,0**
	Y : **5 972 692,9**
	Z : **201,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-09-05**
Profondeur du sondage :	**15,36 m**

TYPE D'ÉCHANTILLON
- CF Cuillère fendue
- CR Échantillon par forage au diamant
- EM Manuel
- TA Tarière
- TT Tube transparent
- TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
- Remanié
- Intact
- Perdu
- Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
- N: Indice de pénétration standard
- R: Refus (N > 100)
- PM: Poids du marteau / 61 cm
- % RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION

Piézo | Hauteur du PVC/Sol* (m)

** PVC hors sol : -*
PVC sous la surface du terrain : +

NIVEAUX D'EAU

Piézo | Date | Prof* (m) | Niveau (m)

** Prof. par rapport à la surface du terrain*

GRAPHIQUE
- × : N (pen. standard)
- + : Nc (pen. dynamique)
- ■ : Cu (laboratoire)
- □ : Cur (laboratoire)
- ▲ : Cu (chantier)
- △ : Cur (chantier)

Wp w Wl — 20 40 60 80

ESSAIS
- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

STRATIGRAPHIE / ÉCHANTILLONS

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
201,00	Niveau
0,00	Roc: Syénite à quartz, gris foncé à pâle rosé, grains moyens à très grossiers, massif, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Moyenne jusqu'à 0,85 m, puis excellente par la suite.
193,03 7,97	Syénite à quartz, gris foncé à pâle rosé, grains moyens à grossiers, légèrement rubanné, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Bonne à excellente excepté de 10,09 à 11,65 m où la qualité est plutôt moyenne.
185,64 15,36	Fin du forage.

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm
CR-01		BTW	100	55	
CR-02		BTW	100	92	
CR-03		BTW	100	94	
CR-04		BTW	100	99	
CR-05		BTW	100	94	
CR-06	A B	BTW	100	98	
CR-07		BTW	99	77	
CR-08		BTW	100	69	
CR-09		BTW	100	94	
CR-10		BTW	100	85	
CR-11		BTW	100	100	

Profondeur (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Profondeur (pi): 5 10 15 20 25 30 35 40 45 50 55

Remarque(s) :

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : Société de développement crie

RAPPORT DE FORAGE

Sondage N° R-054C-F1

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **345 508,0** Y : **6 010 809,3** Z : **212,00**
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.** Inclinaison : **90**	No. de projet :	**211-08415-00**
Type de forage :	**Forage au diamant** Azimut :	No. plan de localisation :	**ANNEXE E-1**
Diamètre du forage :	**BTW** Diamètre du carottier : **BTW**	Date du début du sondage :	**2022-09-02**
Technicien :	**Christophe Ménard, CPI** Vérifié par : **Philip Dumont, géo.**	Profondeur du sondage :	**15,89 m**

TYPE D'ÉCHANTILLON
CF Cuillère fendue
CR Échantillon par forage au diamant
EM Manuel
TA Tarière
TT Tube transparent
TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
Remanié
Intact
Perdu
Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
N: Indice de pénétration standard
R: Refus (N > 100)
PM: Poids du marteau / 61 cm
% RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo | Hauteur du PVC/Sol* (m)
* PVC hors sol : -
PVC sous la surface du terrain : +

NIVEAUX D'EAU
Piézo | Date | Prof* (m) | Niveau (m)
* Prof. par rapport à la surface du terrain

GRAPHIQUE
× : N (pen. standard)
+ : Nc (pen. dynamique)
■ : Cu (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)
Wp w Wl
20 40 60 80

ESSAIS
AG Analyse granulométrique
AC Analyse chimique
W_L Limite liquide
W_P Limite plastique
W_N Teneur en eau
Cu Cisaillement non drainé
Cur Cisaillement remanié
σ'_p Préconsolidation
U^p Compression uniaxiale sur carotte de roc
Dup Éch. duplicata prélevé

STRATIGRAPHIE / ÉCHANTILLONS

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	TYPE - NO	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD
212,00	Niveau				
0,00	Roc: Syénite à quartz, gris pâle rosé à gris foncé, grains moyens à grossiers, massif, très peu altéré et très faiblement météorisé près de la surface. Présence d'enclaves mafiques arrondies centimétriques à décimétriques. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Bonne jusqu'à 0,84 m, puis excellente par la suite.	CR-01	BTW	100	87
		CR-02	BTW	100	96
		CR-03	BTW	100	94
		CR-04	BTW	100	97
		CR-05	BTW	100	94
		CR-06	BTW	100	94
		CR-07	BTW	100	96
		CR-08	BTW	100	98
201,70 10,30	Monzonite à quartz, gris pâle rosé à gris foncé, grains moyens à grossiers, massif, très peu altéré et très faiblement météorisé. Présence d'enclaves mafiques arrondies centimétriques à décimétriques. Présence de joints sub-horizontaux. Roc de qualité (RQD): Excellente.	CR-09	BTW	100	100
		CR-10	BTW	100	90
		CR-11	BTW	100	97
		CR-12	BTW	100	100
196,11 15,89	Fin du forage.				

Remarque(s) :

Date de production : 2022-11-24

WSP_FR_Log.sty

Nom du consultant : WSP

Nom du client : Société de développement crie

RAPPORT DE FORAGE

Sondage N° R-054D-F2

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)
X : **346 271,1**
Y : **6 010 975,9**
Z : **200,00**

No. de projet : **211-08415-00**
No. plan de localisation : **ANNEXE E-1**
Date du début du sondage : **2022-08-31**
Profondeur du sondage : **16,02 m**

TYPE D'ÉCHANTILLON
CF Cuillère fendue
CR Échantillon par forage au diamant
EM Manuel
TA Tarière
TT Tube transparent
TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
Remanié
Intact
Perdu
Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
N: Indice de pénétration standard
R: Refus (N > 100)
PM: Poids du marteau / 61 cm
% RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo | Hauteur du PVC/Sol* (m)
* PVC hors sol : -
PVC sous la surface du terrain : +

NIVEAUX D'EAU
Piézo | Date | Prof* (m) | Niveau (m)
* Prof. par rapport à la surface du terrain

GRAPHIQUE
× : N (pen. standard)
+ : Nc (pen. dynamique)
■ : Cur (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)
Wp w Wl
20 40 60 80

ESSAIS
AG Analyse granulométrique
AC Analyse chimique
W_L Limite liquide
W_P Limite plastique
W_N Teneur en eau
Cu Cisaillement non drainé
Cur Cisaillement remanié
σ'_p Préconsolidation
U Compression uniaxiale sur carotte de roc
Dup Éch. duplicata prélevé

STRATIGRAPHIE

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
200,00	Niveau
0,00	Roc: Syénite à quartz, gris moyen rosé à gris foncé verdâtre, grains moyens à grossiers, massif, très peu altéré et très faiblement météorisé. Présence d'enclaves mafiques arrondies centimétriques à décimétriques. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Bonne à excellente.
183,98 16,02	Fin du forage.

ÉCHANTILLONS

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm
CR-01		BTW	100	83	
CR-02		BTW	100	88	
CR-03		BTW	99	93	
CR-04		BTW	100	94	
CR-05		BTW	99	77	
CR-06	A B	BTW	100	86	
CR-07		BTW	100	100	
CR-08		BTW	100	99	
CR-09		BTW	100	83	
CR-10		BTW	99	93	
CR-11		BTW	100	95	

Remarque(s) :

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : Société de développement crie — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° **R-110-F1**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **334 806,3** Y : **6 054 882,3** Z : **173,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-27**
Profondeur du sondage :	**15,70 m**

TYPE D'ÉCHANTILLON
CF Cuillère fendue
CR Échantillon par forage au diamant
EM Manuel
TA Tarière
TT Tube transparent
TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
Remanié
Intact
Perdu
Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
N: Indice de pénétration standard
R: Refus (N > 100)
PM: Poids du marteau / 61 cm
% RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo | Hauteur du PVC/Sol* (m)
* PVC hors sol : -
PVC sous la surface du terrain : +

NIVEAUX D'EAU
Piézo | Date | Prof* (m) | Niveau (m)
* Prof. par rapport à la surface du terrain

GRAPHIQUE
× : N (pen. standard)
+ : Nc (pen. dynamique)
■ : Cu (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)
Wp w Wl
20 40 60 80

ESSAIS
AG Analyse granulométrique
AC Analyse chimique
W_L Limite liquide
W_P Limite plastique
W_N Teneur en eau
Cu Cisaillement non drainé
Cur Cisaillement remanié
σ'_p Préconsolidation
U Compression uniaxiale sur carotte de roc
Dup Éch. duplicata prélevé

STRATIGRAPHIE / ÉCHANTILLONS

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
173,00	Niveau
0,00	Roc: Monzonite à quartz, gris pâle rosé à gris foncé verdâtre, grains grossiers, massif avec léger rubannement, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Bonne jusqu'à 0,84 m, puis excellente par la suite.
167,22 5,78	Syénite à quartz, gris pâle rosé, grains moyens à grossiers, massif avec léger rubannement, non altéré et très faiblement météorisé. Présence de quelques injections pegmatitiques centimétriques. Présence de joints sub-horizontaux. Roc de qualité (RQD): Excellente excepté entre 10,94 et 12,55 m où la qualité est plutôt bonne.
157,30 15,70	Fin du forage.

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD
CR-01		BTW	100	85
CR-02		BTW	100	100
CR-03		BTW	100	100
CR-04		BTW	100	99
CR-05		BTW	100	92
CR-06		BTW	100	100
CR-07		BTW	100	99
CR-08		BTW	100	100
CR-09		BTW	100	87
CR-10	A B	BTW	100	90
CR-11		BTW	100	96

Remarque(s) :

WSP_FR_Log.sty

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° **R-110-F2B**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83) — X : **334 792,5** Y : **6 055 318,9** Z : **206,00**

No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-28**
Profondeur du sondage :	**16,16 m**

TYPE D'ÉCHANTILLON
CF Cuillère fendue
CR Échantillon par forage au diamant
EM Manuel
TA Tarière
TT Tube transparent
TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
Remanié
Intact
Perdu
Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
N: Indice de pénétration standard
R: Refus (N > 100)
PM: Poids du marteau / 61 cm
% RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo — Hauteur du PVC/Sol* (m)
* PVC hors sol : -
PVC sous la surface du terrain : +

NIVEAUX D'EAU
Piézo — Date — Prof* (m) — Niveau (m)
* Prof. par rapport à la surface du terrain

GRAPHIQUE
× : N (pen. standard)
+ : Nc (pen. dynamique)
■ : Cu (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)
Wp w Wl
20 40 60 80

ESSAIS
AG Analyse granulométrique
AC Analyse chimique
W_L Limite liquide
W_P Limite plastique
W_N Teneur en eau
Cu Cisaillement non drainé
Cur Cisaillement remanié
σ'_p Préconsolidation
U Compression uniaxiale sur carotte de roc
Dup Éch. duplicata prélevé

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm	INSTALLATION	ESSAIS
206,00	Niveau								
0,00	Roc: Syénite à quartz, gris pâle rosé à gris foncé verdâtre, grains moyens à grossiers, très peu altéré et très faiblement météorisé près de la surface. Présence de quelques passages pegmatitiques et d'enclaves mafiques arrondies centimétriques et décimétriques. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Excellente.	CR-01		BTW	100	100			
		CR-02		BTW	100	99			
		CR-03		BTW	99	93			
		CR-04		BTW	100	91			
		CR-05		BTW	99	99			
		CR-06		BTW	100	94			
		CR-07		BTW	100	92			
		CR-08		BTW	99	94			
		CR-09		BTW	100	100			
		CR-10		BTW	99	99			
		CR-11		BTW	100	100			
189,84 16,16	Fin du forage.								

PROFONDEUR (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
PROFONDEUR (pi): 5 10 15 20 25 30 35 40 45 50 55

Remarque(s) :

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : Société de développement crie — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° R-147-F1

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **326 516,5**
	Y : **6 087 599,3**
	Z : **188,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-24**
Profondeur du sondage :	**15,84 m**

TYPE D'ÉCHANTILLON
- CF Cuillère fendue
- CR Échantillon par forage au diamant
- EM Manuel
- TA Tarière
- TT Tube transparent
- TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
- Remanié
- Intact
- Perdu
- Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
- N: Indice de pénétration standard
- R: Refus (N > 100)
- PM: Poids du marteau / 61 cm
- % RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo | Hauteur du PVC/Sol* (m)

** PVC hors sol : -
PVC sous la surface du terrain : +*

NIVEAUX D'EAU
Piézo | Date | Prof* (m) | Niveau (m)

** Prof. par rapport à la surface du terrain*

GRAPHIQUE
- × : N (pen. standard)
- + : Nc (pen. dynamique)
- ■ : Cu (laboratoire)
- □ : Cur (laboratoire)
- ▲ : Cu (chantier)
- △ : Cur (chantier)

Wp w Wl — 20 40 60 80

ESSAIS
- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

STRATIGRAPHIE / ÉCHANTILLONS

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
188,00	Niveau
0,00	Roc: Monzonite, beige rosé à gris foncé, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence d'enclaves mafiques arrondies centimétriques. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Excellente.
180,87 / 7,13	Monzonite et Diorite, beige rosé à gris foncé, grains moyens à grossiers, massif avec léger rubannement, non altéré et très faiblement météorisé. Présence d'enclaves arrondies centimétriques de composition variable. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Excellente.
175,22 / 12,78	Monzodiorite, beige à gris foncé, grains moyens à grossiers, massif avec léger rubannement, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Excellente.
172,16 / 15,84	Fin du forage.

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD
CR-01		BTW	100	100
CR-02		BTW	100	100
CR-03		BTW	100	100
CR-04		BTW	98	98
CR-05		BTW	100	100
CR-06		BTW	98	98
CR-07		BTW	100	100
CR-08		BTW	100	100
CR-09		BTW	100	100
CR-10	A, B	BTW	96	96
CR-11		BTW	100	100

PROFONDEUR (m): 1 – 17; PROFONDEUR (pi): 5 – 55

Remarque(s) :

Nom du consultant : WSP

Nom du client : Société de développement crie

RAPPORT DE FORAGE

Sondage N° **R-147-F2B**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **326 759,6**
	Y : **6 087 311,6**
	Z : **185,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-26**
Profondeur du sondage :	**16,00 m**

TYPE D'ÉCHANTILLON
CF Cuillère fendue
CR Échantillon par forage au diamant
EM Manuel
TA Tarière
TT Tube transparent
TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
Remanié
Intact
Perdu
Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
N: Indice de pénétration standard
R: Refus (N > 100)
PM: Poids du marteau / 61 cm
% RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo | Hauteur du PVC/Sol* (m)
** PVC hors sol : -*
PVC sous la surface du terrain : +

NIVEAUX D'EAU
Piézo | Date | Prof* (m) | Niveau (m)
** Prof. par rapport à la surface du terrain*

GRAPHIQUE
× : N (pen. standard)
+ : Nc (pen. dynamique)
■ : Cu (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)
Wp W Wl
20 40 60 80

ESSAIS
AG Analyse granulométrique
AC Analyse chimique
W_L Limite liquide
W_P Limite plastique
W_N Teneur en eau
Cu Cisaillement non drainé
Cur Cisaillement remanié
σ'_p Préconsolidation
U^p Compression uniaxiale sur carotte de roc
Dup Éch. duplicata prélevé

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD
185,00	Niveau					
0,00	Roc: Monzonite, beige rosé à gris foncé, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence d'enclaves granitiques arrondies centimétriques. Présence de joints sub-horizontaux et obliques.	CR-01		BTW	74	74
		CR-02		BTW	95	95
182,92 / 2,08	Roc de qualité (RQD): Moyenne jusqu'à 0,85 m, puis excellente par la suite.	CR-03	A, B	BTW	100	100
	Monzonite à Monzodiorite, beige rosé ou verdâtre à gris foncé, grains moyens à grossiers, massif avec léger rubannement, non altéré et très faiblement météorisé. Présence d'enclaves arrondies centimétriques de composition variable. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Bonne à excellente.	CR-04		BTW	93	93
		CR-05		BTW	96	96
		CR-06		BTW	87	87
		CR-07		BTW	100	100

PROFONDEUR (m): 1, 2, 3, 4, 5, 6, 7
PROFONDEUR (pi): 5, 10, 15, 20, 25

Remarque(s) :

WSP_FR_Log.sty

Nom du consultant : WSP

Nom du client : Société de développement Crie — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° R-147-F2B

STRATIGRAPHIE | **ÉCHANTILLONS** | **GRAPHIQUE** | **INSTALLATION** | **ESSAIS**

Légende graphique :
- × : N (pen. standard)
- + : Nc (pen. dynamique)
- ■ : Cu (laboratoire)
- □ : Cur (laboratoire)
- ▲ : Cu (chantier)
- △ : Cur (chantier)

Wp w Wl — 20 40 60 80

Essais :
- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm
		CR-08		BTW	99	99	
		CR-09		BTW	100	100	
		CR-10		BTW	100	100	
172,25 / 12,75	Monzonite, beige légèrement rosé à verdâtre, grains moyens à grossiers, massif, très peu altéré et très faiblement météorisé. Présence d'enclaves mafiques arrondies centimétriques. Présence de joints sub-horizontaux et obliques. Roc de qualité (RQD): Excellente.	CR-11		BTW	100	100	
170,62 / 14,38	Monzonite à Monzodiorite, beige rosé à gris foncé, grains moyens à grossiers, massif avec léger rubannement, très peu altéré et très faiblement météorisé. Présence d'enclaves arrondies centimétriques de composition variable. Présence d'un joint oblique. Roc de qualité (RQD): Excellente.	CR-12		BTW	100	100	
169,00 / 16,00	Fin du forage.						

PROFONDEUR (m): 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

PROFONDEUR (pi): 30, 35, 40, 45, 50, 55, 60, 65, 70

WSP_FR_Log.sty

Nom du consultant : WSP

Nom du client : Société de développement crie (Respect · Collaboration · Puissance)

RAPPORT DE FORAGE

Sondage N° R-165-F1

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**
Nom du requérant :	**Société de développement crie**
Localisation civile :	**Grande Alliance - Baie-James**
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**
Inclinaison :	**90**
Type de forage :	**Forage au diamant**
Azimut :	
Diamètre du forage :	**BTW**
Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**
Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **328 631,0**
	Y : **6 104 614,3**
	Z : **175,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-23**
Profondeur du sondage :	**15,49 m**

TYPE D'ÉCHANTILLON
- CF Cuillère fendue
- CR Échantillon par forage au diamant
- EM Manuel
- TA Tarière
- TT Tube transparent
- TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
- Remanié
- Intact
- Perdu
- Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
- N: Indice de pénétration standard
- R: Refus (N > 100)
- PM: Poids du marteau / 61 cm
- % RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION

Piézo | Hauteur du PVC/Sol* (m)

* PVC hors sol : -
PVC sous la surface du terrain : +

NIVEAUX D'EAU

Piézo | Date | Prof* (m) | Niveau (m)

* Prof. par rapport à la surface du terrain

GRAPHIQUE
- × : N (pen. standard)
- + : Nc (pen. dynamique)
- ■ : Cu (laboratoire)
- □ : Cur (laboratoire)
- ▲ : Cu (chantier)
- △ : Cur (chantier)

Wp w Wl — 20 40 60 80

ESSAIS
- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

STRATIGRAPHIE

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
175,00	Niveau
0,00	Roc: Syénite à quartz, gris pâle rosé, grains moyens à grossiers, massif, faiblement altéré et très faiblement météorisé. Présence de joints sub-horizontaux, obliques et sub-verticaux. Roc de qualité (RQD): Très mauvaise jusqu'à 0,80 m, puis bonne à excellente par la suite, excepté entre 2,40 et 8,20 m où la qualité du roc est plutôt moyenne.
159,51 15,49	Fin du forage.

ÉCHANTILLONS

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm
CR-01		BTW	85	15	
CR-02		BTW	99	92	
CR-03		BTW	100	62	
CR-04		BTW	100	70	
CR-05		BTW	100	80	
CR-06		BTW	100	72	
CR-07		BTW	100	91	
CR-08		BTW	100	75	
CR-09		BTW	100	81	
CR-10		BTW	100	100	
CR-11		BTW	100	75	

Remarque(s) :

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : Société de développement crie (Respect · Collaboration · Puissance)

RAPPORT DE FORAGE

Sondage N° R-165-F2

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **328 129,6** Y : **6 104 687,0** Z : **170,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-22**
Profondeur du sondage :	**15,29 m**

TYPE D'ÉCHANTILLON
CF Cuillère fendue
CR Échantillon par forage au diamant
EM Manuel
TA Tarière
TT Tube transparent
TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
Remanié
Intact
Perdu
Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
N: Indice de pénétration standard
R: Refus (N > 100)
PM: Poids du marteau / 61 cm
% RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION
Piézo | Hauteur du PVC/Sol* (m)
** PVC hors sol : -*
PVC sous la surface du terrain : +

NIVEAUX D'EAU
Piézo | Date | Prof* (m) | Niveau (m)
** Prof. par rapport à la surface du terrain*

GRAPHIQUE
× : N (pen. standard)
\+ : Nc (pen. dynamique)
■ : Cu (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)
Wp w Wl
20 40 60 80

ESSAIS
AG Analyse granulométrique
AC Analyse chimique
W_L Limite liquide
W_P Limite plastique
W_N Teneur en eau
Cu Cisaillement non drainé
Cur Cisaillement remanié
σ'_p Préconsolidation
U Compression uniaxiale sur carotte de roc
Dup Éch. duplicata prélevé

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	TYPE - NO	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD
170,00	Niveau				
0,00	Roc: Syénite à quartz, gris moyen rosé, grains moyens à grossiers, massif, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux, obliques et sub-verticaux. Roc de qualité (RQD): Excellente.	CR-01	BTW	100	100
		CR-02	BTW	98	91
		CR-03	BTW	100	96
		CR-04	BTW	100	94
		CR-05	BTW	99	99
		CR-06	BTW	100	99
		CR-07	BTW	100	92
		CR-08	BTW	100	100
		CR-09	BTW	100	98
		CR-10	BTW	100	96
		CR-11	BTW	100	100
154,71 / 15,29	Fin du forage.				

Remarque(s) :

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : Société de développement Crie — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° R-192-F1

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**
Nom du requérant :	**Société de développement crie**
Localisation civile :	**Grande Alliance - Baie-James**
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**
Inclinaison :	**90**
Type de forage :	**Forage au diamant**
Azimut :	
Diamètre du forage :	**BTW**
Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**
Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **335 744,9**
	Y : **6 127 981,8**
	Z : **141,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-20**
Profondeur du sondage :	**15,84 m**

TYPE D'ÉCHANTILLON
- CF Cuillère fendue
- CR Échantillon par forage au diamant
- EM Manuel
- TA Tarière
- TT Tube transparent
- TS Tube shelby

ÉTAT DE L'ÉCHANTILLON
- Remanié
- Intact
- Perdu
- Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
- N: Indice de pénétration standard
- R: Refus (N > 100)
- PM: Poids du marteau / 61 cm
- % RQD = Σ Carottes > 4 po. (10 cm) / Longueur forée

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION

Piézo	Hauteur du PVC/Sol* (m)

** PVC hors sol : -*
PVC sous la surface du terrain : +

NIVEAUX D'EAU

Piézo	Date	Prof* (m)	Niveau (m)

** Prof. par rapport à la surface du terrain*

GRAPHIQUE
- × : N (pen. standard)
- + : Nc (pen. dynamique)
- ■ : Cu (laboratoire)
- □ : Cur (laboratoire)
- ▲ : Cu (chantier)
- △ : Cur (chantier)
- Wp w Wl
- 20 40 60 80

ESSAIS
- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

STRATIGRAPHIE

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
141,00	Niveau
0,00	Roc: Monzonite à Monzodiorite à quartz, blanc rosé à gris foncé verdâtre, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence d'enclaves mafiques centimétriques à décimétriques de 1,60 à 1,92 m, de 4,98 à 5,54 m et de 11,72 à 14,99 m. Présence de joints sub-horizontaux. Roc de qualité (RQD): Bonne à excellente.
125,16 / 15,84	Fin du forage.

ÉCHANTILLONS

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm
CR-01		BTW	100	100	
CR-02	A, B, C, D	BTW	100	75	
CR-03		BTW	100	92	
CR-04	A, B	BTW	100	94	
CR-05	A, B	BTW	100	100	
CR-06		BTW	100	92	
CR-07		BTW	100	91	
CR-08		BTW	100	100	
CR-09	A, B	BTW	100	90	
CR-10	A, B	BTW	100	91	
CR-11	A, B	BTW	100	95	

Remarque(s) :

Date de production : 2022-11-24

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Nom du consultant : WSP

Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° **R-192-F2**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**		
Nom du requérant :	**Société de développement crie**		
Localisation civile :	**Grande Alliance - Baie-James**		
Entrepreneur en forage :	**Succession Forage George Downing Ltée.**	Inclinaison :	**90**
Type de forage :	**Forage au diamant**	Azimut :	
Diamètre du forage :	**BTW**	Diamètre du carottier :	**BTW**
Technicien :	**Christophe Ménard, CPI**	Vérifié par :	**Philip Dumont, géo.**

Coordonnées géodésiques (m) UTM Zone 18 (NAD 83)	X : **336 502,3**
	Y : **6 127 540,5**
	Z : **144,00**
No. de projet :	**211-08415-00**
No. plan de localisation :	**ANNEXE E-1**
Date du début du sondage :	**2022-08-19**
Profondeur du sondage :	**15,57 m**

TYPE D'ÉCHANTILLON
- CF Cuillère fendue
- CR Échantillon par forage au diamant
- EM Manuel
- TA Tarière
- TT Tube transparent
- TS Tube shelby

ÉTAT DE L'ÉCHANTILLON: Remanié; Intact; Perdu; Forage au diamant

COMPACITÉ et INDICE "N"

Très lâche	0-4
Lâche	4-10
Compact	10-30
Dense	30-50
Très dense	>50

INDICE DE QUALITÉ DU ROC

% RQD	QUALIFICATIF
<25	Très mauvais
25-50	Mauvais
50-75	Moyen
75-90	Bon
90-100	Excellent

SYMBOLES
- N: Indice de pénétration standard
- R: Refus (N > 100)
- PM: Poids du marteau / 61 cm
- % RQD = $\frac{\sum \text{Carottes} > 4 \text{ po. (10 cm)}}{\text{Longueur forée}}$

TERMINOLOGIE

"traces"	1-10%
"un peu"	10-20%
adjectif (...eux)	20-35%
"et"	35-50%

CLASSIFICATION DES SOLS

Argile	< 0,002 mm
Silt	0,002 à 0,080 mm
Sable	0,080 à 5 mm
Gravier	5 à 80 mm
Cailloux	80 à 300 mm
Blocs	> 300 mm

CONSISTANCE et RÉSISTANCE au CISAILLEMENT (Cu)

Très molle	<12 kPa
Molle	12-25 kPa
Ferme	25-50 kPa
Raide	50-100 kPa
Très raide	100-200 kPa
Dure	>200 kPa

DÉTAILS D'INSTALLATION: Piézo | Hauteur du PVC/Sol* (m)

** PVC hors sol : -*
PVC sous la surface du terrain : +

NIVEAUX D'EAU: Piézo | Date | Prof* (m) | Niveau (m)

** Prof. par rapport à la surface du terrain*

GRAPHIQUE: × : N (pen. standard); + : Nc (pen. dynamique); ■ : Cu (laboratoire); □ : Cur (laboratoire); ▲ : Cu (chantier); △ : Cur (chantier); Wp w Wl; 20 40 60 80

ESSAIS: AG Analyse granulométrique; AC Analyse chimique; W_L Limite liquide; W_P Limite plastique; W_N Teneur en eau; Cu Cisaillement non drainé; Cur Cisaillement remanié; σ'_p Préconsolidation; U^p Compression uniaxiale sur carotte de roc; Dup Éch. duplicata prélevé

STRATIGRAPHIE

NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC
144,00	Niveau
0,00	Roc: Monzonite à quartz, blanc rosé à gris foncé verdâtre, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Moyenne jusqu'à 0,98 m, puis bonne à excellente par la suite excepté entre 7,09 et 7,90 m et entre 14,30 et 15,57 m où la qualité est plutôt moyenne.
141,81 / 2,19	Monzonite à quartz, gris moyen à foncé, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Excellente.
138,58 / 5,42	Monzonite, beige à gris foncé, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux, obliques et sub-verticaux. Roc de qualité (RQD): Moyenne à excellente.

ÉCHANTILLONS

TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm
CR-01	A, B, C	BTW	100	73	
CR-02		BTW	100	87	
CR-03		BTW	100	94	
CR-04		BTW	100	95	
CR-05		BTW	100	98	
CR-06		BTW	100	67	

PROFONDEUR (m): 1, 2, 3, 4, 5, 6, 7 — PROFONDEUR (pi): 5, 10, 15, 20, 25

Remarque(s) :

Date de production : 2022-11-24

Nom du consultant : WSP

Nom du client : Société de développement Crie — Respect · Collaboration · Puissance

RAPPORT DE FORAGE

Sondage N° R-192-F2

PROFONDEUR (m)	PROFONDEUR (pi)	NIVEAU (m) / PROFONDEUR	DESCRIPTION DU SOL ET DU ROC	SYMBOLES	TYPE - NO	SOUS - ÉCH.	ÉTAT et CALIBRE	RÉCUPÉRATION (%)	N, Nc ou RQD	COUPS / 15 cm	GRAPHIQUE	INSTALLATION	ESSAIS
					CR-07		BTW	100	99				
9	30	135,00 9,00	Monzondiorite à quartz, gris pâle rosé à gris foncé, grains moyens à grossiers, massif avec un léger rubannement, non altéré et très faiblement météorisé. Présence de joints sub-horizontaux. Roc de qualité (RQD): Excellente et devenant moyenne à partir de 14,30 m.		CR-08		BTW	100	96				
					CR-09		BTW	100	91				
					CR-10		BTW	100	90				
					CR-11		BTW	100	69				
15,57		128,43 15,57	Fin du forage.										

Profondeur (m) : 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Profondeur (pi) : 30, 35, 40, 45, 50, 55, 60, 65, 70

GRAPHIQUE

× : N (pen. standard)
+ : Nc (pen. dynamique)
■ : Cu (laboratoire)
□ : Cur (laboratoire)
▲ : Cu (chantier)
△ : Cur (chantier)

Wp w Wl

20 40 60 80

ESSAIS

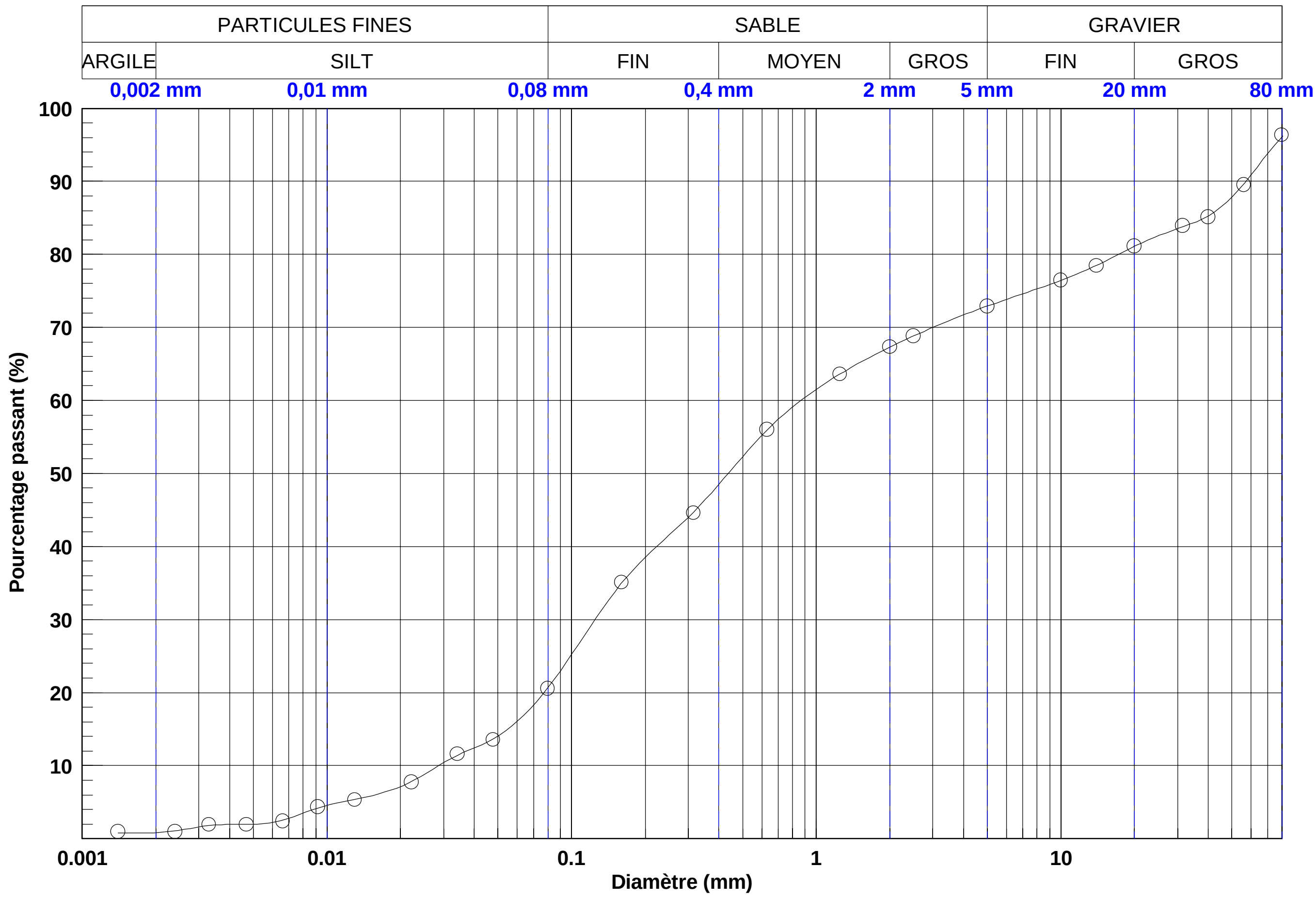
- AG Analyse granulométrique
- AC Analyse chimique
- W_L Limite liquide
- W_P Limite plastique
- W_N Teneur en eau
- Cu Cisaillement non drainé
- Cur Cisaillement remanié
- σ'_p Préconsolidation
- U Compression uniaxiale sur carotte de roc
- Dup Éch. duplicata prélevé

APPENDIX

E-3 *LABORATY TESTS RESULTS*

Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE Respect · Collaboration · Puissance	 **ANALYSE GRANULOMÉTRIQUE** **Sondage N°** **D-010**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	ARGILE	SILT	SABLE	GRAVIER
	0.8	19.8	52.3	23.2

Courbe	0,002 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
	0.83	20.63	34.97	44.71	55.94	63.61	68.83	72.91	76.44	78.50	81.10	83.16	85.25	89.66	96.09

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
	D-010	01	0.15 - 0.30	Sable graveleux, un peu de silt, présence de cailloux.	0.03	0.12	0.87	30.1	0.6	SM	6.3

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

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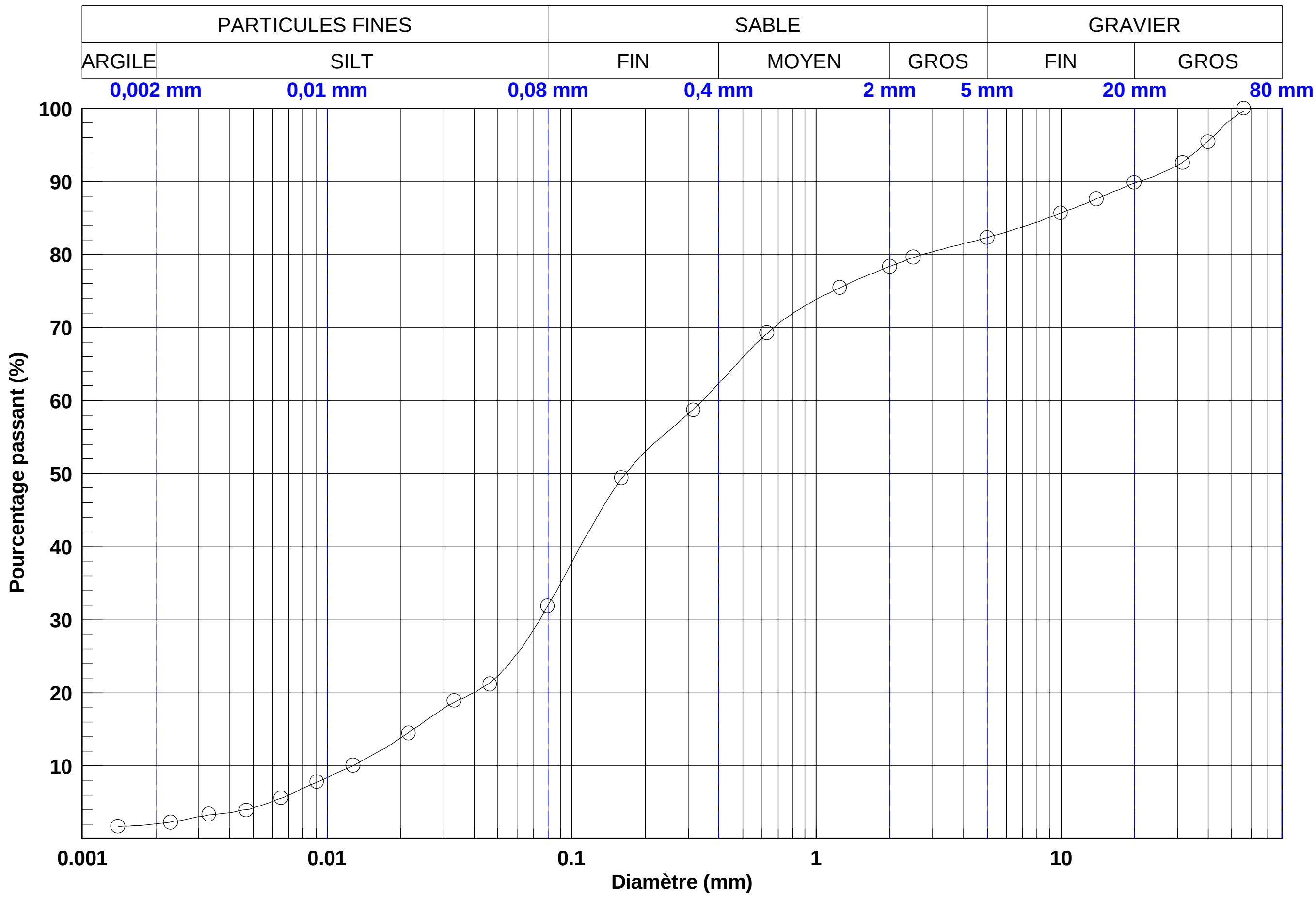
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE	

ANALYSE GRANULOMÉTRIQUE

Sondage N° **B-017**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	ARGILE	SILT	SABLE	GRAVIER
—○—	2.0	29.9	50.4	17.7

Courbe	0,002 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	2.00	31.86	49.26	58.80	69.20	75.44	79.56	82.29	85.65	87.60	89.73	91.67	95.54	99.66	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	B-017	01	0.00 - 0.60	Sable silteux, un peu de gravier, traces d'argile.	0.01	0.07	0.34	26.9	1.3	SM	6.5

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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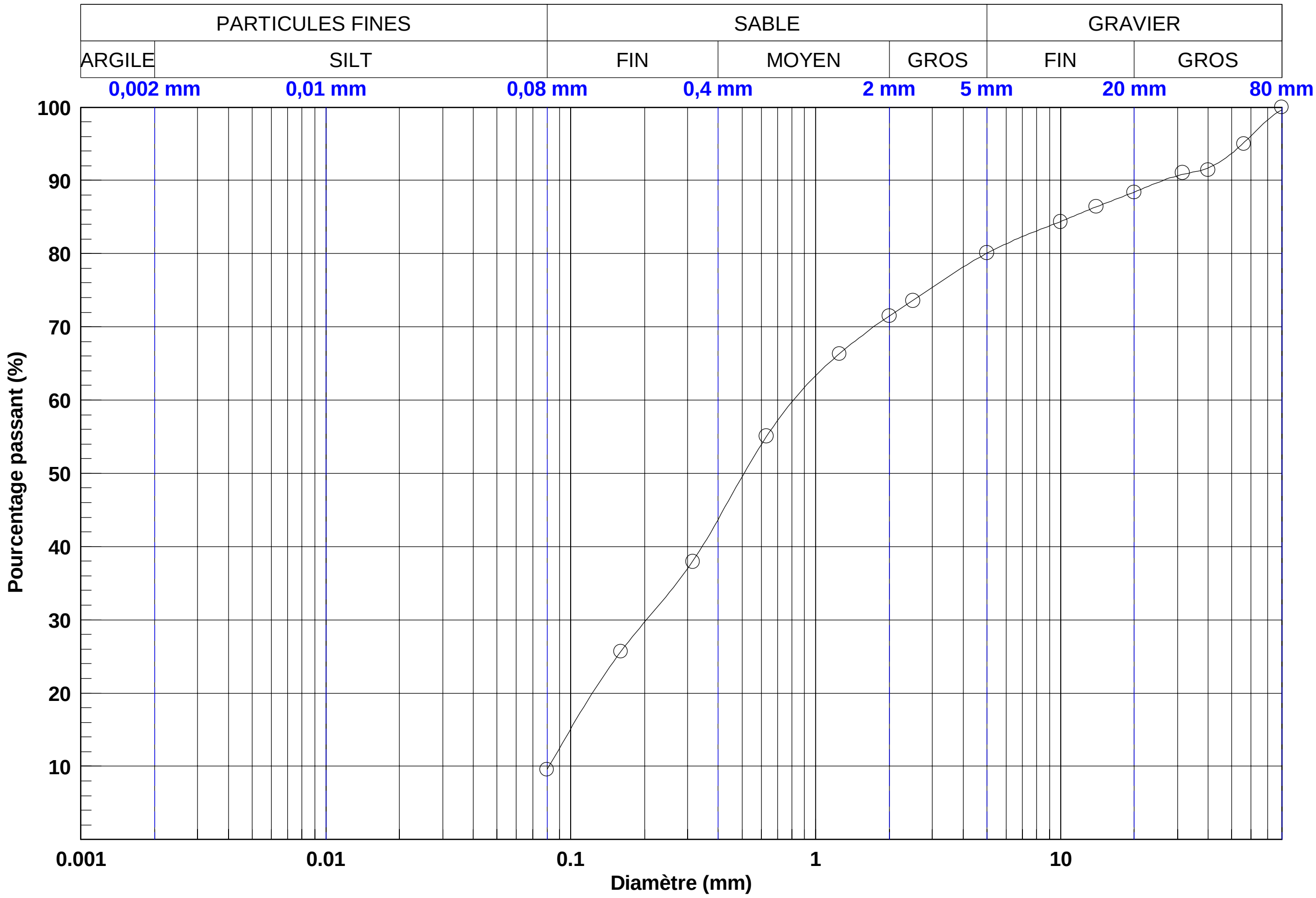
Nom du consultant : WSP	Nom du client : Société de développement Crie	Page 1 de 1

ANALYSE GRANULOMÉTRIQUE

Sondage N° **D-025A**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	9.6	70.5	19.6

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	9.57	9.57	25.62	38.07	55.00	66.34	73.64	80.06	84.38	86.39	88.43	90.32	91.69	95.15	99.65

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	D-025A	01	0.10 - 0.45	Sable, un peu de gravier, traces de silt.	0.08	0.20	0.81	10.0	0.6	SP-SM	4.8

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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Nom du consultant : WSP

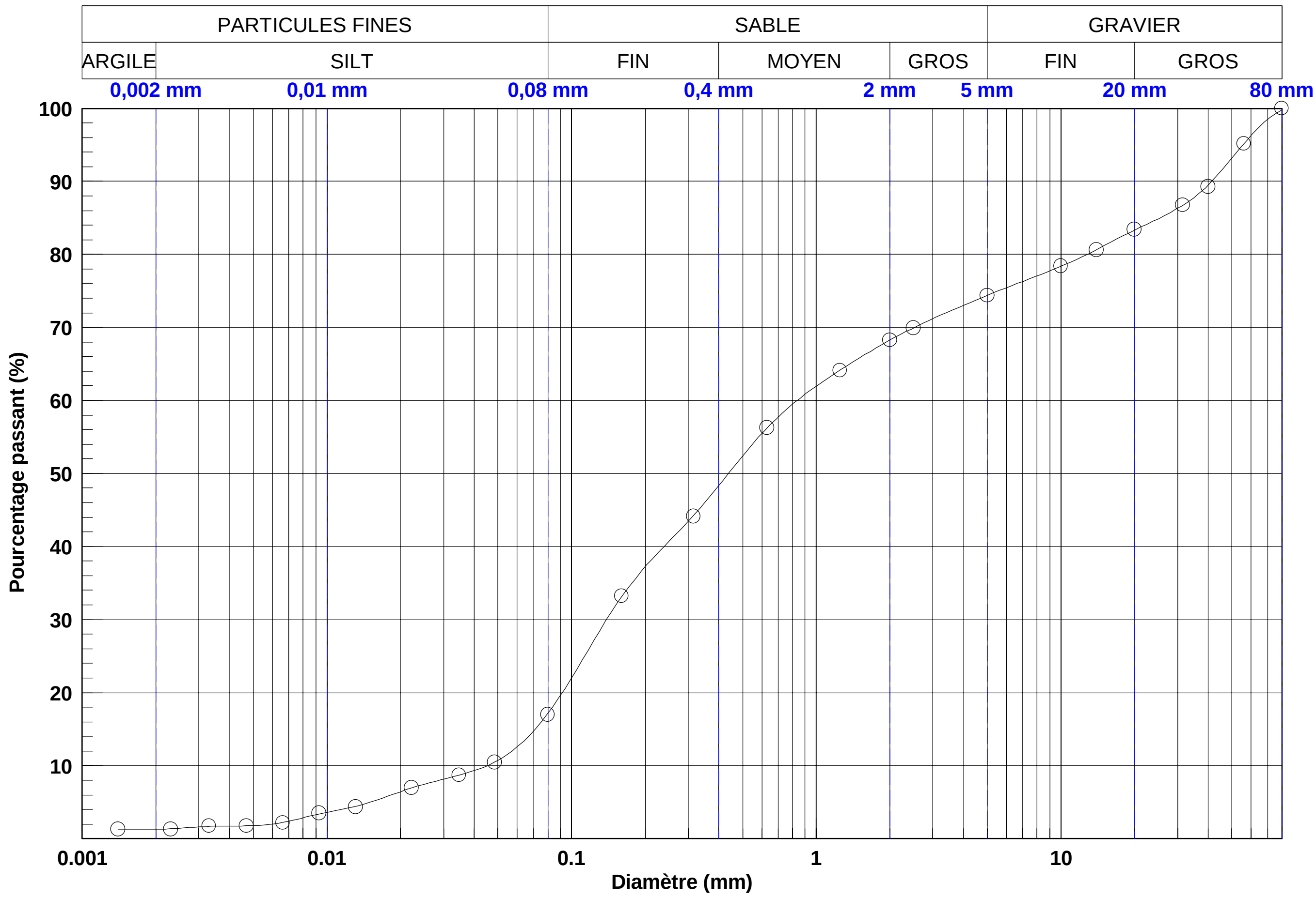
Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE

Respect · Collaboration · Puissance

ANALYSE GRANULOMÉTRIQUE

Sondage N° **D-025A**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	ARGILE	SILT	SABLE	GRAVIER
—○—	1.3	15.8	57.3	25.4

Courbe	0,002 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	1.28	17.09	33.10	44.23	56.21	64.13	69.93	74.39	78.39	80.63	83.32	85.73	89.49	95.15	99.75

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	D-025A	02	0.15 - 0.70	Sable graveleux, un peu de silt, traces d'argile.	0.05	0.14	0.84	18.5	0.5	SM	4.8

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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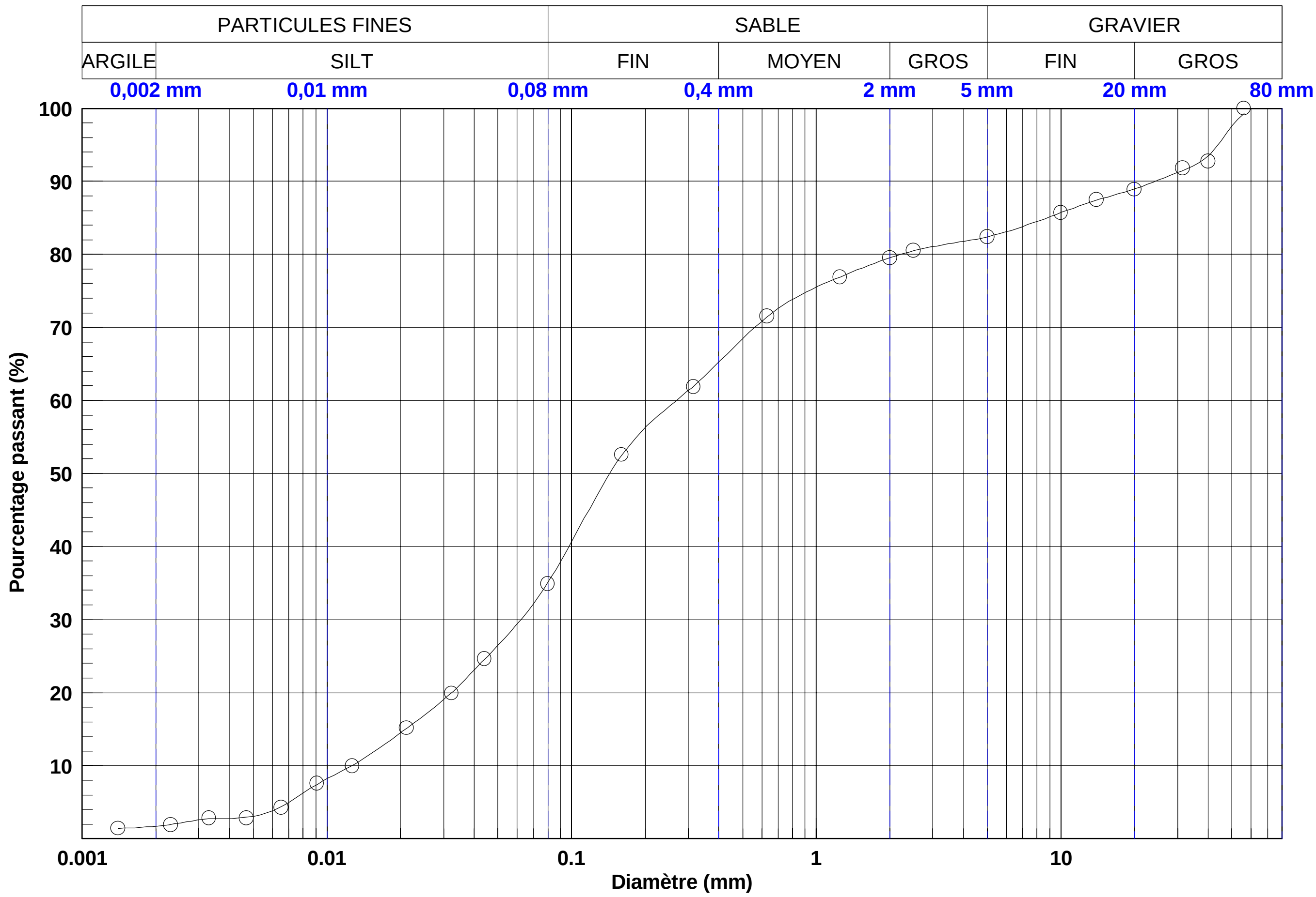
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE Respect · Collaboration · Puissance	 **ANALYSE GRANULOMÉTRIQUE** **Sondage N°** **B-034**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	ARGILE	SILT	SABLE	GRAVIER
-○-	1.7	33.3	47.4	17.6

Courbe	0,002 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
-○-	1.71	35.04	52.42	61.96	71.46	76.91	80.49	82.40	85.71	87.43	88.96	90.81	93.52	99.30	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
-○-	B-034	01	0.13 - 0.70	Sable silteux, un peu de gravier, traces d'argile.	0.01	0.06	0.27	21.2	1.1	SM	6.6

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

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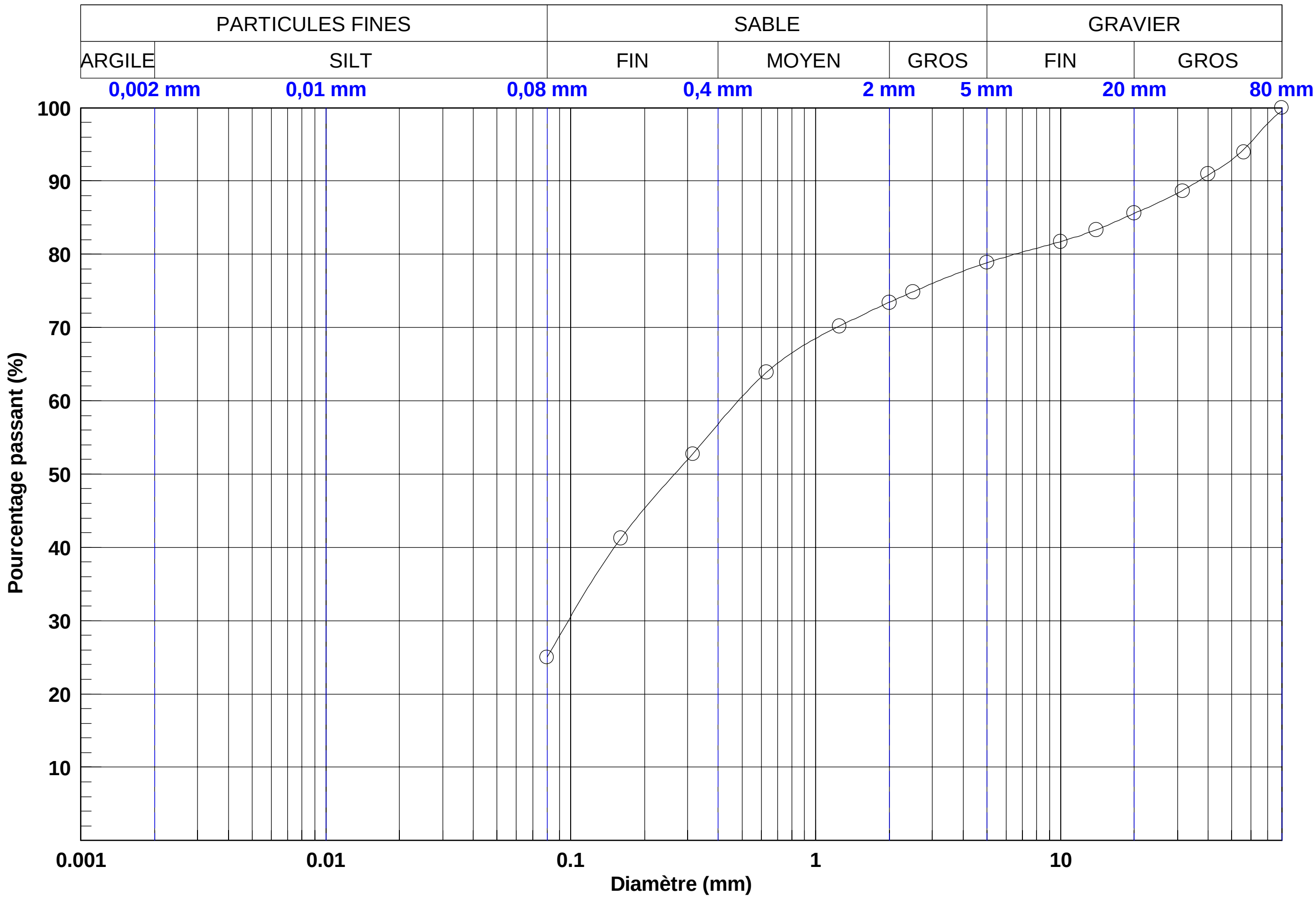
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE (Respect · Collaboration · Puissance)	Page 1 de 1

ANALYSE GRANULOMÉTRIQUE

Sondage N° **B-034**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	25.0	53.8	20.7

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	25.03	25.03	41.19	52.79	63.86	70.20	74.87	78.85	81.72	83.35	85.59	87.81	90.79	94.31	99.53

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	B-034	02	0.20 - 0.60	Sable silteux et graveleux.	-	0.10	0.48	-	-	SM	7.1

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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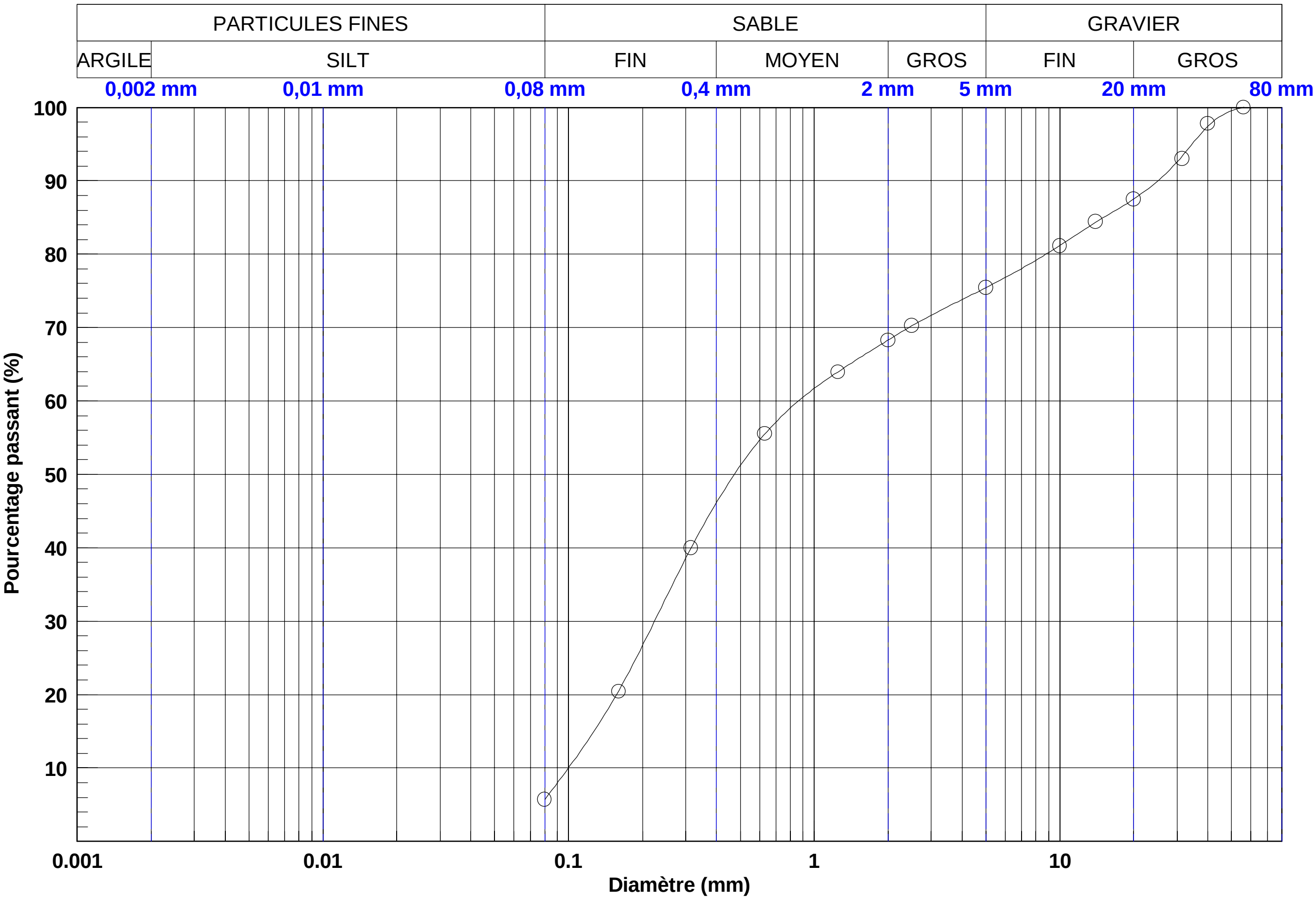
Nom du consultant : WSP	Nom du client : Société de développement crie	Page 1 de 1
		ANALYSE GRANULOMÉTRIQUE
		Sondage N° **D-046**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	5.7	69.8	24.6

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	5.68	5.68	20.52	39.93	55.51	63.97	70.24	75.44	81.18	84.35	87.52	91.48	97.42	100.00	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	D-046	01	0.15 - 0.55	Sable graveleux, traces de silt.	0.10	0.22	0.86	8.6	0.6	SP-SM	6.1

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

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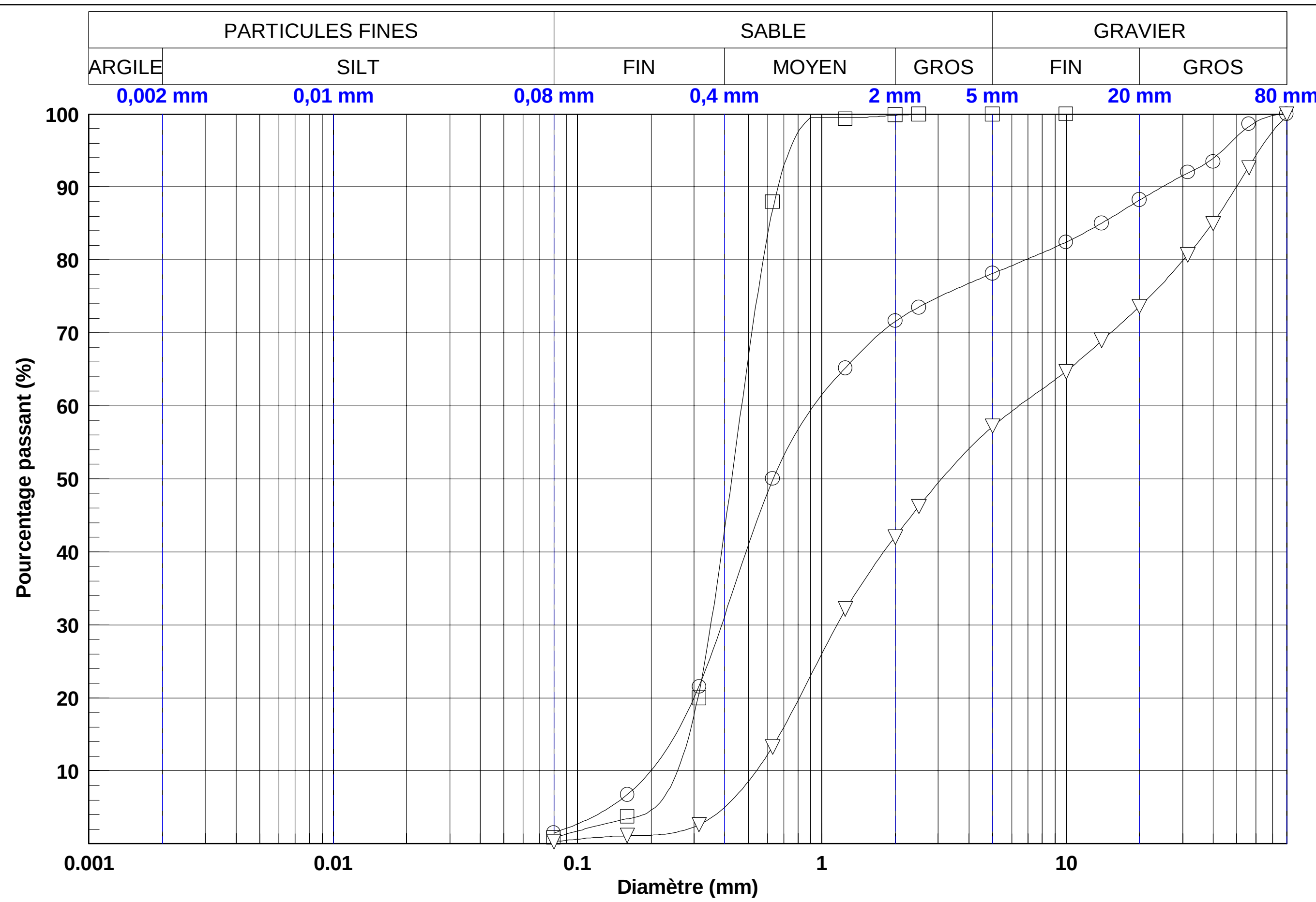
Nom du consultant :	Nom du client :	
WSP	SOCIÉTÉ DE DÉVELOPPEMENT CRIE Respect · Collaboration · Puissance	**ANALYSE GRANULOMÉTRIQUE** **Sondage N° D-061**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
○	1.5	76.7	21.8
□	0.8	99.1	0.0
▽	0.3	56.9	42.4

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
○	1.48	1.48	6.73	21.72	49.81	65.27	73.54	78.16	82.44	85.04	88.22	90.99	93.89	98.30	100.00
□	0.85	0.85	3.40	20.90	86.93	99.56	99.96	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00
▽	0.29	0.29	1.09	2.64	13.34	32.07	46.23	57.19	64.72	68.94	73.64	78.70	85.11	92.77	99.57

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
○	D-061	03	0.05 - 0.50	Sable graveleux, traces de silt.	0.20	0.39	0.92	4.6	0.8	SP	3.1
□	D-061	01	0.10 - 0.50	Sable.	0.26	0.35	0.47	1.8	1.0	SP	3.4
▽	D-061	02	0.10 - 0.50	Sable et gravier.	0.54	1.15	6.40	11.8	0.4	SP	0.8

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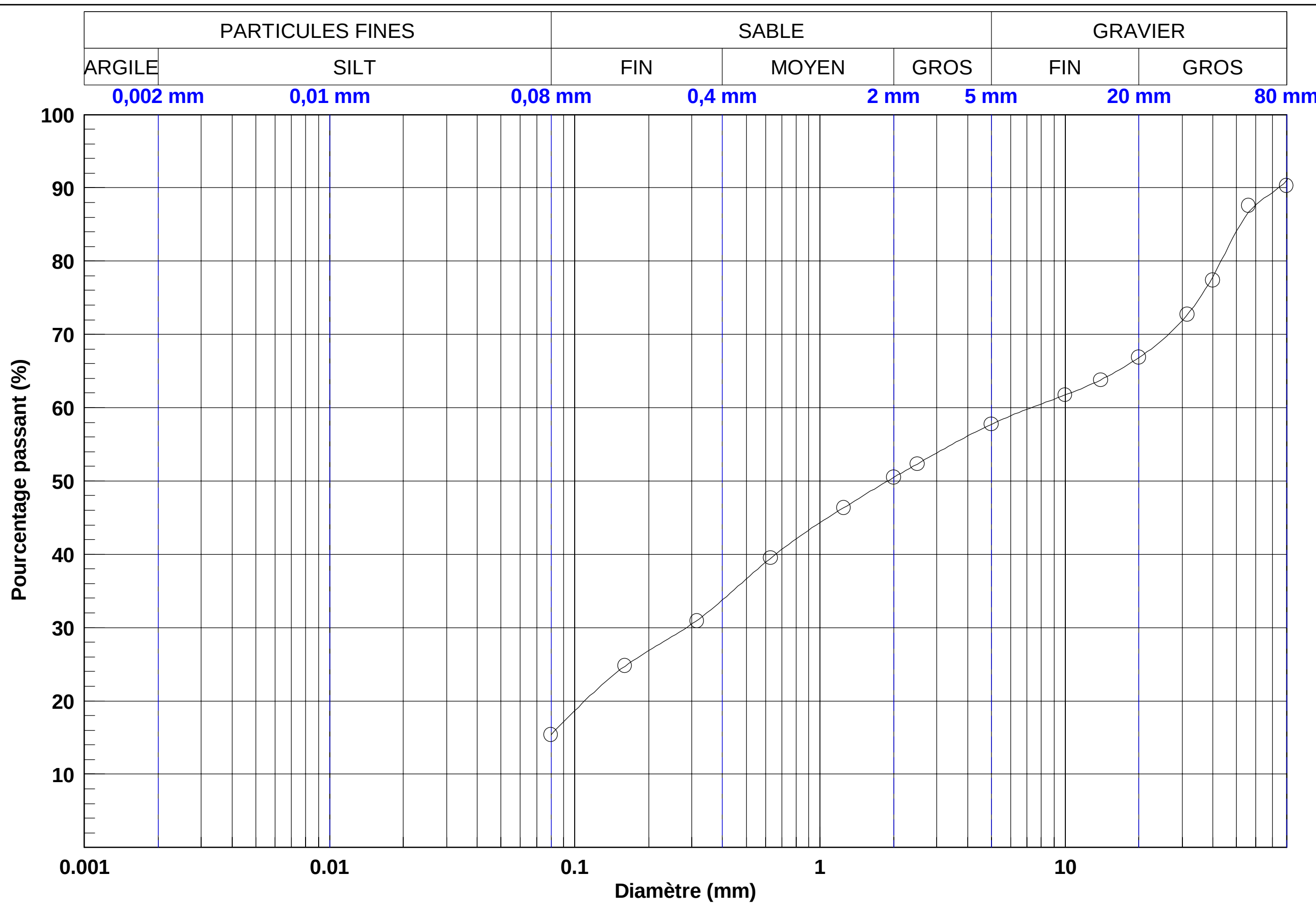
			Date de production : 2023-01-19

Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE — Respect · Collaboration · Puissance	**ANALYSE GRANULOMÉTRIQUE** **Sondage N°** **BV-089**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	15.4	42.3	33.3

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	15.41	15.41	24.72	30.99	39.48	46.34	52.34	57.75	61.74	63.81	66.84	70.82	77.88	86.65	91.03

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	BV-089	01	0.10 - 0.45	Sable graveleux, un peu de silt, présence de cailloux.	-	0.29	7.27	-	-	SM	5.7

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			Date de production : 2023-01-19

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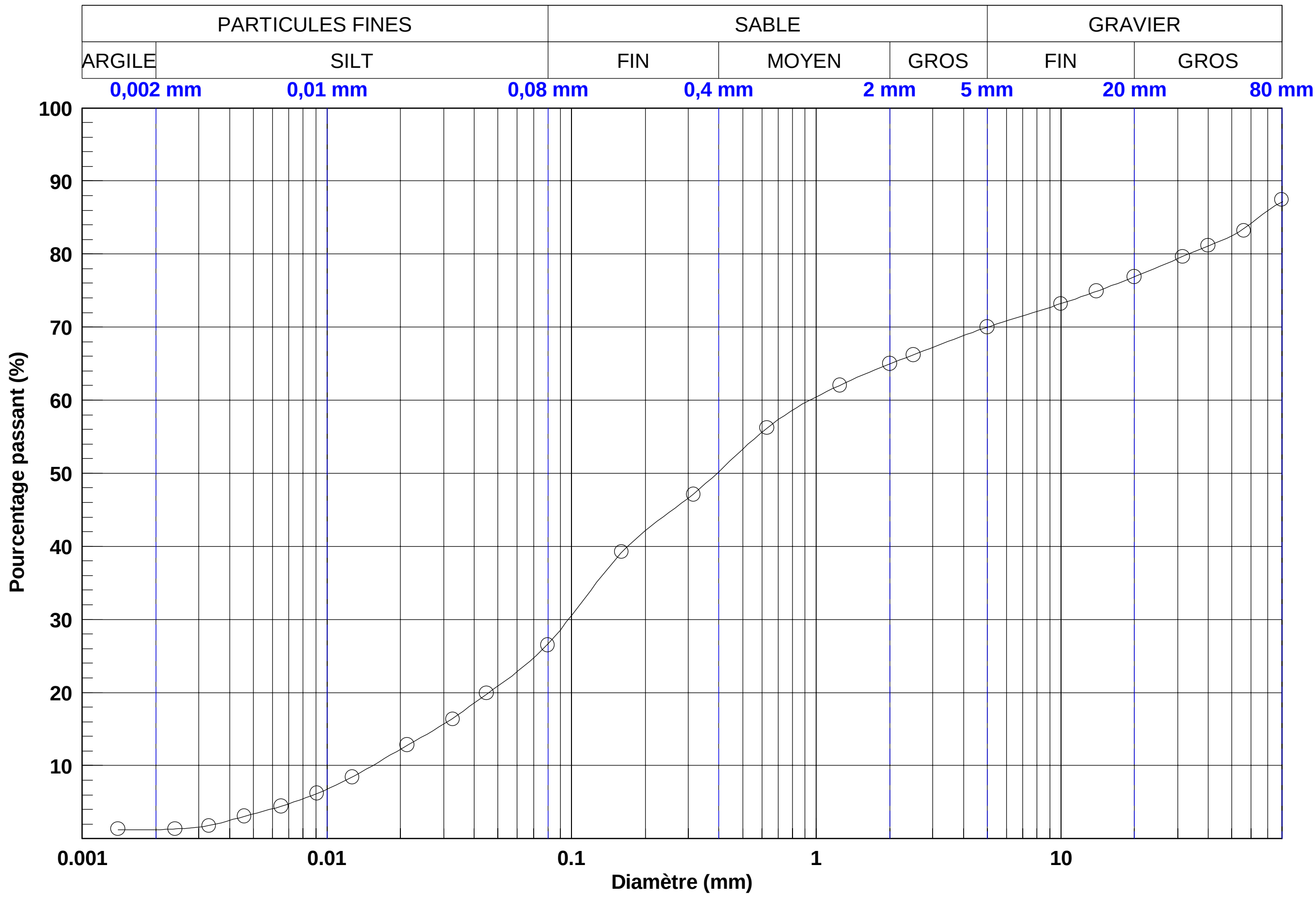
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE Respect · Collaboration · Puissance	Page 1 de 1

ANALYSE GRANULOMÉTRIQUE

Sondage N° **B-110**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	ARGILE	SILT	SABLE	GRAVIER
—○—	1.2	25.4	43.4	17.1

Courbe	0,002 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	1.24	26.62	39.13	47.17	56.17	62.05	66.22	69.98	73.21	74.91	76.89	78.93	81.08	83.49	87.11

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	B-110	01	0.20 - 0.80	Sable silteux, un peu de gravier, traces d'argile, présence de cailloux.	0.02	0.10	0.94	61.1	0.7	SM	7.5

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

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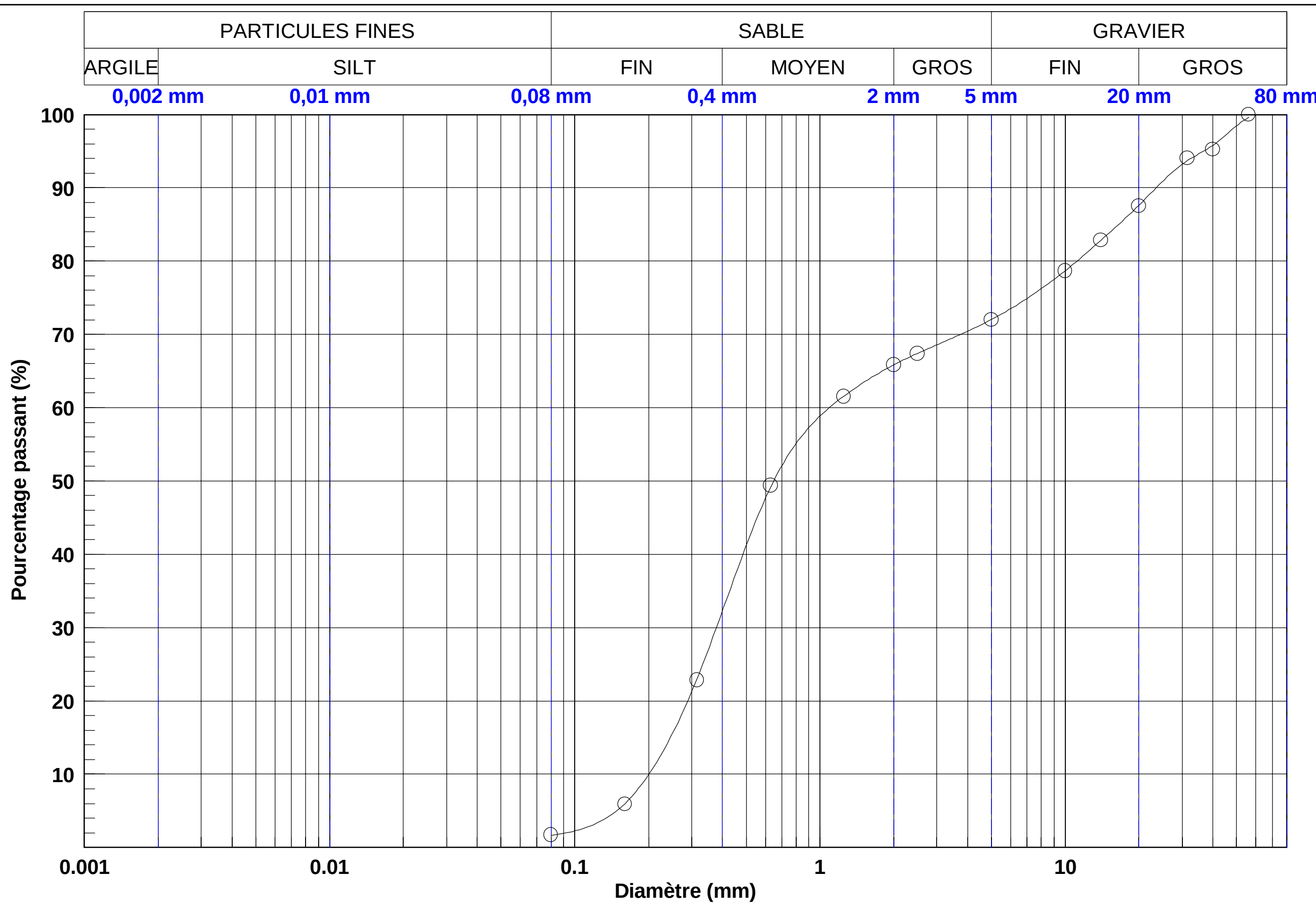
Nom du consultant : WSP | Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE
Respect · Collaboration · Puissance

ANALYSE GRANULOMÉTRIQUE

Sondage N° **B-119**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	1.6	70.4	28.0

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	1.65	1.65	5.97	22.99	49.20	61.57	67.41	72.02	78.68	82.83	87.64	92.40	95.79	99.59	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	B-119	01	0.05 - 0.40	Sable graveleux, traces de silt.	0.20	0.38	1.09	5.4	0.7	SP	2.0

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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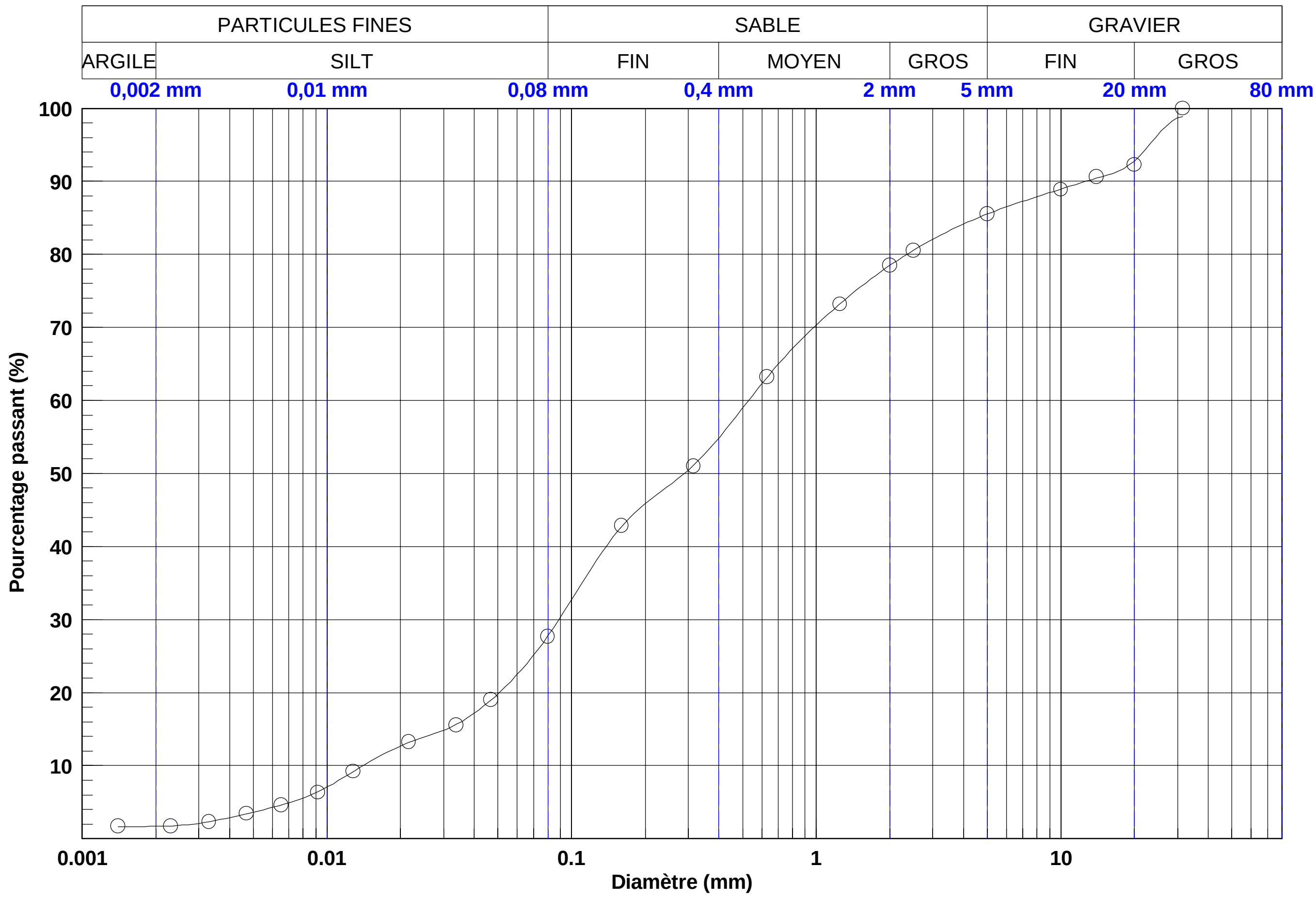
Nom du consultant : WSP	Nom du client : Société de développement crie	

ANALYSE GRANULOMÉTRIQUE

Sondage N° **B-119**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	ARGILE	SILT	SABLE	GRAVIER
—○—	1.7	26.1	57.8	14.5

Courbe	0,002 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	1.69	27.75	42.72	51.11	63.17	73.22	80.56	85.53	88.93	90.44	92.80	98.02	99.81	100.00	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	B-119	02	0.10 - 0.50	Sable silteux, un peu de gravier, traces d'argile.	0.01	0.09	0.53	37.6	1.1	SM	8.0

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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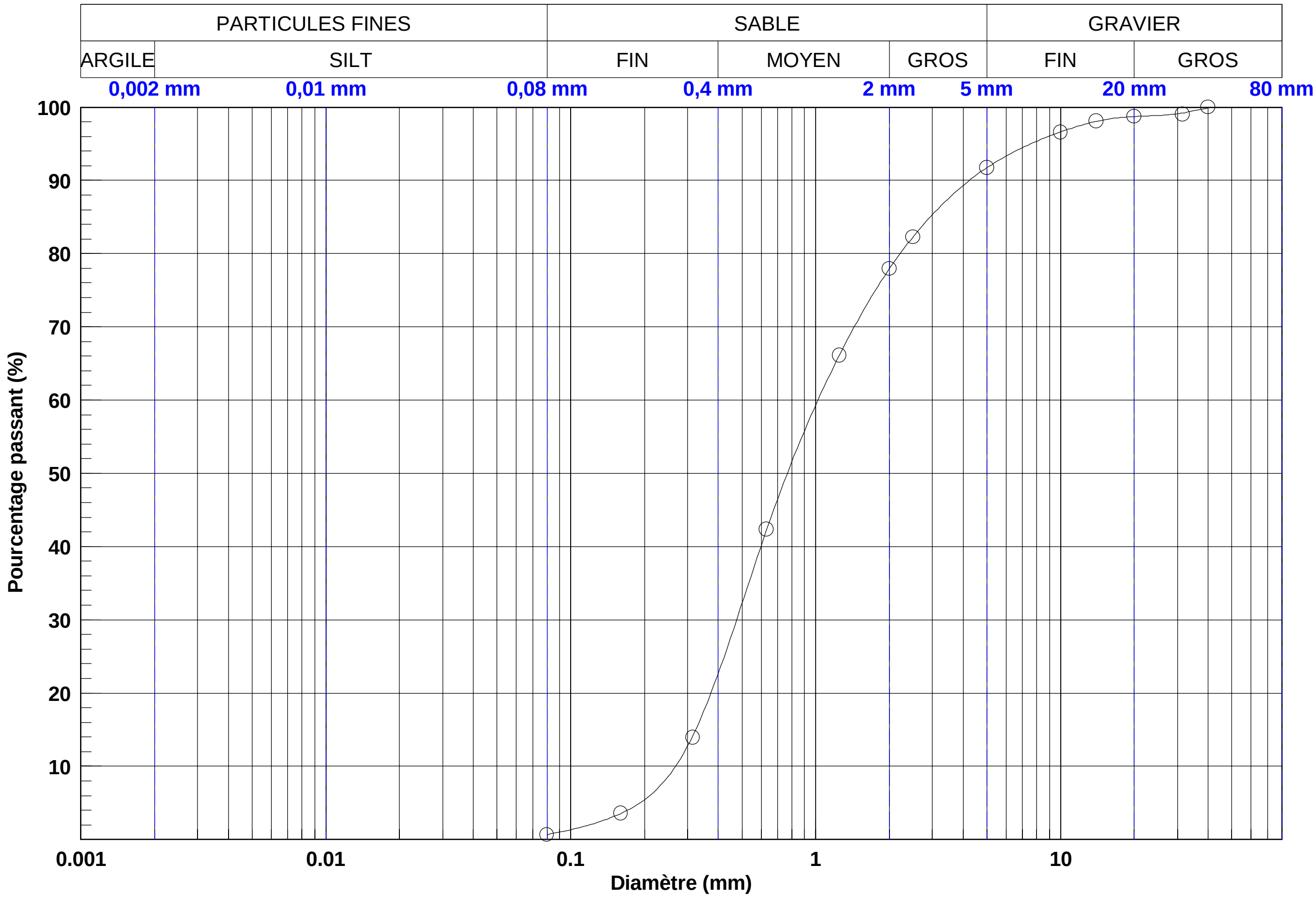
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE	**ANALYSE GRANULOMÉTRIQUE** **Sondage N°** **B-146**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-13**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	0.7	91.1	8.3

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	0.65	0.65	3.55	14.13	42.24	66.13	82.29	91.73	96.61	98.07	98.72	98.97	99.85	100.00	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	B-146	01	-	Sable, traces de gravier.	0.27	0.48	1.02	3.8	0.8	SP	3.6

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

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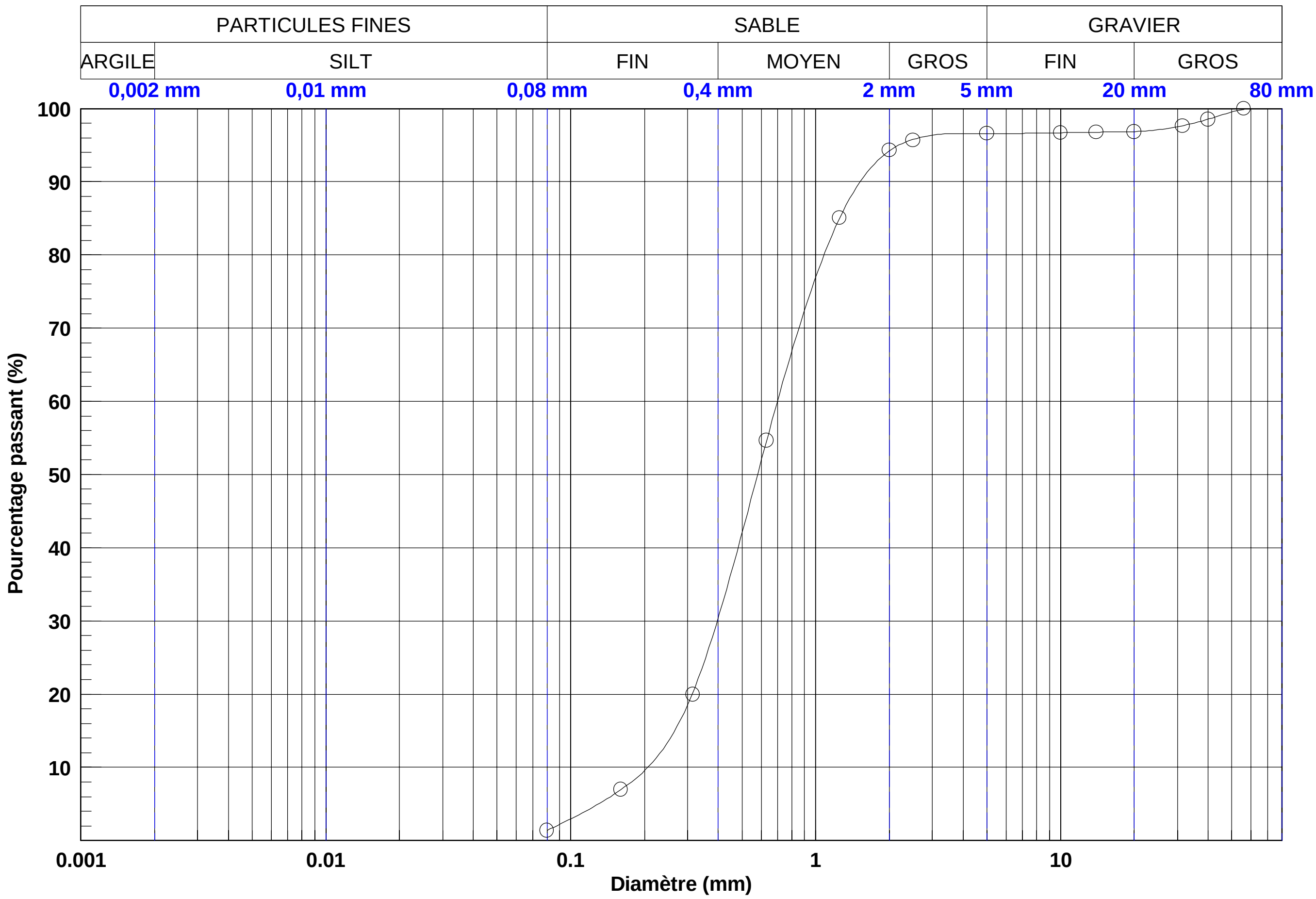
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE Respect · Collaboration · Puissance	Page 1 de 1 **ANALYSE GRANULOMÉTRIQUE** **Sondage N°** **D-164**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-14**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	1.4	95.2	3.4

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	1.38	1.38	6.93	20.18	54.56	84.97	95.77	96.60	96.68	96.77	96.85	97.34	98.55	99.89	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	D-164	01	0.00 - 0.70	Sable, traces de gravier et de silt.	0.21	0.40	0.70	3.4	1.1	SP	2.0

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

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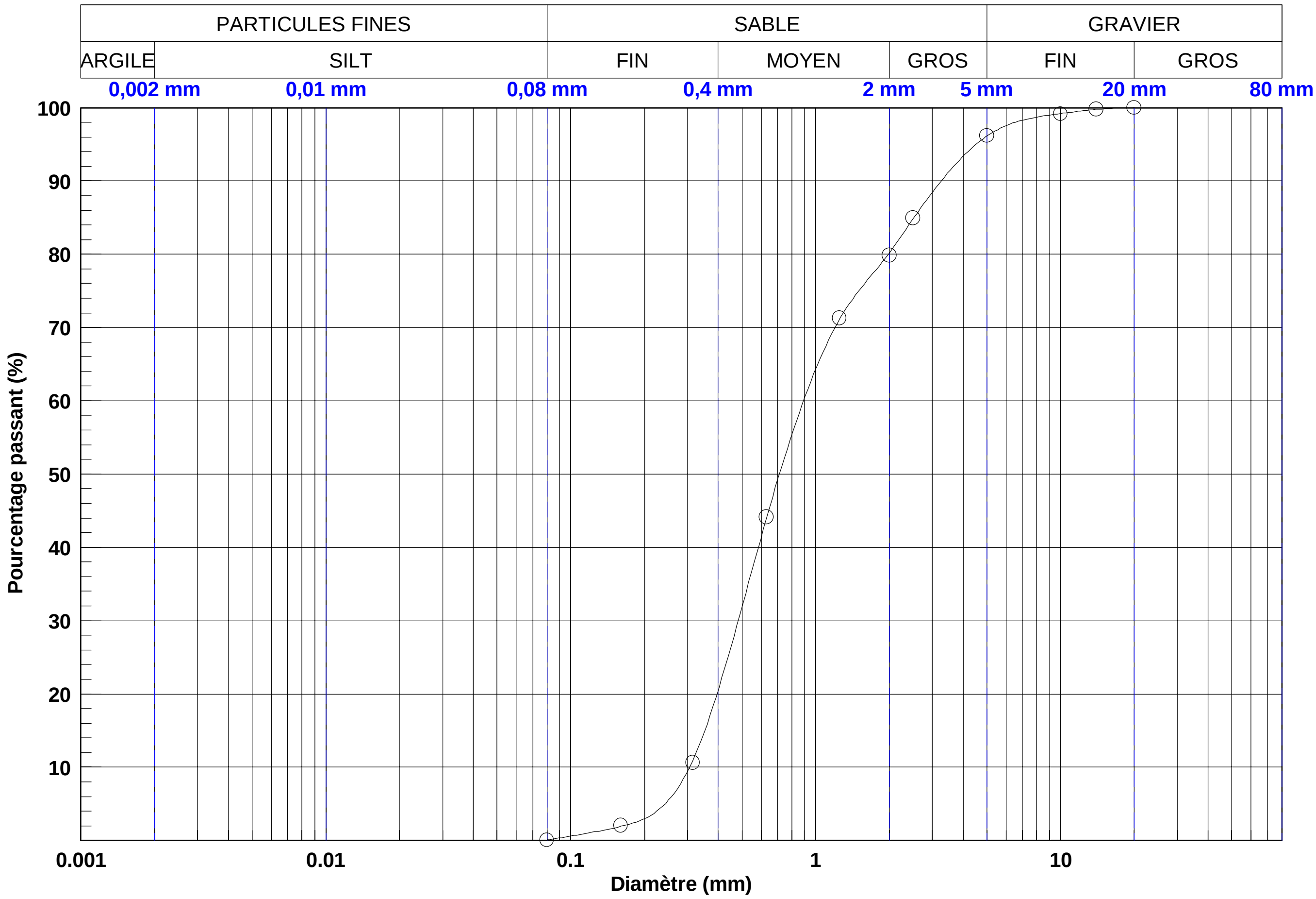
Nom du consultant : WSP	Nom du client : SOCIÉTÉ DE DÉVELOPPEMENT CRIE — Respect · Collaboration · Puissance	

ANALYSE GRANULOMÉTRIQUE

Sondage N° **D-181A**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-14**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	0.1	96.0	3.9

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	0.06	0.06	1.92	10.90	44.00	71.08	84.83	96.11	99.19	99.77	100.00	100.00	100.00	100.00	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	D-181A	01	0.00 - 0.90	Sable, traces de gravier.	0.31	0.48	0.89	2.9	0.9	SP	3.1

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

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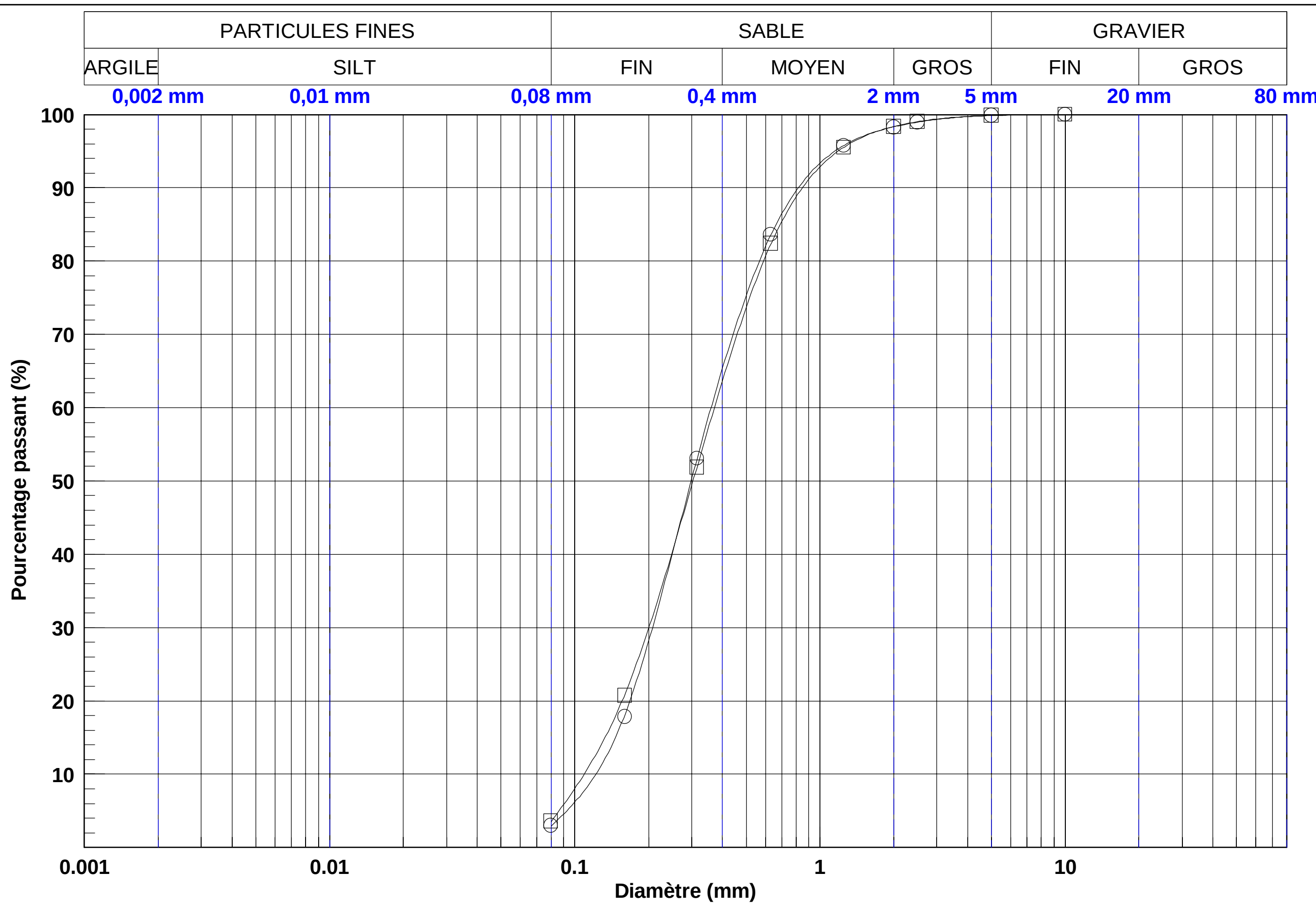
Nom du consultant : WSP	Nom du client : Société de développement Crie	

ANALYSE GRANULOMÉTRIQUE

Sondage N° **D-192**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-14**



Courbe	PARTICULES FINES	SABLE	GRAVIER
○	2.9	97.0	0.1
□	3.5	96.4	0.1

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
○	2.90	2.90	18.10	52.99	83.53	95.78	98.95	99.86	100.00	100.00	100.00	100.00	100.00	100.00	100.00
□	3.50	3.50	20.88	51.85	82.28	95.52	99.02	99.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
○	D-192	01	0.10 - 0.95	Sable, traces de silt.	0.12	0.21	0.36	2.9	1.0	SP	4.3
□	D-192	02	0.10 - 0.60	Sable, traces de silt.	0.11	0.20	0.37	3.4	1.0	SP	4.3

Effectué par : -	Date : -	Vérifié par : -	Date : -

Date de production : 2023-01-19

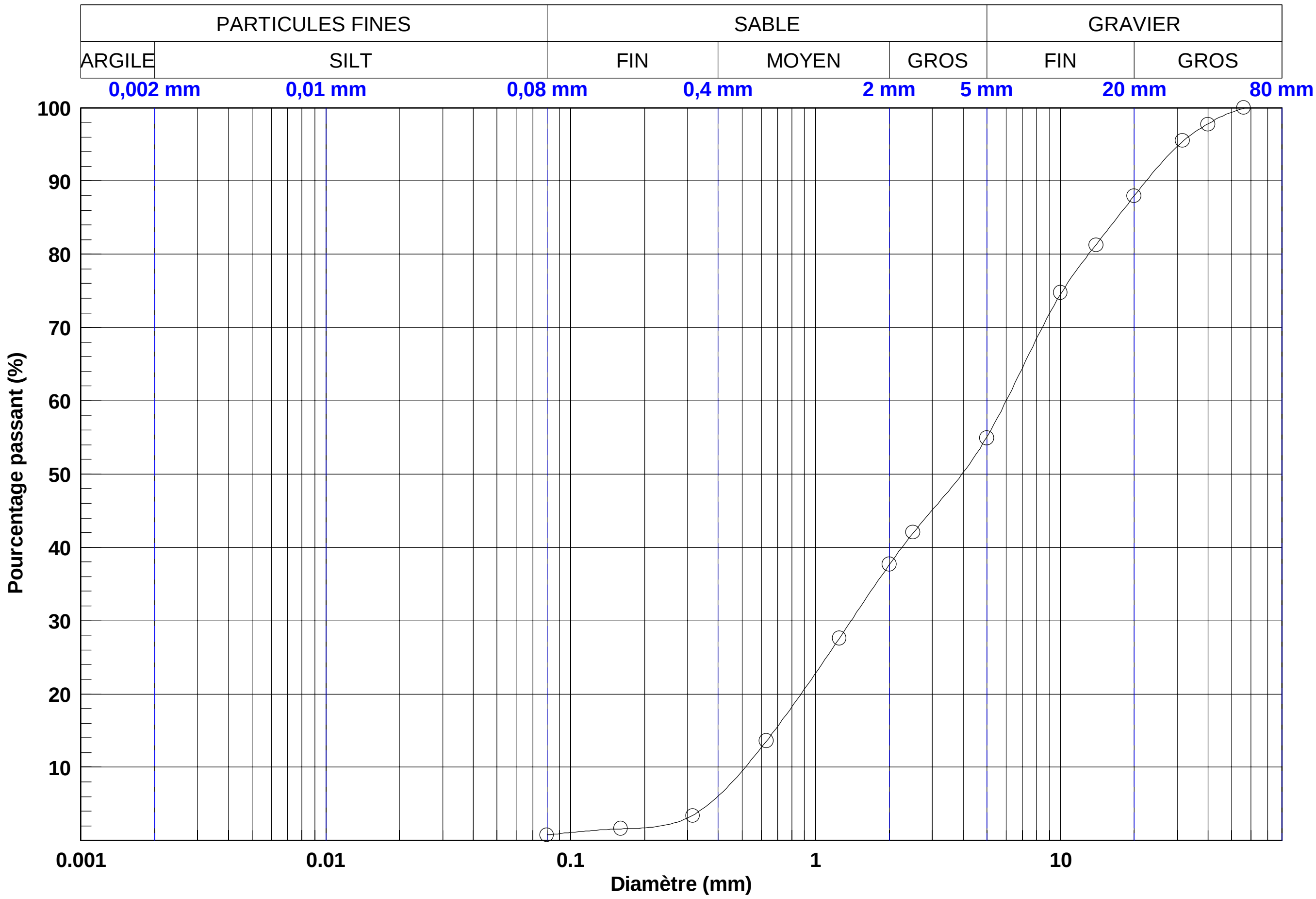
\\cacol2lic02\geotec\geotec_80\Style\lab1_FRANÇAIS\WSP_FR_Lab_Granulo.sty

Nom du consultant : WSP	Nom du client : Société de développement Crie	

ANALYSE GRANULOMÉTRIQUE

Sondage N° **D-201B**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-15**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	0.8	54.3	44.9

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	0.76	0.76	1.59	3.46	13.58	27.60	41.97	55.06	74.57	81.38	87.99	93.76	97.81	99.89	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	D-201B	01	0.10 - 0.50	Sable et gravier.	0.52	1.40	6.00	11.6	0.6	SP	3.3

Effectué par : -	Date : -	Vérifié par : -	Date : -

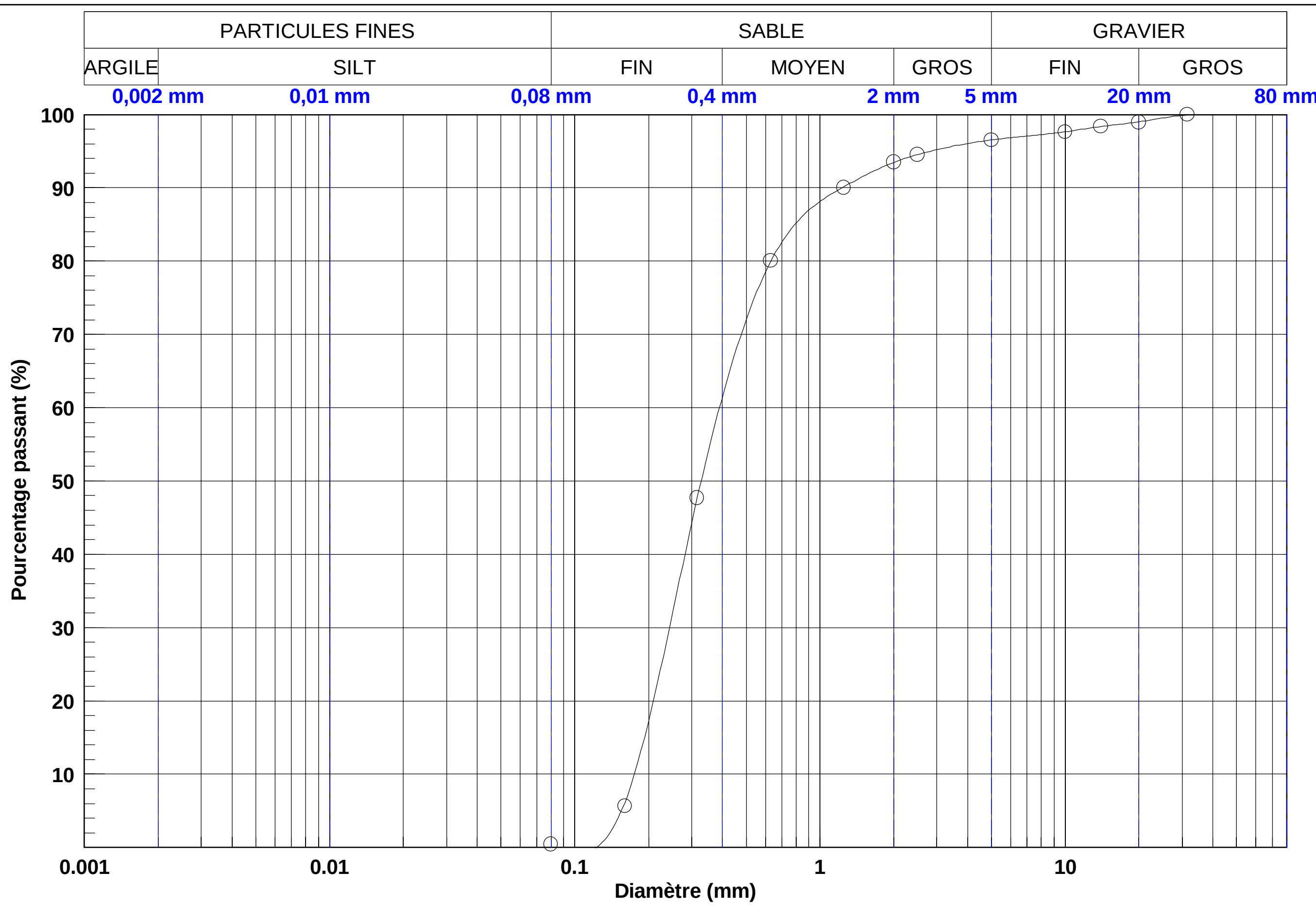
Date de production : 2023-01-19

Nom du consultant : WSP	Nom du client : Société de développement Crie	Page 1 de 1

ANALYSE GRANULOMÉTRIQUE

Sondage N° **95882**

Nom du projet :	**Étude de faisabilité - La Grande Alliance - Infrastructures de transport**	No. de projet :	**211-08415-00**
Nom du requérant :	**Société de développement crie**	No. plan de localisation :	**ANNEXE E-1**
Localisation civile :	**Radisson-Kuujjuarapik**	Date du début du sondage :	**2022-07-15**



Courbe	PARTICULES FINES	SABLE	GRAVIER
—○—	0.0	96.5	3.5

Courbe	0,08 mm	0,08 mm	0,16 mm	0,315 mm	0,63 mm	1,25 mm	2,5 mm	5 mm	10 mm	14 mm	20 mm	28 mm	40 mm	56 mm	80 mm
—○—	0.00	0.00	6.12	47.46	79.95	90.12	94.53	96.53	97.65	98.35	99.00	99.76	100.00	100.00	100.00

Courbe	Sondage	Éch.	Profondeur (m)	Description	D10	D30	D60	Cu	Cc	USCS	W_N
—○—	95882	01	0.00 - 0.35	Sable, traces de gravier.	0.17	0.24	0.39	2.2	0.9	SP	21.1

Effectué par : -	Date : -	Vérifié par : -	Date : -
			Date de production : 2023-01-19

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-662
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-010-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		25,3
Coefficient Friabilité	LC 21-080		17,5
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		0,02

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: Radisson - Kuujjuarapik

No Dossier: 211-08415-00
No Labo: G22-656

Type de Matériaux:
Calibre:
Utilisation:

Provenance:
Localisation: B-017-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		19,9
Coefficient Friabilité	LC 21-080		19,8
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		0,12

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-660
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-025A-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		19,8
Coefficient Friabilité	LC 21-080		16,1
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie	**No Dossier:** 211-08415-00
Projet: Radisson - Kuujjuarapik	**No Labo:** G22-661
Type de Matériaux:	**Provenance:**
Calibre:	**Localisation:** D-025A-02
Utilisation:	**Prélevé le:**

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		21,7
Coefficient Friabilité	LC 21-080		16,3
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		0,03

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech	**Date:** 22-nov-22	**Approuvé par:** E. Cardinal, tech Sr.	**Date:** 2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: Radisson - Kuujjuarapik

No Dossier: 211-08415-00
No Labo: G22-658

Type de Matériaux:
Calibre:
Utilisation:

Provenance:
Localisation: B-034-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		23,6
Coefficient Friabilité	LC 21-080		24,3
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		0,06

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-659
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	B-034-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		21,9
Coefficient Friabilité	LC 21-080		17,5
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-657
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-046-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		20,4
Coefficient Friabilité	LC 21-080		18,3
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: Radisson - Kuujjuarapik

No Dossier: 211-08415-00
No Labo: G22-664

Type de Matériaux:
Calibre:
Utilisation:

Provenance:
Localisation: D-061-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		12,0
Coefficient Friabilité	LC 21-080		11,6
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-665
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-061-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade F	8,1
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		15,1
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-666
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-061-03
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		46,3
Coefficient Friabilité	LC 21-080		16,1
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-663
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	BV-089-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade F	22,9
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		19,6
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewycky j, tech	**Date:** 22-nov-22	**Approuvé par:** E. Cardinal, tech Sr.	**Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-667
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	B-110-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		12,9
Coefficient Friabilité	LC 21-080		18,8
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		0,01

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech	**Date:** 22-nov-22	**Approuvé par:** E. Cardinal, tech Sr.	**Date:** 2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: Radisson - Kuujjuarapik

No Dossier: 211-08415-00
No Labo: G22-655

Type de Matériaux:
Calibre:
Utilisation:

Provenance:
Localisation: B-119-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		17,9
Coefficient Friabilité	LC 21-080		15,3
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-669
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	B-119-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		15,7
Coefficient Friabilité	LC 21-080		20,3
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		0,02

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-668
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	B-146-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		20,0
Coefficient Friabilité	LC 21-080		14,6
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewycky, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-654
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-164-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		13,5
Coefficient Friabilité	LC 21-080		13,5
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewycky̌j, tech	**Date:** 22-nov-22	**Approuvé par:** E. Cardinal, tech Sr.	**Date:** 2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: Radisson - Kuujjuarapik

No Dossier: 211-08415-00
No Labo: G22-653

Type de Matériaux:
Calibre:
Utilisation:

Provenance:
Localisation: D-181A-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		13,3
Coefficient Friabilité	LC 21-080		13,8
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-651
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-192-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		18,6
Coefficient Friabilité	LC 21-080		7,2
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-652
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-192-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		18,8
Coefficient Friabilité	LC 21-080		13,7
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-650
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	D-201B-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		13,0
Coefficient Friabilité	LC 21-080		17,4
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	Radisson - Kuujjuarapik		
		No Labo:	G22-649
Type de Matériaux:		**Provenance:**	
Calibre:		**Localisation:**	95882-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade	
Micro Deval	LC 21-070	grade	
Micro Deval (fin)	LC 21-101		17,6
Coefficient Friabilité	LC 21-080		13,2
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		
Valeur bleu de Méthylène	LC21-255		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1145
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-010-F1-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade B	31,8
Micro Deval	LC 21-070	grade F	10,6
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech	**Date:** 22-nov-22	**Approuvé par:** E. Cardinal, tech Sr.	**Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1146
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-010-F1-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	30,7
Micro Deval	LC 21-070	grade F	10,3
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: La Grande Alliance

No Dossier: 211-08415-00
No Labo: G22-1137

Type de Matériaux: Roc concassé
Calibre:
Utilisation:

Provenance:
Localisation: R-010-F2-ECH-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	31,5
Micro Deval	LC 21-070	grade F	10,8
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance	**No Labo:**	G22-1138
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-010-F2-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	31,3
Micro Deval	LC 21-070	grade F	11,4
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client: Société de développement crie

Projet: La Grande Alliance

No Dossier: 211-08415-00

No Labo: G22-1147

Type de Matériaux: Roc concassé

Calibre:

Utilisation:

Provenance:

Localisation: R-054C-F1-ECH-01

Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode	Grade	Résultats
Los Angeles	LC 21-400	grade B	27,8
Micro Deval	LC 21-070	grade F	9,5
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1148
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-054C-F1-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	24,1
Micro Deval	LC 21-070	grade F	9,4
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: La Grande Alliance

No Dossier: 211-08415-00
No Labo: G22-1139

Type de Matériaux: Roc concassé
Calibre:
Utilisation:

Provenance:
Localisation: R-054D-F2-ECH-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade B	30,0
Micro Deval	LC 21-070	grade F	10,3
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1140
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-054D-F2-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	29,3
Micro Deval	LC 21-070	grade F	10,4
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22
Approuvé par:	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1149
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-110-F1-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade B	30,9
Micro Deval	LC 21-070	grade F	11,4
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1150
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-110-F1-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	30,8
Micro Deval	LC 21-070	grade F	8,9
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1141
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-110-F2B-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	29,6
Micro Deval	LC 21-070	grade F	7,7
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1142
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-110-F2B-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	31,6
Micro Deval	LC 21-070	grade F	10,0
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1151
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-147-F1-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	22,2
Micro Deval	LC 21-070	grade F	6,3
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1152
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-147-F1-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade B	21,0
Micro Deval	LC 21-070	grade F	7,1
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22
Approuvé par:	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1143
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-147-F2B-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	16,6
Micro Deval	LC 21-070	grade F	7,7
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: La Grande Alliance

No Dossier: 211-08415-00
No Labo: G22-1144

Type de Matériaux: Roc concassé
Calibre:
Utilisation:

Provenance:
Localisation: R-147-F2B-ECH-02
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade B	22,7
Micro Deval	LC 21-070	grade F	9,6
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1153
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-165-F1-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

Essai	Méthode		Résultats
Los Angeles	LC 21-400	grade B	23,2
Micro Deval	LC 21-070	grade F	6,9
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

Essai	Méthode		Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1154
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-165-F1-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	25,0
Micro Deval	LC 21-070	grade F	6,1
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1155
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-165-F2-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	23,8
Micro Deval	LC 21-070	grade F	5,8
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1156
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-165-F2-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	24,8
Micro Deval	LC 21-070	grade F	7,6
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: La Grande Alliance

No Dossier: 211-08415-00
No Labo: G22-1157

Type de Matériaux: Roc concassé
Calibre:
Utilisation:

Provenance:
Localisation: R-192-F1-ECH-01
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	27,0
Micro Deval	LC 21-070	grade F	8,4
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client: Société de développement crie
Projet: La Grande Alliance

No Dossier: 211-08415-00
No Labo: G22-1158

Type de Matériaux: Roc concassé
Calibre:
Utilisation:

Provenance:
Localisation: R-192-F1-ECH-02
Prélevé le:

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	28,0
Micro Deval	LC 21-070	grade F	7,8
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech **Date:** 22-nov-22 **Approuvé par:** E. Cardinal, tech Sr. **Date:** 2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance	**No Labo:**	G22-1159
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-192-F2-ECH-01
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	23,5
Micro Deval	LC 21-070	grade F	8,6
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par:	T. Lewyckyj, tech	**Date:**	22-nov-22	**Approuvé par:**	E. Cardinal, tech Sr.	**Date:**	2022-11-22

Essais sur matériau

Client:	Société de développement crie	**No Dossier:**	211-08415-00
Projet:	La Grande Alliance		
		No Labo:	G22-1160
Type de Matériaux:	Roc concassé	**Provenance:**	
Calibre:		**Localisation:**	R-192-F2-ECH-02
Utilisation:		**Prélevé le:**	

Propriétés Intrinsèques, de fabrication et complémentaire

			Résultats
Los Angeles	LC 21-400	grade B	24,7
Micro Deval	LC 21-070	grade F	8,1
Micro Deval (fin)	LC 21-101		
Coefficient Friabilité	LC 21-080		
Particules Plates	LC 21-265		
Particules Allongées	LC 21-265		
Densité Brute sec	LC 21-067/66		
Densité Brute sec(sss)	LC 21-067/66		
Densité Brute apparente	LC 21-067/66		
Absorption	LC 21-067/66		
Densité Brute sec	LC 21-065		
Densité Brute sec(sss)	LC 21-065		
Densité Brute apparente	LC 21-065		
Absorption	LC 21-065		

			Résultats
Los Angeles	CSA A23.2-16A/17A	grade	
Micro Deval	CSA A23.2-23A	grade	
Micro Deval(fin)	CSA A23.2-29A		
Masse Volumique Tassée	CSA A23.2-10A		
Pourcentages de vides Tassée	CSA A23.2-10A		
Masse Volumique Non Tassée	CSA A23.2-10A		
Pourcentages de vides Non Tassée	CSA A23.2-10A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Densité Brute sec	CSA A23.2-12A		
Densité Brute sec(sss)	CSA A23.2-12A		
Densité Brute apparente	CSA A23.2-12A		
Absorption	CSA A23.2-12A		
Particules Plates	CSA A23.2-13A		
Particules Allongées	CSA A23.2-13A		
Essai Proctor modifié	NQ 2501-255	Méthode C	
		Teneur en eau	
Particules < 5 µm	NQ 2501-025		

Remarques:

Vérifié par: T. Lewyckyj, tech	**Date:** 22-nov-22	**Approuvé par:** E. Cardinal, tech Sr.	**Date:** 2022-11-22

APPENDIX

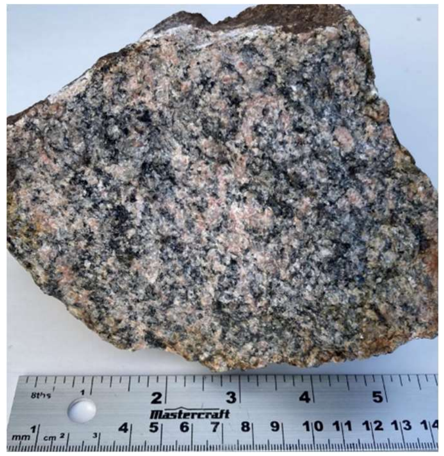
E-4 *GRAB SAMPLES ROCK TABLE*

Tableau **Description lithologique du roc rencontré**

No affleurement	No échantillon	Lithologie	Couleur	Texture/structures	Composition	Présence de sulfures	Météorisation/Altération	Observations à l'échelle de l'affleurement *	Photo
2393	2393-01	Monzonite à Qtz	Gris pâle rosé	Massif, phanéritique, grenue, grains variables moyens à grossiers <0,5 cm, et plus gros Fld-K <2 cm	Fld-K blancs ou rosé (parfois mâcle de Carlsbad), et un peu moins de Plagio; 5-10% Qtz; 10-15% de minéraux mafiques (Hornblende, biotite et magnétite). Roche faiblement à moyennement magnétique.	Non	Roc sain très faiblement météorisé en surface mm (altération blanchâtre des Flds et peu de limonite)	Quelques dykes felsiques porphyriques N342/70	
R-010	R-010-01	Monzonite à Qtz	Gris pâle rosé	Massif, phanéritique, grenue, grains variables moyens à grossiers <0,5 cm, et plus gros Fld-K <1,5 cm	Fld-K blancs ou rosé (parfois mâcle de Carlsbad), et un peu de Plagio; 5-10% Qtz; 20-25% de minéraux mafiques (Hornblende, biotite et magnétite). Roche faiblement à moyennement magnétique.	Non	Roc sain faiblement météorisé en surface cm (oxydation et altération blanchâtre des Flds), limonite dans les joints, minéraux noirs un peu oxidés (limonite)	Intrusions de pegmatite (N045/90)	
	R-010-02	Idem à R-010-01	Idem à R-010-01	Idem à R-010-01	Idem à R-010-01	Idem à R-010-01	Idem à R-010-01	Idem à R-010-01	
R-025	R-025-01	Granodiorite	Gris pâle à moyen, localement rosé	Massif, phanéritique, grains fins à moyens avec qlqs porphyres <1 cm de Flds-K rosé	Principalement Plagio et un peu moins de Fld-K; 20-25% Qtz; 7-10% biotite, magnétite et autres minx mafiques vert foncé à noir. Roche très faiblement magnétique	Non	Roc sain, très faiblement météorisé en surface (oxydation et altération blanchâtre des Flds)	Foliation moyenne N007/95	

R-033	R-033-01	Gneiss granitique (Orthogneiss)	Gris pâle à moyen rosé	Grains grossiers variables <1 cm, rubanement moyennement défini (bandes felsiques gris et roses, et mafique noirs)	Variable (rubanement). Fld plagio et Fld-K rosé (grains grossiers à Porphyres >2cm); 5-15% Qtz; 2-8% biotite, magnétite et minx mafiques vert foncé à noir.	Non	Roc sain faiblement météorisé en surface (oxydation et altération des Flds), un peu de limonite dans les joints, minéraux noirs un peu oxydés (limonite)	Déformation en rubanements ondulés, foliation locale N020/55. Présence de veines de qtz, faible météorisation en surface	
R-046	R-046-01	Granite	Gris pâle rosé	Massif, phanéritique, grains moyens à grossiers <1 cm.	Principalement Fld-K, peu de Plagio; 20-25% Qtz; 2-3% magnétite et minx mafiques (Biotite et autres min noirs). Roche très faiblement magnétique.	Non	Roc sain faiblement météorisé en surface (oxydation et altération blanchâtre des Flds), un peu de limonite dans les joints.	Pas de structures observées	
	R-046-02	Pegmatite granitique	Gris pâles rosé à noir verdâtre	Pegmatitique, en amas ou bandes de minéraux grossiers mafiques et felsiques	Fld-K et Plagio; 20-25% Qtz; 25-30% minx mafiques (Biotite et autres min noirs(amphiboles), peu de magnétite fine). Roche très faiblement magnétique.	Non	Roc sain faiblement météorisé en surface (oxydation et altération blanchâtre des Flds), un peu de limonite dans les joints.	Pas de structures observées	

R-054C	R-054C-01	Syénite à Qtz pegmatitique	Gris pâle rosé	Massif, légèrement folié, grains grossiers <0,5 cm à très grossiers <3 cm.	Majoritairement Fld-K rosé, peu de Plagio; 10% Qtz; 5-10% Biotite-magnétite. Localement moyennement magnétique.	non	Roc sain très faiblement météorisé en surface (faible oxydation et altération des Flds)	Forte présence de xénolithes de diorite par endroits. Légère déformation/foliation par endroits. Veines cm à dm de Qtz-Fld	
RV-096	RV-096-01	Gneiss granitique (Orthogneiss)	Gris pâle à blanchâtre	Grains moyens à grossiers <0,5 cm, rubannement en fines bandes ondulées	Variable (rubannement). Fld-k et plagio; 3-8% Qtz; 5-12% biotite, magnétite et minx mafiques vert foncé à noir.	Non	Faible à moyenne météorisation en surface (altération des Fld-Plagio et oxydation), un peu de limonite dans les joints, min noirs oxidés (limonite)	Texture variable en bandes ondulées. Foliation N270/80	
	RV-096-02	Gneiss granitique (Orthogneiss)	Gris pâle rosé	Grains grossiers vaiables <0,5 cm, rubanement légèrement défini à l'échelle de l'échantillon (bandes felsiques gris et roses, et mafique noirs)	Variable (rubannement). Fld-k rosé et plagio; 5-10% Qtz; 3-10% biotite, magnétite et minx mafiques vert foncé à noir.	Non	Roc sain, faible météorisation millimétrique en surface (altération des Fld-Plagio et oxydation), un peu de limonite dans les joints, 1% de min noirs oxydés (limonite)	Texture variable en bandes ondulées. Foliation N270/80	

R-110	R-110-01	Granite	Gris pâle rosé	Massif, phanéritique, grains moyens à grossiers <0,5 cm	Majoritairement Fld-K, avec Plagioclases calciques (mâcles polysynthétiques visibles); 10-15% de Qtz; 2-3% Biotite-magnétite. Roche faiblement magnétique.	Non	Roc sain, faible météorisation millimétrique en surface (altération des Fld-Plagio et oxydation), un peu de limonite dans les joints, 1% de min noirs oxidés (limonite)	Faible déformation métamorphique, foliation apparente par endroit, intrusion de pegmatite NE-SO (20 cm de large). Présence xénolithes (enclaves) décimétriques de diorite.	
R-018-01	R-118-01	Monzonite-Syénite à Qtz	Gris pâle à moyen rosé	Massif, phanéritique, grains moyens à grossiers <1 cm	Majoritairement Fld-K (parfois mâcles Carlsbad), et Plagio; 10-15% de Qtz; 10-15% minx mafiques, surtout Biotite, un peu de Hornblende et magnétite. Roche faiblement magnétique.	Non	Roc sain, faible météorisation millimétrique en surface (altération blanchâtre des Fld), un peu de limonite dans les joints.	Faible texture gneissique	
	R-118-02	Monzonite-Syénite à Qtz	Gris pâle à moyen rosé	Massif, phanéritique, grains moyens à grossiers <0,5 cm, légère texture gneissique	Variable, majoritairement Fld-K (parfois mâcles Carlsbad), et Plagio; 10-15% de Qtz; 5-10% minx mafiques, surtout Biotite, un peu de Hornblende et magnétite. Roche très faiblement magnétique.	Non	Roc sain, faible météorisation d'1 cm en surface (altération blanchâtre des Fld et limonite), limonite dans les joints.	Faible texture gneissique	
R-129A	R-129A-01	Gneiss granitique (Orthogneiss)	Gris pâle à moyen	Porphyrique (>2 cm), matrice grenue grossière, massif, rubanement visible de bandes felsiques et mafiques	Variable (rubanement). Fld plagio (grains grossiers à Porphyres >2cm); 5-10% Qtz; 2-5% minx mafiques (biotite et autres min noirs), magnétite.	Traces (<1%) de fine pyrite disséminée	Roc sain, faiblement météorisé en surface (oxydation et altération des Flds), un peu de limonite dans les joints, minéraux noirs peu à moyennement oxydés (limonite)	Déformation en rubanement ondulés, texture de fluage magmatique avec xénolithes et autres fragments. Rubanement métamorphique, Foliation N320/60. Présence de veines de qtz, forte météorisation en surface	

R-140B	R-140B-01	Diorite à qtz	Gris pâle à moyen légèrement verdâtre	Massif, phanéritique, avec pseudo-bandes de composition variables, grains moyens à grossiers (<0,5 cm).	Variable, principalement plagioclases calciques, en bandes plus foncées, et bandes plus pâles plus riches en qtz et magnétite et minx mafiques (Biotite et autres min noirs). Roche faiblement à moyennement magnétique par endroits.	Non	Roc sain, faiblement météorisé en surface (faible altération des plagio en surface, avec un peu d'oxydes)	Massif, météorisation superficielle	
R-147	R-147-01	Diorite à Qtz	Gris pâle à moyen légèrement verdâtre	Massif, phanéritique, grains moyens à grossiers (<0,5 cm).	Principalement plagioclases calciques avec mâcles polysynthétiques; 5-10% Qtz; 5-10% magnétite et minx mafiques (Biotite et autres min noirs). Roche faiblement magnétique.	Non	Roc sain faiblement météorisé en surface (altération blanche superficielle des plagio) très peu de limonite dans les joints, minéraux noirs un peu oxydés (limonite)	Foliation/rubanement apparente par endroit, présence xénolithes (enclaves) décimétriques de diorite et autres.	
	R-147-02	Monzodiorite	Gris moyen verdâtre à gris pâle rosé	Massif, phanéritique, grains moyens à grossiers (<1 cm).	Principalement Plagio et Fld-K; 5% Qtz; 15-20% magnétite et minx mafiques (Biotite et autres min noirs verdâtres). Roche moyennement magnétique.	Non	Roc sain, faiblement météorisé en surface (altération blanche superficielle des Fld) très peu de limonite dans les joints, minéraux noirs très peu oxidés (limonite)	Idem	
	R-147-03	Monzonite à Qtz	Gris pâle	Massif, phanéritique, grains moyens à grossiers (<1 cm).	Principalement Fld-K et Plagio; 5-10% Qtz; 5-15% magnétite et minx mafiques (Biotite et autres min noirs verdâtres). Roche faiblement magnétique.	Non	Roc sain, faiblement météorisé en surface (altération blanche superficielle des Fld) très peu de limonite dans les joints, minéraux noirs très peu oxydés (limonite)	Idem	

R-165	R-165-01	Syénite à qtz	Gris pâle rosé	Massif, phanéritique, grains moyens à grossiers	Flds-K; 10-20% Qtz; 1-3% magnétite et autres minx mafiques noirs)	Non	Roc sain, faible météorisation millimétrique en surface (oxydation), un peu de limonite dans les joints, 1% de min noirs oxydés (limonite)	Massif, semble homogène, sans textures ou structures apparentes	
	R-165-02	Syénite à qtz		Idem à R-165-01	Idem à R-165-01		Idem à R-165-01		
R-181A	R-181A-01	Syénite à qtz	Rose et plaquage gris verdâtre	Massif, phanéritique, grains moyens à grossiers <0,5 cm.	Principalement Fld-K, un peu moins de Plagio;10-15% Qtz; 5-15% minx mafiques (Biotite et autres min noirs verdâtres (Amphiboles)). Roche non magnétique.	Non	Roc sain, faible météorisation millimétrique en surface, altération des Fld) et oxydation en surface et plaquage verdâtre (chlorite) avec limonite dans les joints.	Aucune photo ou info du terrain	
	R-181A-02	Monzonite à Qtz	Gris pâle légèrement rosé	Massif, phanéritique, grains moyens à grossiers <0,5 cm.	Principalement Fld-K et Plagio; 10-15% Qtz; 15-20% minx mafiques (Biotite, magnétite et autres min noirs verdâtres). Roche faiblement magnétique.	Non	Roc sain, faible météorisation millimétrique en surface, altération blanchâtre des Fld) et oxydation en surface et dans les joints.	Aucune photo ou info du terrain	

R-192	R-192-01	Diorite à Qtz-Tonalite	Gris pâle à moyen	Massif, phanéritique, grains moyens à grossiers (<1 cm).	Principalement plagioclases calciques avec mâcles parfois polysynthétiques, très peu de Fld-K; 15-20% Qtz; 10-15% magnétite et minx mafiques (Biotite et autres minx noirs). Roche faiblement à moyennement magnétique.	Non	Roc sain faiblement météorisé en surface (altération blanchâtre superficielle des plagio et très peu oxydé), limonite dans les joints	Rien de particulier selon les photos de terrain	
	R-192-02	Monzonite à Qtz	Gris pâle rosé	Massif, phanéritique, grains moyens à grossiers (<0,5 cm).	Principalement Fld-K et Plagio; 5-15% Qtz; 5-15% magnétite, Hornblende et minx mafiques (Biotite et autres minx noirs). Roche moyennement magnétique.	Non	Roc sain faiblement météorisé en surface d'1 cm (altération blanchâtre superficielle des plagio et limonite), limonite dans les joints	Rien de particulier selon les photos de terrain	
R-202A	R-202A-01	Gneiss granitique (Orthogneiss)	Gris pâle rosé à gris moyen-foncé verdâtre	Texture gneissique, grains grossiers variables <0,5 , rubanement (bandes felsiques gris et roses, et mafique noirs)	Variable (rubanement). Fld-K et plagio; 5-10% Qtz; 10-20% minx mafiques (surtout biotite, et autres min noirs); Roche non magnétique	Non	Roc sain, faible météorisation millimétrique en surface (altération blanchâtre des Fld), faible oxydation en surface et dans les joints.	Aucune observation particulière à l'échelle de l'affleurement	
	R-202A-02	Gneiss granitique (Orthogneiss)	Gris pâle rosé à gris moyen-foncé verdâtre	Texture gneissique, grains grossiers vaiables <0,5 , rubanement (bandes felsiques gris et roses, et mafique noirs)	Variable (rubannement). Fld-K et plagio; 5-10% Qtz; 10-20% minx mafiques (biotite et autres min noirs), magnétite; Roche faiblement magnétique	Non	Roc sain, faible météorisation millimétrique en surface (altération blanchâtre des Fld), très faible oxydation dans les joints.		

	R-202A-03	Syénite à qtz	Rosé	Grains grossiers vaiables <0,5 à 1,5 cm, léger rubanement légèrement (bandes felsiques gris et roses, et mafique noirs)	Principalement Fld-K rosé, peu de plagio; 15-25% Qtz; 10-15 minx mafiques (Biotite et autres min noirs verdâtres). Roche non magnétique.	Non	Roc sain, faible météorisation millimétrique en surface (altération blanchâtre des Fld et oxydation), limonite dans les joints		

APPENDIX

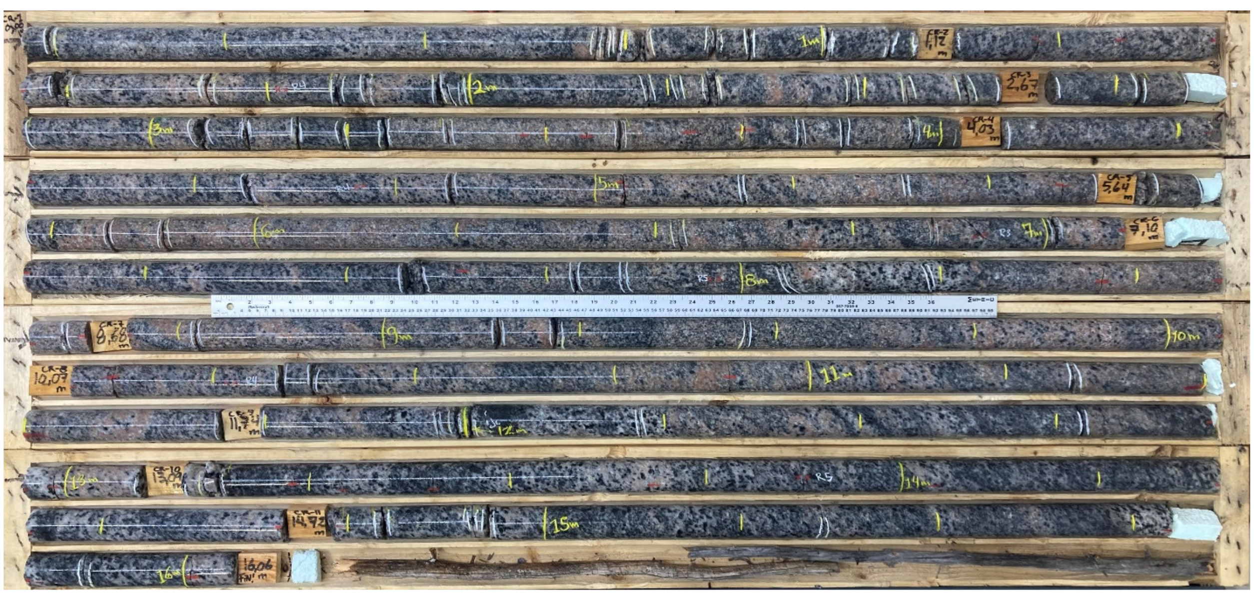
E-5 *PHOTOGRAPHIC REPORT OF THE BOREHOLE ROCK CORES*

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-010-F1

0,00 à 16,06 m, CR-1 à CR-11, boîtes 1 à 4, sec



0,00 à 16,06 m, CR-1 à CR-11, boîtes 1 à 4, humide

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-010-F2

0,00 à 15,36 m, CR-1 à CR-11, boîtes 1 à 4, sec

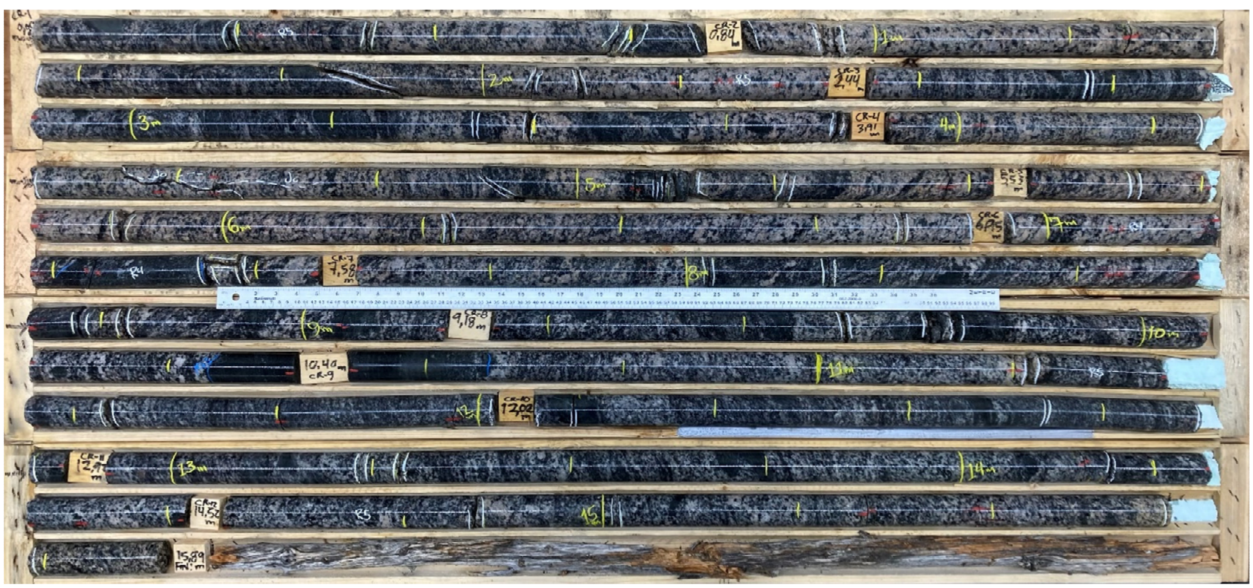
0,00 à 15,36 m, CR-1 à CR-11, boîtes 1 à 4, humide

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-054C-F1

0,00 à 15,89 m, CR-1 à CR-12, boîtes 1 à 4, sec

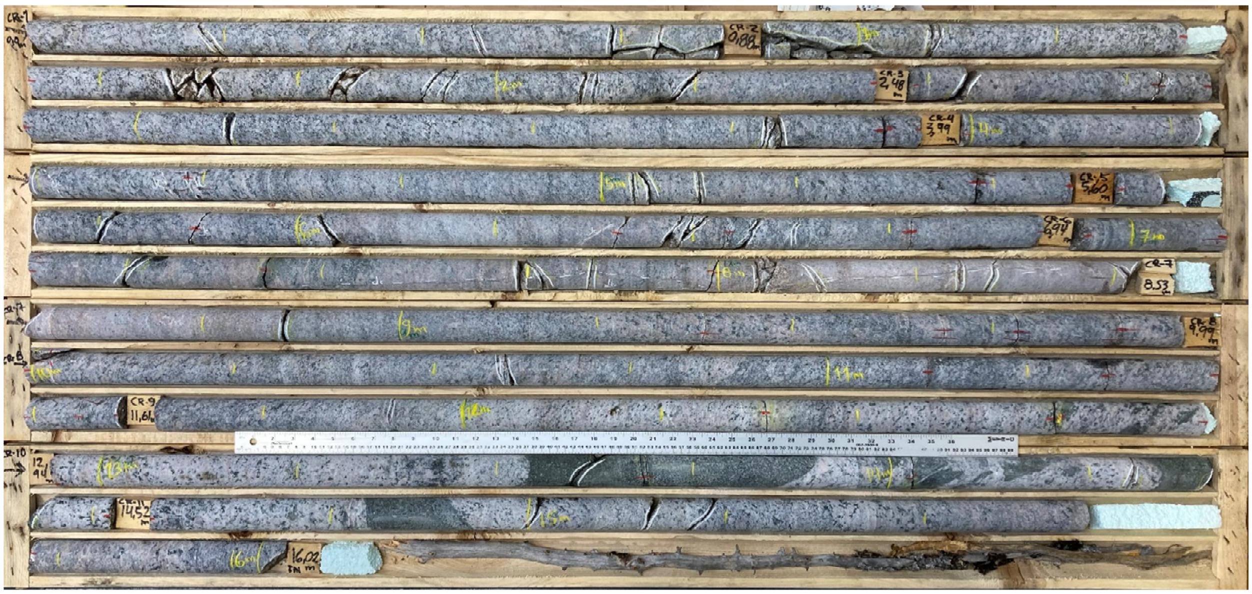


0,00 à 15,89 m, CR-1 à CR-12, boîtes 1 à 4, humide

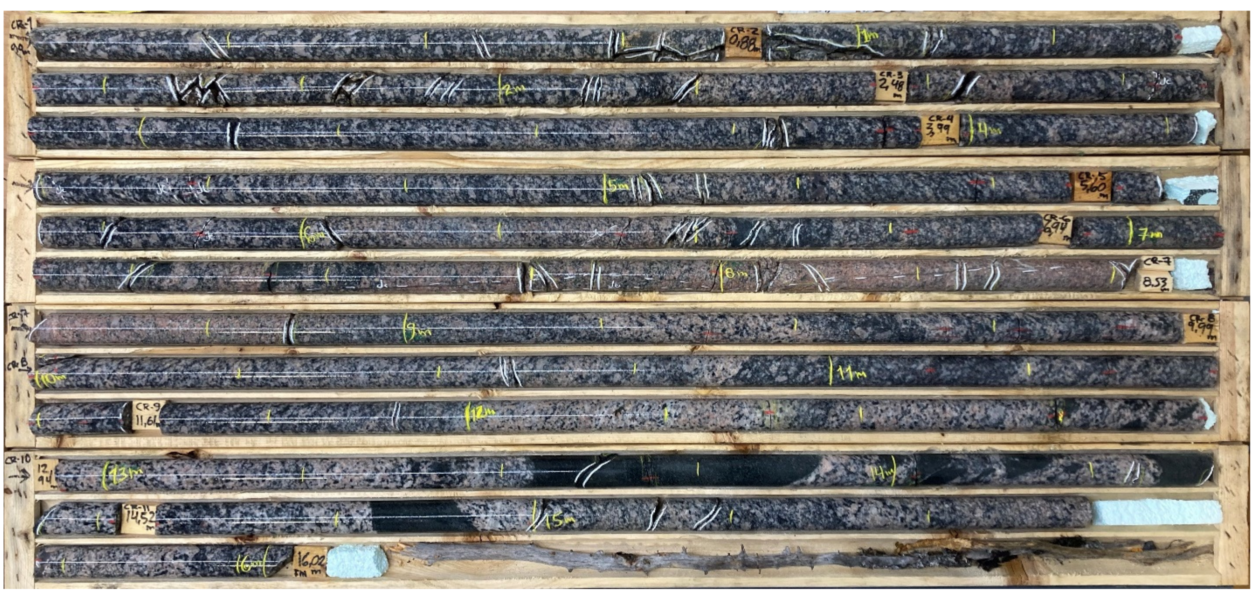
ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-054D-F2



0,00 à 16,02 m, CR-1 à CR-11, boîtes 1 à 4, sec



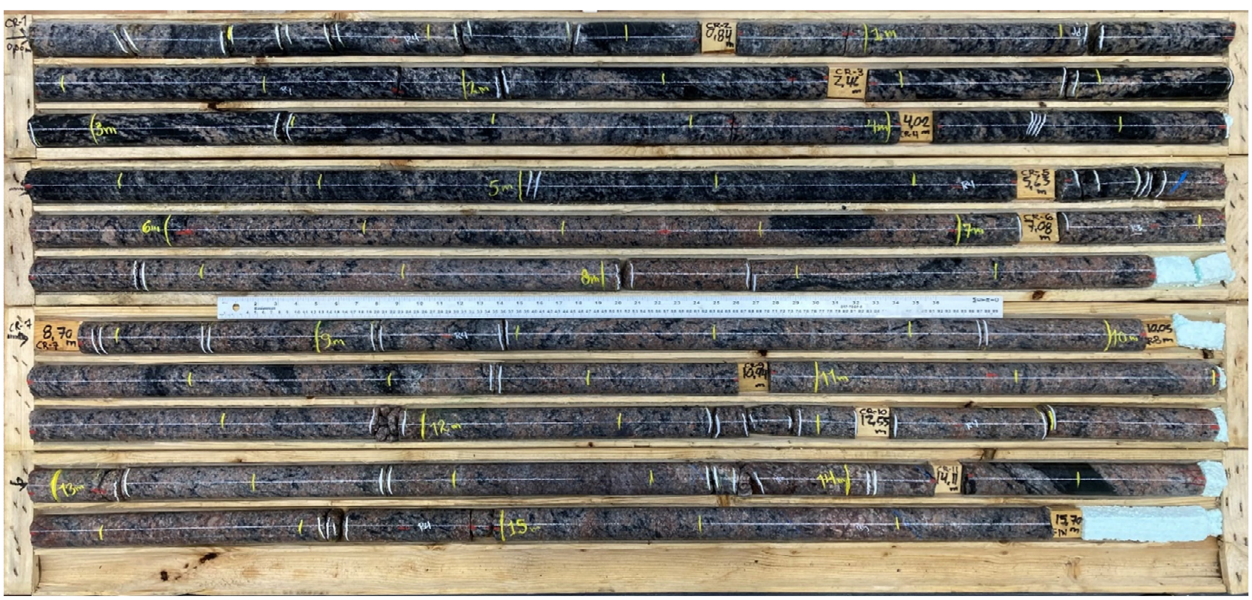
0,00 à 16,02 m, CR-1 à CR-11, boîtes 1 à 4, humide

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-110-F1

0,00 à 15,70 m, CR-1 à CR-11, boîtes 1 à 4, sec

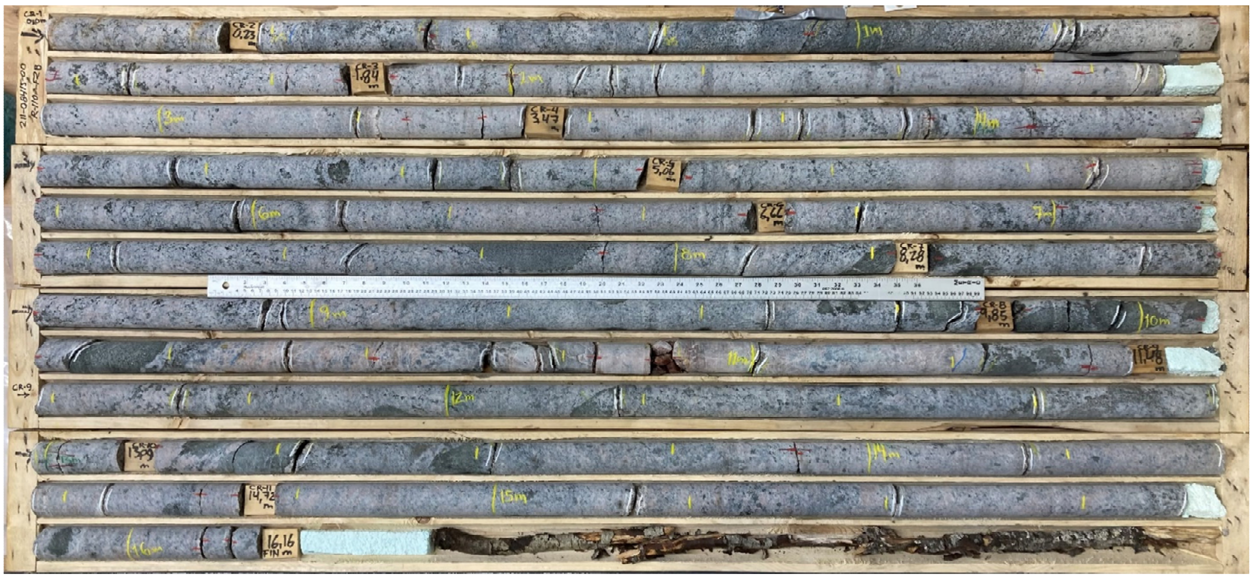


0,00 à 15,70 m, CR-1 à CR-11, boîtes 1 à 4, humide

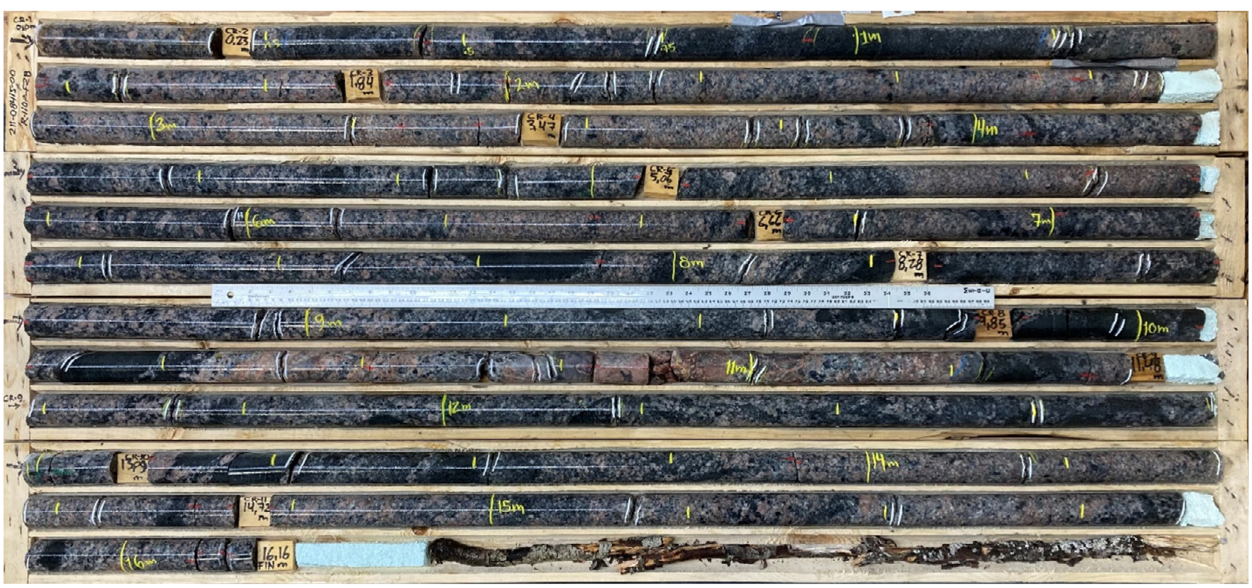
ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-110-F2B



0,00 à 16,16 m, CR-1 à CR-11, boîtes 1 à 4, sec

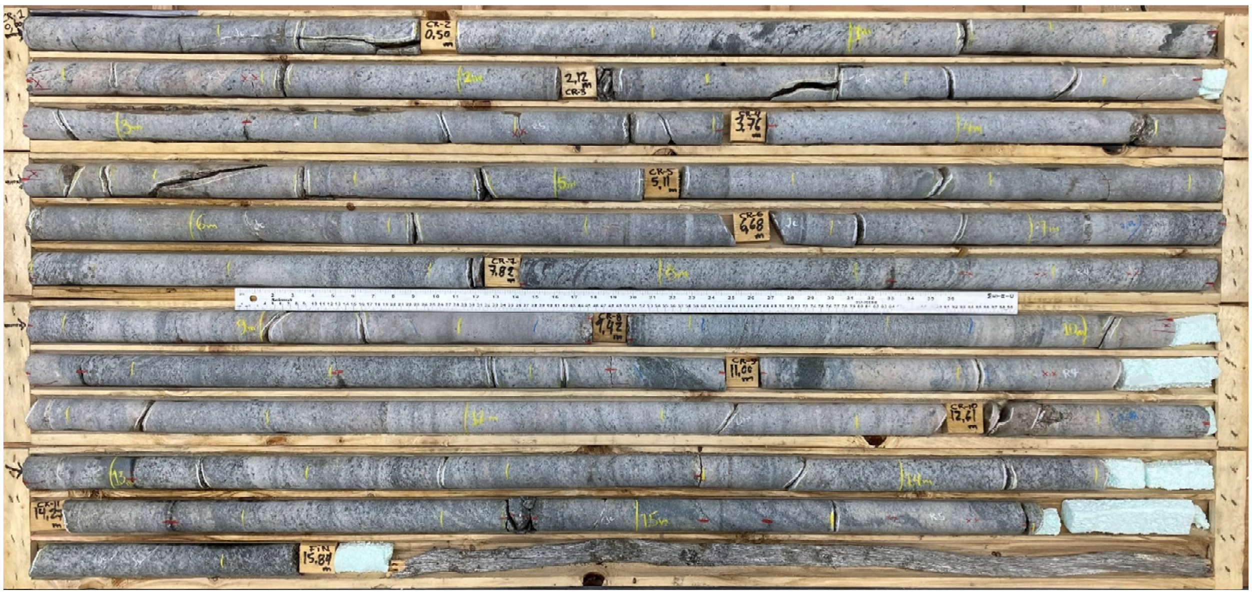


0,00 à 16,16 m, CR-1 à CR-11, boîtes 1 à 4, humide

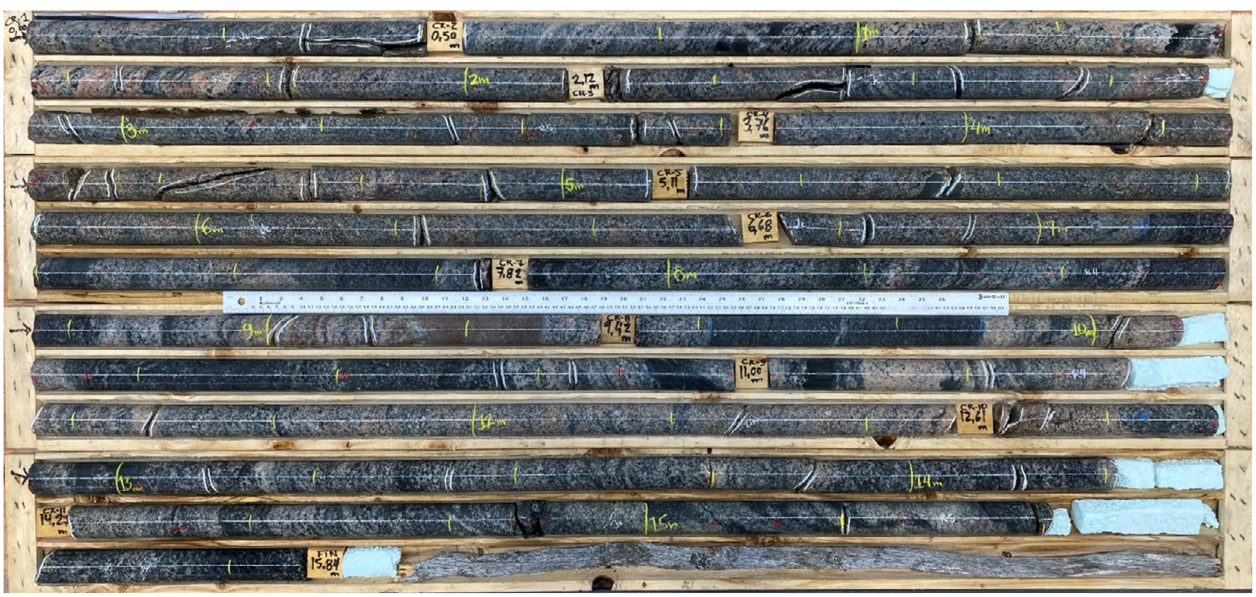
ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-147-F1



0,00 à 15,84 m, CR-1 à CR-11, boîtes 1 à 4, sec

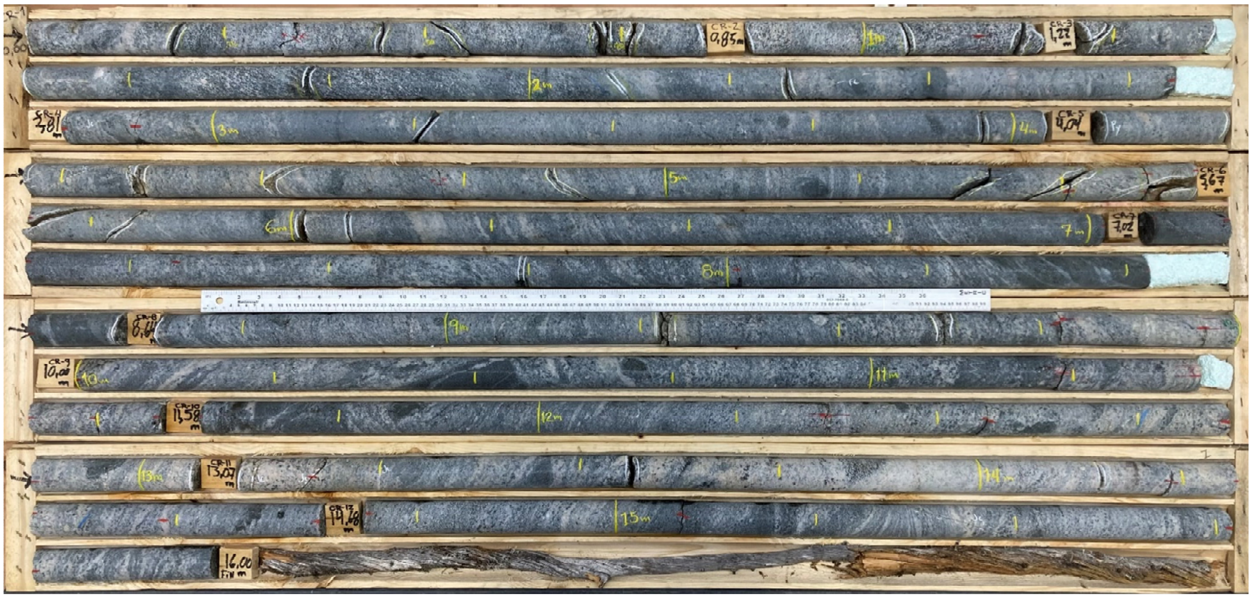


0,00 à 15,84 m, CR-1 à CR-11, boîtes 1 à 4, humide

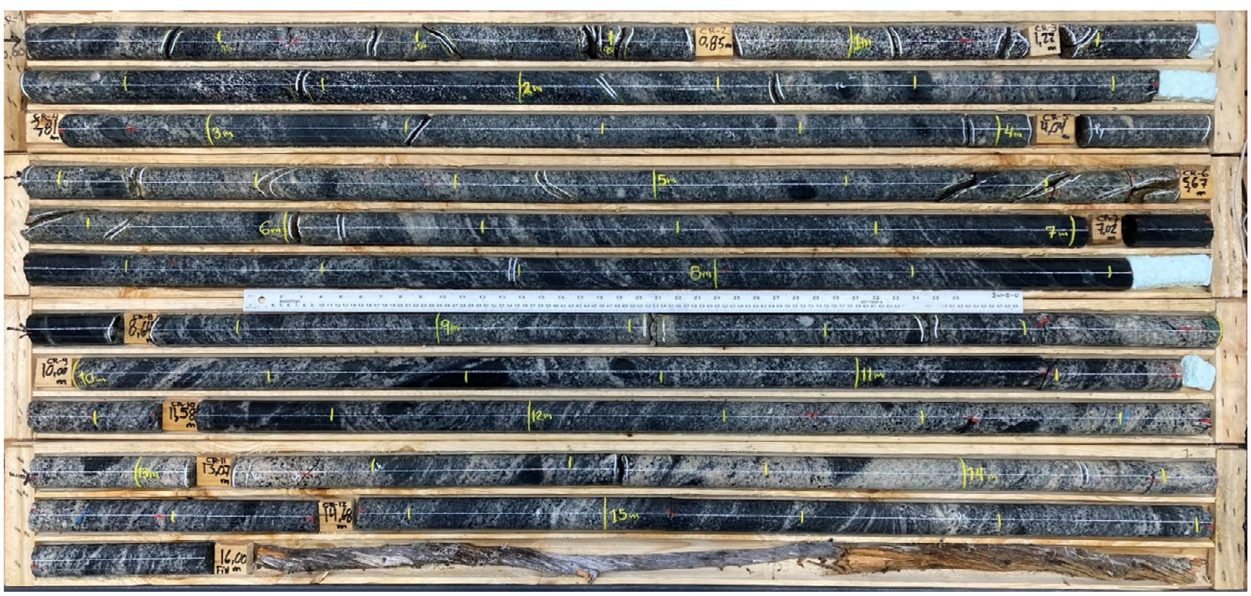
ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-147-F2B



0,00 à 16,00 m, CR-1 à CR-12, boîtes 1 à 4, sec

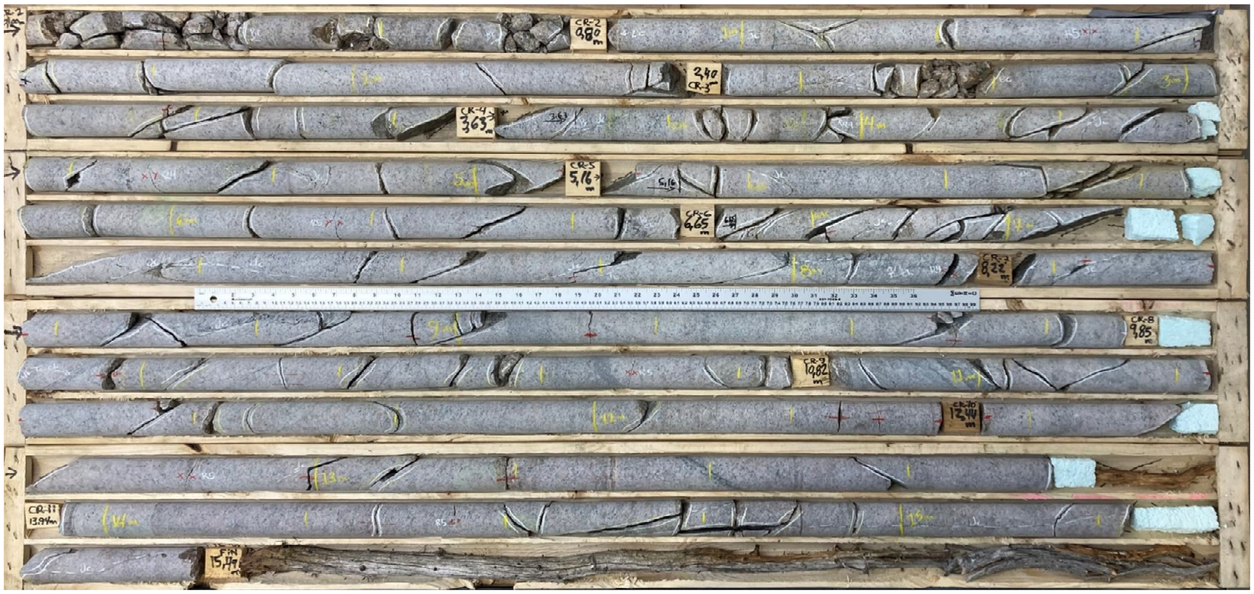


0,00 à 16,00 m, CR-1 à CR-12, boîtes 1 à 4, humide

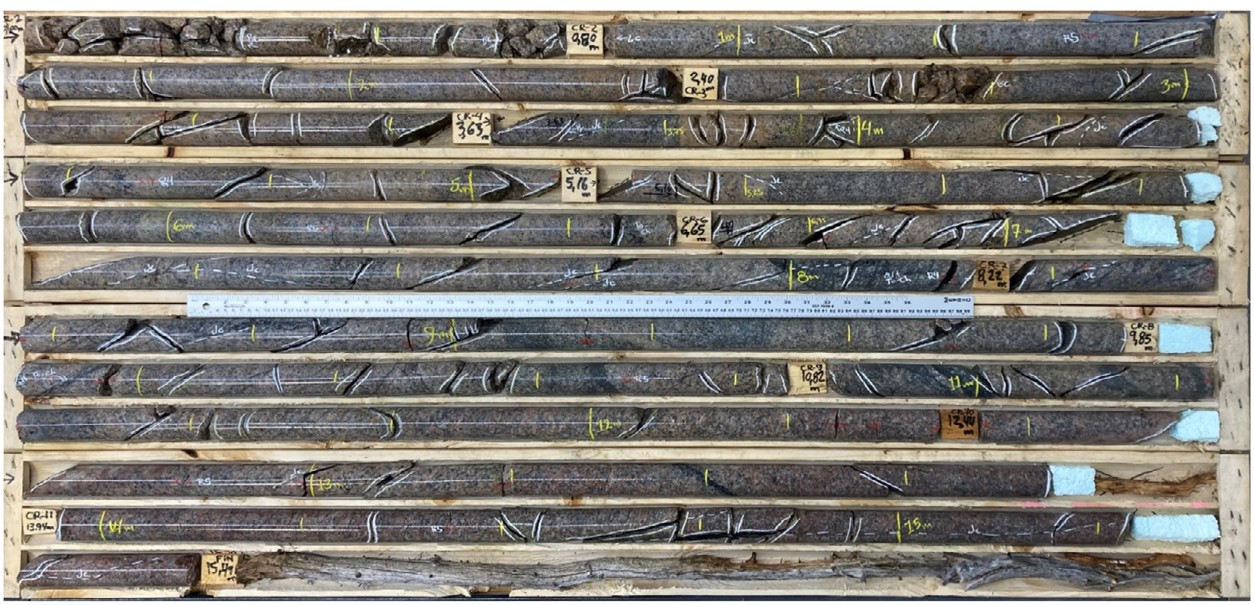
ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-165-F1



0,00 à 15,49 m, CR-1 à CR-11, boîtes 1 à 4, sec



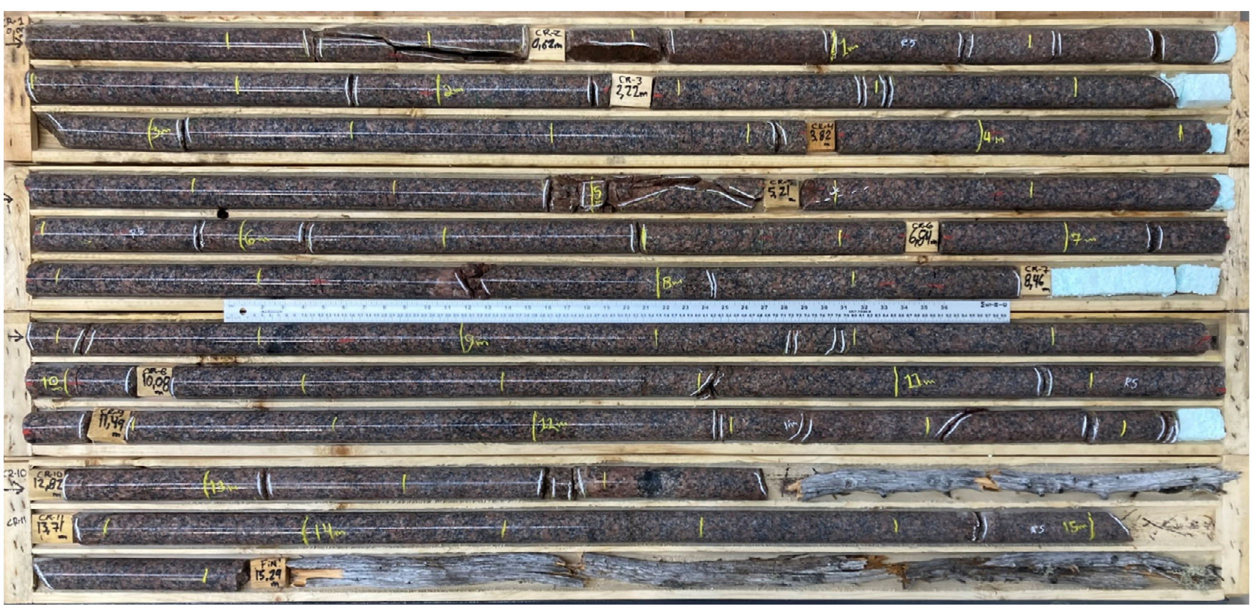
0,00 à 15,49 m, CR-1 à CR-11, boîtes 1 à 4, humide

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-165-F2

0,00 à 15,29 m, CR-1 à CR-11, boîtes 1 à 4, sec



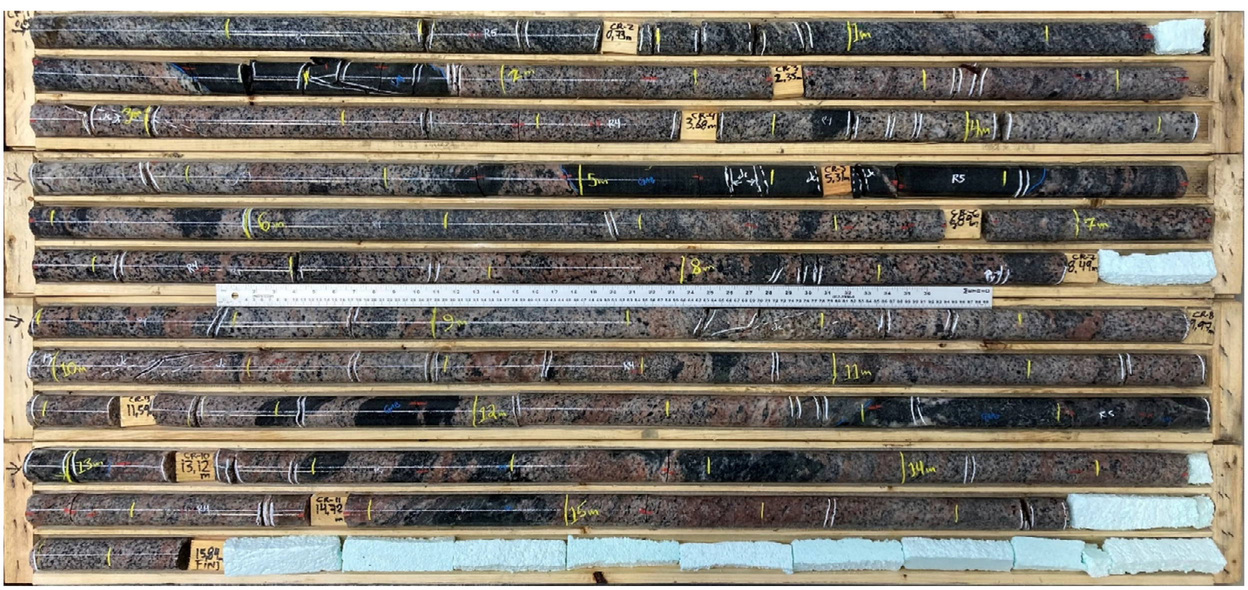
0,00 à 15,29 m, CR-1 à CR-11, boîtes 1 à 4, humide

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-192-F1

0,00 à 15,84 m, CR-1 à CR-11, boîtes 1 à 4, sec



0,00 à 15,84 m, CR-1 à CR-11, boîtes 1 à 4, humide

ANNEXE

RAPPORT PHOTOGRAPHIQUE

FORAGE R-192-F2

0,00 à 15,57 m, CR-1 à CR-11, boîtes 1 à 4, sec

0,00 à 15,57 m, CR-1 à CR-11, boîtes 1 à 4, humide