CREE DEVELOPMENT CORPORATION

LA GRANDE ALLIANCE

# LA GRANDE ALLIANCE

## PRE-FEASIBILITY STUDY – PHASES II & III – TRANSPORTATION INFRASTRUCTURE

# TECHNICAL NOTE 12

## RAIL

### FINAL VERSION

DATE: MARCH 25, 2024


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# EXECUTIVE SUMMARY

This Technical Note 12 – Rail presents the pre-feasibility railway alignments developed by WSP for the following two segments:

### PHASE II (6-15 YEARS)

– **Railway: Rupert to La Grande**

  A proposed railway alignment following, as much as possible, that of the Billy-Diamond Highway (BDH) starting at km 257 (after the Rupert River Bridge, which is the junction point with the railway alignment developed by the Phase I Consultant) all the way to La Grande River. The Phase II railway alignment extends over an approximate distance of 340 km.

### PHASE III (16-30 YEARS)

– **Railway: La Grande to Whapmagoostui/Kuujjuarapik**

  A railway which follows, as much as possible, the projected road leading to Whapmagoostui/Kuujjuarapik (from the junction with the Phase II railway alignment). The Phase III railway alignment extends over an approximate distance of 219 km.

It is important to note that although there are railways in a comparable environment to the Study Zone - notably two mining railways further to the east on the Québec North Shore – there are no railways in the area covered by Phases II and III of La Grande Alliance.

Development of a Phase II and III pre-feasibility alignment involved following both best practice Railway Design Criteria and in addition, respecting the following environmental, technical, and economic drivers:

- Respect, as much as possible, the natural site topography (mountains and plains);
- Consider the overall geology of the study area, including the locations of aggregate material deposits;
- Avoid, as much as possible, lakes and rivers; minimize the length of crossings and bridges where these are unavoidable;
- Avoid, as much as possible, existing, and projected Protected Areas; minimize encroachment and/or provide mitigation measures where these are unavoidable;
- Minimize crossing and impacts on caribou migration corridors;
- Avoid, as much as possible, areas of cultural significance such as areas currently used by Cree land users, archeological sites, etc.; minimize encroachment and/or provide mitigation measures where these are unavoidable;
- Propose, wherever applicable, alignment variants that could offer added value, such as:
  - Locations that minimize environmental footprint;
  - Locations that minimize construction cost;
  - Locations that minimize the impacts on existing camps and facilities;
- Remain, as much as possible, in close proximity to existing and/or proposed roads;
- Remain within 1 km corridor centered on existing and/or proposed roads when surrounded by recognized Protected Areas on both sides;
- Minimize the number of times the railway crosses existing and/or proposed roads.

The conclusion of this pre-feasibility study is that it is possible to develop a railway alignment, stretching from slightly north-west of the Rupert River bridge to La Grande (Phase II) and a railway alignment from La Grande to Whapmagoostui/Kuujjuarapik that meets the Design Criteria and other social-environmental design drivers.

# TECHNICAL NOTE 12 – RAIL

The overall length of the Phase II alignment is of 340 km, and its sinuous nature reflects the many lakes and the varied topography traversed. As requested, to minimize the environmental impacts, the railway alignment generally follows the Billy-Diamond Highway (70% of the total length). The approximately 30% which is not within 100 meter from the studied road is due to the railway design criteria that do not allow to follow the highway curves. However, some horizontal curves were designed for a speed reduced to 65 mph (±105 km/h) for passenger trains, which represents approximately 48 km, or about 14% of the 340 km-long alignment.

The overall length of the Phase III alignment is 219 km, and its sinuous nature reflects the many lakes and the varied topography crossed. As requested, to minimize the environmental impacts, the railway alignment generally follows the proposed road to Whapmagoostui/Kuujjuarapik (75% of the total length). The approximately 25% which is not within 100 meter from the studied road is due to the railway design criteria that do not allow to follow the road curves. The railway could potentially follow the roadway up to 100% of the way (within 100-m) with refined detailed engineering, i.e., combination of adjustment to the railway design criteria as well as road optimization to suit the railway. However, adjusting the road to always fit the railway alignment may result in higher road infrastructure cost.

For Phase III's alignment, in order to avoid waterbodies and to minimize the offset from the roadway corridor, the design speed in a considerable part of the horizontal curves of Phase III is reduced to 60 mph (±97 km/h) for passengers and 50 mph (±80 km/h) for freight, instead of 80 mph and 60 mph respectively. Those reduced speed zones sum up to approximately 69 km, which represents about 31% of the 219 km-long alignment.

One important challenge for phase III rail corridor is crossing La Grande River. Due to the heavy axle load and lack of space above the Dam structure, the rail corridor could not use the Dam or the spillway to cross the river. The length of this potential structure was estimated over 1 km long due to the topography and railway design slope limitation. This potential structure is preliminary located 4.5 km downstream from the Dam.

In terms of additional considerations, the design of a new railway typically required the determination of a best-practice railway alignment – which has as of now been carried out at a pre-feasibility level and the rightsizing, as a function of freight/ridership levels, infrastructure elements, rolling stock quantities, maintenance facilities, and ultimately staffing levels all tasks which will need to be carried out in future studies.

As the studies moves forward, future design activity should focus on detailed infrastructure design but also on the following aspects of a railway project that influence the technical aspects:

- Ownership structure – private or Cree-Quebec joint ownership, operations model – at one extreme with all management, operations, and maintenance services provided in-house and, at the other extreme, all services contracted out;
- Training: if a stand-alone, fully self-staffed operating entity is privileged, the significant upfront requirement for training to provide the unique skillsets needed to manage, operate, and maintain a railway must not be underestimated. The time required to carry out these training activities can rival the time required to construct such a railway.

We must emphasize that the proposed alignments are conceptual and preliminary. Further studies and discussions with land users will be required to refine that design. The main objective of this current study is to identify and document the main design guidelines to be considered. Other issues will likely emerge and will influence the detailed design. The innovative process used has the great advantage of opening the dialogue between all the stakeholders allowing them to be involved throughout all the phases of the project development.

The Figure on the following page presents a map with an overview of the proposed railway location.

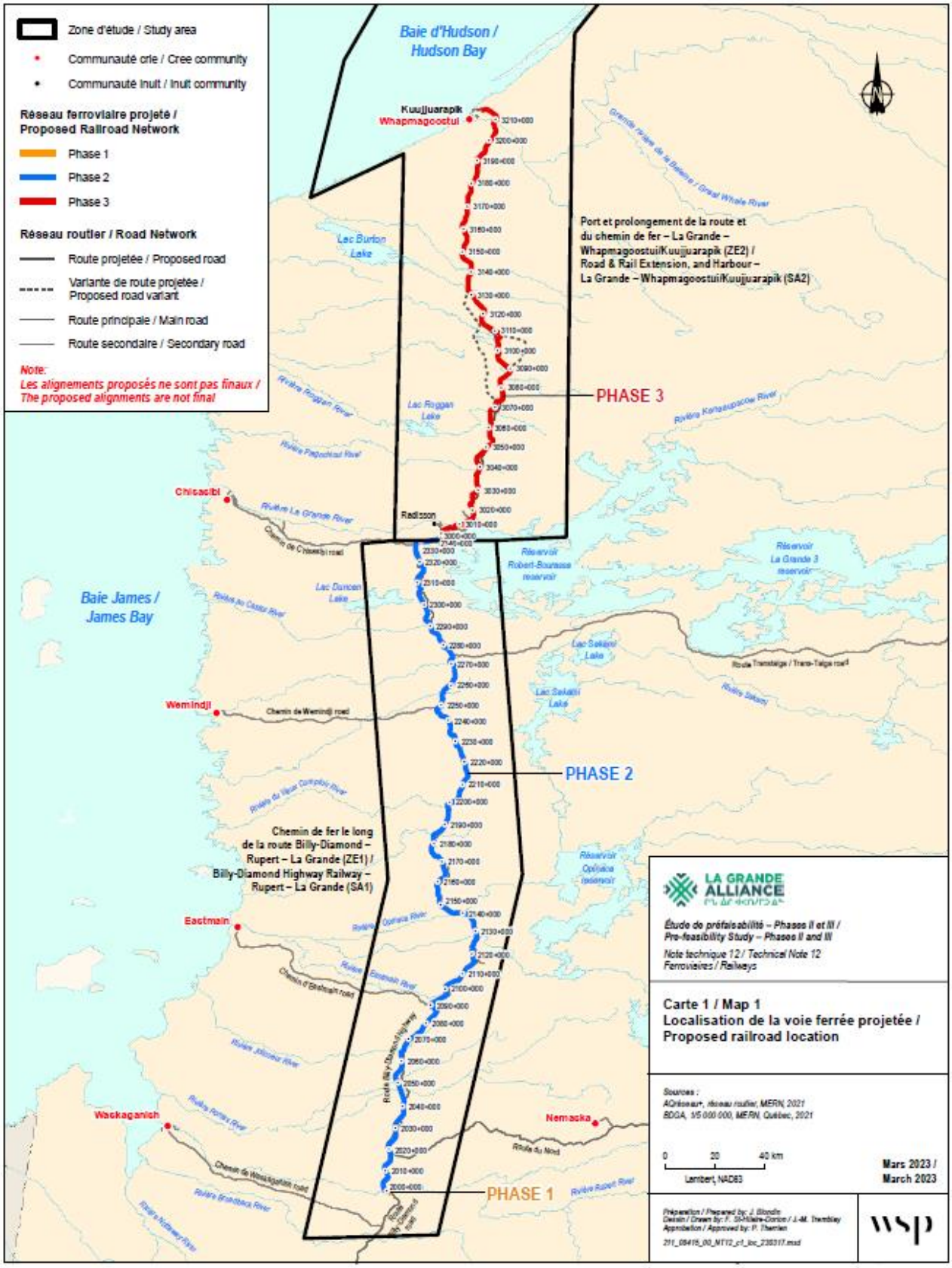


**Figure** **Proposed Railway Alignments**

# LIST OF ABBREVIATIONS AND ACRONYMS

| ABBREVIATIONS/ ACRONYMS | DEFINITION |
|---|---|
| AMIC | ArcelorMittal Mining Railway |
| AREMA | American Railway Engineering and Maintenance-of-way association |
| ATGD | Abitibi-Témiscamingue General Directorate |
| CN | Canadian National Railway |
| JBEC | James Bay Energy Corporation |
| CDC/SODAB | Cree Development Corporation/James Bay Native Development Corporation |
| JBNQA | James Bay and Northern Quebec Agreement |
| MERN | Ministère de l'Énergie et des Ressources Naturelles (Ministry of Energy and Natural Resources) |
| MTQ | Ministère des Transports du Québec (Quebec Ministry of Transportation) |
| ONR | Ontario Northland Railway |
| QNS&L | Quebec North Shore and Labrador Railway |
| RADF | Règlement sur l'Aménagement Durable des Forêts du domaine de l'État (Regulation Respecting the Sustainable Development of Forests in the Domain of the State) |
| SCT | Secrétariat du Conseil du Trésor (Treasury Board Secretariat) |
| SDBJ | Société de développement de la Baie James |
| TFT | Tshiuetin Rail Transportation |

# BRIEF STATIONS EXPLANATION

A station indicates the relative position along the horizontal centerline of a linear structure. In our specific case, the linear structures are the roads. A starting station is set at a specific location and the linear distance along the centerline is added to that starting station. Stations are usually presented as follows:

KKK+MMM

Where:

K: Kilometers

M: Meters

For examples:

1. If the starting station was set at 000+000, station 000+001 would be located on the centerline 1 meter away from the starting station.
2. If the starting station was set at 000+000, station 000+020 would be located on the centerline 20 meters away from the starting station.
3. If the starting station was set at 000+000, station 000+300 would be located on the centerline 300 meters away from the starting station.
4. If the starting station was set at 000+000, station 004+000 would be located on the centerline 4 kilometers away from the starting station.
5. If the starting station was set at 000+000, station 050+000 would be located on the centerline 50 kilometers away from the starting station.
6. If the starting station was set at 000+000, station 600+000 would be located on the centerline 600 kilometers away from the starting station.
7. If the starting station was set at 000+000, station 324+678 would be located on the centerline 324 kilometers and 678 meters (324 678 m in total) away from the starting station.
8. If the starting station was set at 100+000, station 324+678 would be located on the centerline 224 kilometers and 678 meters (224 678 m in total) away from the starting station.

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# 1 INTRODUCTION

This Technical Note 12 presents the pre-feasibility railway alignments developed by WSP for the following two segments:

- Phase II – Rupert to La Grande

  A proposed railway alignment following, as much as possible, that of the Billy-Diamond Highway (BDH) starting at km 257 (after the Rupert River Bridge, which is the junction point with the railway alignment developed by the Phase I Consultant), all the way to La Grande River. The Phase II railway alignment extends over an approximate distance of 340 km;

- Phase III – La Grande to Whapmagoostui/Kuujjuarapik

  A proposed railway alignment extending from the Phase II railway alignment, and which follows, as much as possible, the proposed roadway alignment leading to Whapmagoostui/Kuujjuarapik developed during this Study by WSP. The Phase III railway alignment extends over an approximate distance of 219 km.

Please refer to the Market Study for the railway economic assessment as this Technical Note objectives is to describe the technical aspects of the proposed railway infrastructures.

# 2 COMPARABLE PROJECTS

The WSP study team compiled a list of northern railways that already exist or are under development.

The following existing railways were identified in Northern Quebec and Ontario:

- Tshiuetin Rail Transportation (TFT);
- Quebec North Shore and Labrador Railway (QNS&L);
- ArcelorMittal Mining Railway (AMIC);
- Ontario Northland Railway (ONR);
- Canadian National Railway (CN).

The following northern railways under development were identified:

- Alaska to Alberta Railway (A2A);
- Preliminary study – QC Rail (Dolbeau-Mistassini to Baie-Comeau) – Innogen 2017;
- Preliminary study – QC Rail (Dolbeau-Mistassini to Baie-Comeau) – SNC Lavalin-Norda Stelo 2022 (ongoing);
- Preliminary study – Railway Fermont to Sept-Iles (CN-Genivar, 2013);
- Preliminary study – Railway Fermont to Baie-Comeau (Genivar, 2012);
- Preliminary study - Railway Schefferville to Kuujjuaq (Genivar, 2011).

The TFT, QNS&L, AMIC and A2A railways were evaluated using elements of comparison developed by the Phase 1 Study Team. More details can be found in Technical Note 1.

It is important to note that there are no railways in the area covered by Phases II and III of La Grande Alliance Study.

In Quebec, north of the 49$^{th}$ parallel, only three railways are present. Two of these railways are owned and operated by mining companies:

- Quebec North Shore and Labrador Railway (QNS&L) is a 414-kilometre-long railway owned by Rio Tinto – Iron Ore Company. This line runs from near Sept-Iles, QC, to Labrador City, NL. QNS&L is operating only freight trains but allows TFT passengers trains. The freight train speed is approximately 60 km/h and the passenger train speed is 80 km/h;
- ArcelorMittal Mining Railway (AMIC) is a 420-kilometre-long railway owned by ArcelorMittal company. This line runs from near Port-Cartier to Fermont, QC. AMIC is operating both freight and private passenger train exclusive to AMIC employees. The freight speed is approximately 55 km/h.

A third railway, Tshiuetin Rail Transportation (TFT), is equally owned by the Naskapi community of Kawawachikamach and the Innu communities of Uashat Mak Mani-Utenam and Matimekush-Lac John. It owns and operates a 216 km railway that connects with the Quebec North Shore and Labrador Railway (QNS&L) at Rose Bay junction to Schefferville, QC. TFT is operating both freight and passenger trains, with limited services during the winter period.

The Figure 2-1 presents a map with overview of existing railways in Northern Quebec and Ontario.

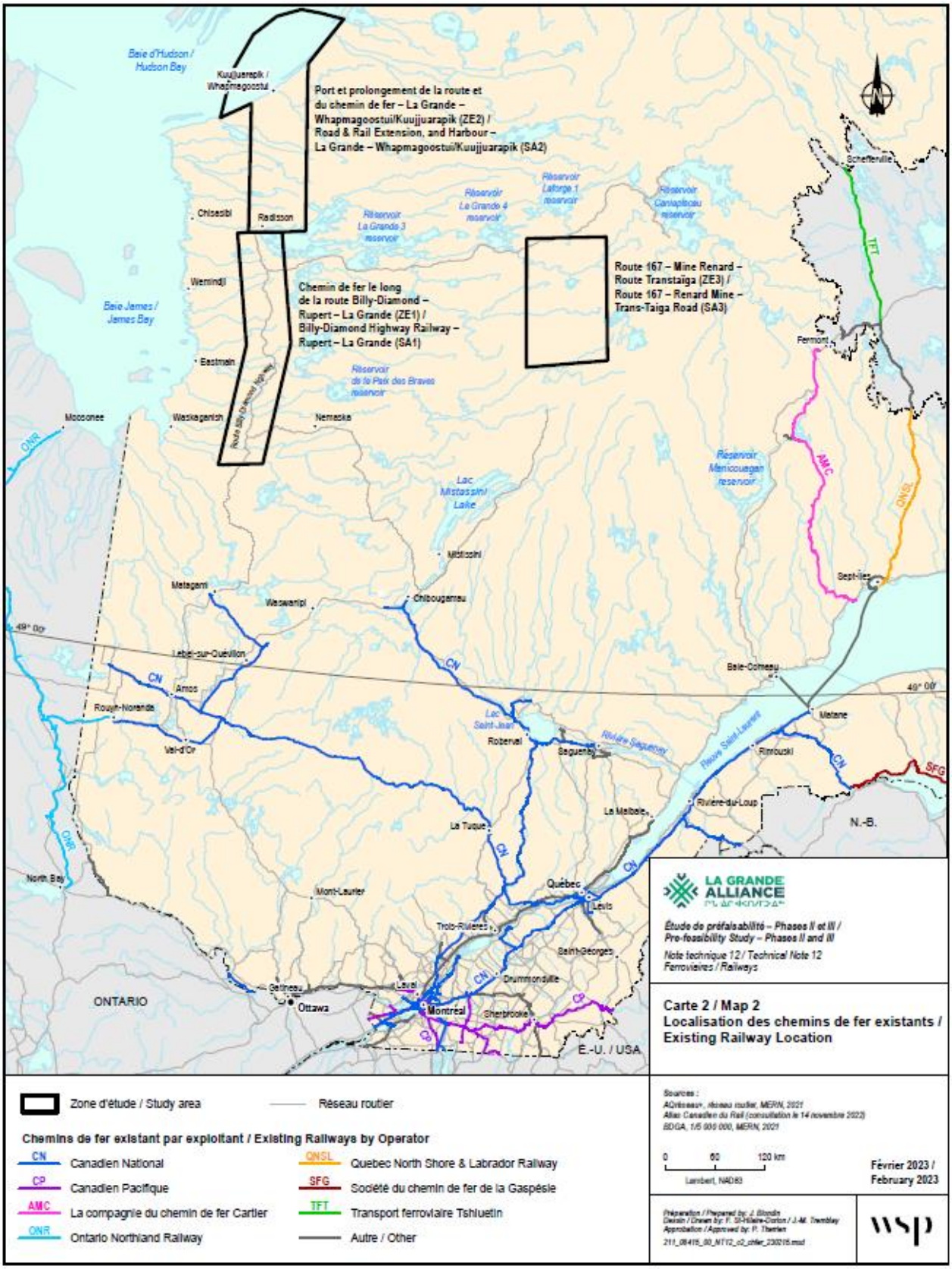


**Figure 2-1 Existing Railway Location**

# 3 RAILWAY OWNERSHIP, OPERATION AND MAINTENANCE

The purpose of this section is to provide an overview of how the potential railway could be structured as an entity, as well as how it could be operated and maintained.

## 3.1 RAILWAY INFRASTRUCTURES OWNERSHIP

The new railway which would be created should the Phase II and Phase III railway components be built would be an extension to the Phase I railway design developed by others. As such, the overall Grande Alliance railway would be connected to the Canadian National Railway (CN) network, and through the CN network, to the overall North American railway network.

Most railways in Québec and Canada are privately owned, but there are a few exceptions. In Québec for example, the right-of-way and the infrastructures of the Chemin de Fer de la Gaspésie (CFG) and the Québec Central Railway (CFQC) are both owned by the Quebec Ministry of Transportation (MTQ). Thus, joint ownership of a new railway by the Cree Development Corporation and the Quebec Ministry of Transportation could be a possibility.

## 3.2 RAILWAY OPERATION AND MAINTENANCE

Should La Grande Alliance foreseen railway be implemented, the railway in Phase II and III could be operated by a new entity to be created and staffed specifically for this purpose. The option also exists, however, for using third party entities to either partially or even completely provide for railway operations and maintenance. As the railway would be directly connected to the Phase I alignment and the greater North American railway network, access to external providers of both track maintenance services and rolling stock (locomotives and railcars) would be possible and should be explored in more detail as the proposed project progresses. However, due to remote distance with existing rolling stock maintenance facilities, La Grande Alliance may consider developing such facilities locally.

Finally, the operation and maintenance of the rail network must be considered as a whole for Phase I, II and III.

### *3.2.1 RAILWAY SAFETY*

Rail safety is a key issue, and every effort should be made both during the elaboration of any proposed railway and its operation to ensure the safety of the public, personnel, and equipment. The *Railway Safety Act* and other Provincial or Federal law and rules require companies to develop a Railway Safety Management System (SMS).

The SMS is a protocol for the implementation of safety in day-to-day railway operations, integrating the responsibility and authorities within a company, the rules, the procedures, the monitoring and evaluation processes to which it is subject, as well as security, enforcement performance and risk assessment objectives.

Information on the SMS could be found in Transport Canada's Railway web site under *Railway Safety Management System Regulations*, 2015: https://tc.canada.ca/en/rail-transportation/rail-safety-canada/safety-management-systems-additional-layer-safety

### 3.2.2 RAILWAY OPERATION IN WINTER

Operating constraints are rougher in winter due to periods of extreme cold or heavy snow in northern regions. Some carriers, like Tshiuetin Rail Transportation (TFT) in northern Quebec, reduce their volume of operation during winter. But all national carriers have put in place winter operating plans that increase maintenance, add heating devices to track switching equipment, and even reduce the length of the trains. The maintenance of infrastructures (track, bridges and telecommunication) and rolling stock (locomotives and wagons) are generally higher during the winter period, because certain components can suffer damage and internal breakage during extreme cold.

Winter operations also have an effect on the infrastructures since it may impose more mid-maintenance site for snow removal team and planning heated shelter for winter emergency situations.

### 3.2.3 YARD, MAINTENANCE CENTER AND SIDING

Depending on the operating mode of the railway, railway yard will have to be considered as a minimum at the terminal station of the railway. A railway yard or transshipment area will also be required wherever freight trains need to load or unload goods. These facilities are also used for refueling locomotives and other rolling equipment such as motorized maintenance crew equipment. Because the need for transshipment areas cannot be defined with precision, their location and size could not be estimated by the team.

The maintenance centers should also have offices and quarters for employees and garages for track maintenance equipment on rails and tires such as snowplows, road rollers, cranes and inspection vehicles, as well as warehouses, material storage areas, fuel tanks. We generally find a turning triangle to turn locomotives in the yard and other maintenance equipment for the way.

Due to the length of Phase II and III, train travel time may be too long to cover the entire route during a normal work shift; a crew change will therefore be necessary along the way. Permanent living quarters midway along the main track may need to be considered for changing train crews and will also be used for railroad inspection and maintenance employees.

Simulation of train movement and operation will need to be performed in a future study phase. These simulations involve studying the potential train schedule, the effect of track slop and curves, train travel time from station to station. The simulation will determine the need for track siding to allow two-way train circulation on a single track. It is also the simulation that will confirm the travel time, which leads to the maximum distance that a train could travel before having to stop and change train crews or to have an appropriate resting point. Note that track sidings should be longer than the longest train considerer. For this pre-feasibility study, it is considered that two track sidings are sufficient: one located close to La Grande and one located at Whapmagoostui.

Any yard and maintenance center should have road access in order to facilitate the transportation of crews and equipment.

### 3.2.4 TELECOMMUNICATION AND WAYSIDE EQUIPMENT

Train operations require a telecommunications system for the following needs:

- Communication between trains;
- Communication between the train and the command center;
- Communication between the signaling equipment, those at the edge of the way and the control center;
- Communication between the maintenance crews and trains.

The centralized traffic control (CTC) mode of operation should not be considered due to the very high cost of such an installation and the low intensity of rail traffic. The foreseen infrastructure should be based on the deployment of an Occupancy Control System (OCS) rail corridor. With OCS, there are no remote-controlled switches or signals on the mainline, therefore the telecommunications system needed is primarily for the support of voice radio communication between the dispatch center and the train crew. The voice radio coverage would need to be consistent over the entire path of the line, not only at the end-of-sidings where the switches are as the train can be anywhere on the line and would permit emergency broadcasts from any point on the line.

There is currently no infrastructure deployed by the major telecom companies in the study area. However, there will be a critical need for maintenance crews and other personnel by the tracks to communicate with the train. This could be achieved using 5-watt handheld radios and attention will need to be paid to ensure that there is sufficient voice radio tower coverage across the alignment. Build/use agreements may be negotiated with the telecom companies as they may have future expansion plans in these areas especially with foreseen new radio towers. In addition, underground fibre is typically installed in the rail corridor and telecommunications companies can use this as a back-up circuit for services they may provide to neighboring communities. Thus, the telecommunication need of the railroad could be an opportunity for Cree land users to obtain better public communication tools.

Train operations will also require equipment and system along the track for the following needs:

- Snow clearing devices;
- Equipment inspection systems;
- Track lubrication equipment.

**Snow clearing Devices**

Switch heaters, blowers, and snow melters may be considered, based on the geographic location and on the railway traffic. The snow will affect the ability to effectively move the switch points. Where heaters system are installed, a method of control also need to minimize energy consumption, thus remotely activated.

**Equipment Inspection systems**

Trains may require that they be inspected near yard, train station, long bridges, tunnel and sensitive areas. These include detectors for Hot Box, Hot Wheel, Dragging Equipment, Derailment, Slide Fences, Slump, Washout, Wheel inspection and other site-specific units. The Hot Box, Hot Wheel, and Dragging Equipment detection can be done at a single location referred to as a Wayside inspect system (WIS). This is a brief description of each system:

- Hot Box Detector (HBD): Detects the temperature of the wheel bearings to detect possible high temperature that can lead to failures;
- Hot Wheel Detector (HWD): Detects the temperature of the wheel surface to detect possible high temperature that can lead to failures;
- Dragging Equipment Detector (DED): Detects for low or dragging equipment that may lead to derailments or other failures, can also detect a derailed set of wheels;
- Slide Fence: Used to detect snow, earth or rockslides that may make the track impassable;
- Washout/Slump Detectors: Detect defects that may make the track impassable due to the area near the track being eroded by water;
- High Water Detector: Used to detect for high water levels that may affect the safe passage of trains;

- Wheel Inspection System: Checks and reports on the condition of the wheels looking for defects that may be unsafe. This can include but not limited to wheel impacts, wheel roundness, alignment, and service life tolerances.
  - Derailment Detectors: Detect wheels that have derailed off the rail that may cause derailments;
  - Automatic Equipment Identification System: Identifies the equipment entering/departing track, used for tracking and billing purposes.

Reliable power is required for the safe operation of the railway. The prefer power sources could be Hydro-Quebec. If a power line is not available locally, generators or solar power plants and wind power can be used.

Wayside equipment represents a small fraction of the overall budget for the foreseen infrastructure. The biggest issue will be reliable power services.

# 4 DESIGN CRITERIA

Design Criteria used for the Phases II and III proposed railway alignments is the same as that used for the Phase I rail concept design, deemed appropriate for the anticipated "Heavy Rail" nature component. Table 4-1below summarizes the principal railway Design Criteria used.

**Table 4-1 Main Railway Design Criteria**

| DESIGN CRITERIA | VALUE |
|---|---|
| Design Speed | Passenger: 80 mph , Freight: 60 mph |
| Axle Loads | Locomotives: 32.4 tonnes per axle<br>Wagons: 286 000 lbs = 30 tonnes per axle |
| Minimum Horizontal Curve Radius | 1150 m or 800 m with speed reduction |
| Maximum Gradient | 1.5% (compensated), 2.0% (over maximum length of 500 m) |
| Rail | 136 lb RE |
| Rail Joints | Welded into Continuous Welded Rail (CWR) |
| Ties | Hardwood |
| Fasteners | Elastic Fasteners |
| Ballast Depth Under Tie | 300 mm Minimum |
| Bridge Design Load | AREMA E90 Cooper |

## 4.1 TRACK INFRASTRUCTURE

A potential railway in Eeyou Istchee-James Bay presents several challenges. It crosses a territory with a presence of permafrost in the northern part of the Phase III as well as several lakes and rivers all along the alignment. Therefore, it is very important to provide a railway platform adapted to the ground conditions. However, at this stage of pre-feasibility, there is no typical section developed specifically for La Grande Alliance needs. The track infrastructure section used for this study is that of the standard drawing TS 2204 of Canadian National. In subsequent phases of the project, it would be advisable to verify the applicability of this section.

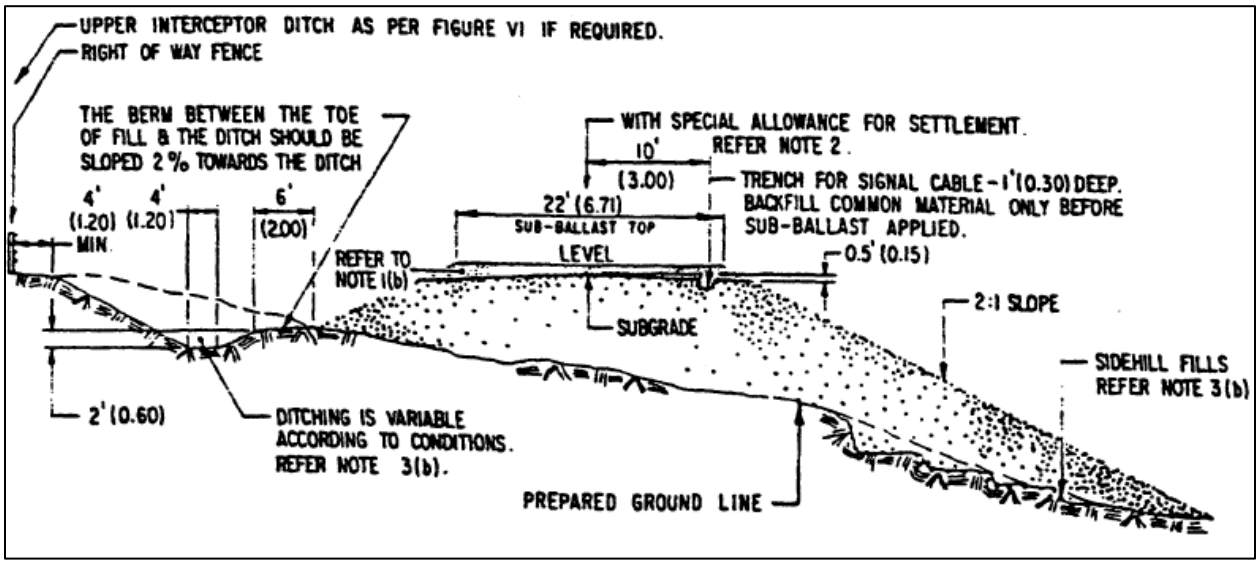


**Figure 4-1 Typical Infrastructure Section – Extract from CN TS-2204**

The main criteria are shown below:

- Rail platform width of 6.7 m (22');
- Slope of fill or excavation: 1V:2H;
- Ditch width: 1 m;
- Stripping height considered: 150 mm.

## 4.2 TRACK MATERIALS

At this stage of pre-feasibility study, no calculation has been done to determine a track structure or identify track materials that would be recommended, nor a choice on the type of sleepers to be used. The section of drawing TS 2205 with wooden sleepers, of the CN standard is only considered for estimation purposes.

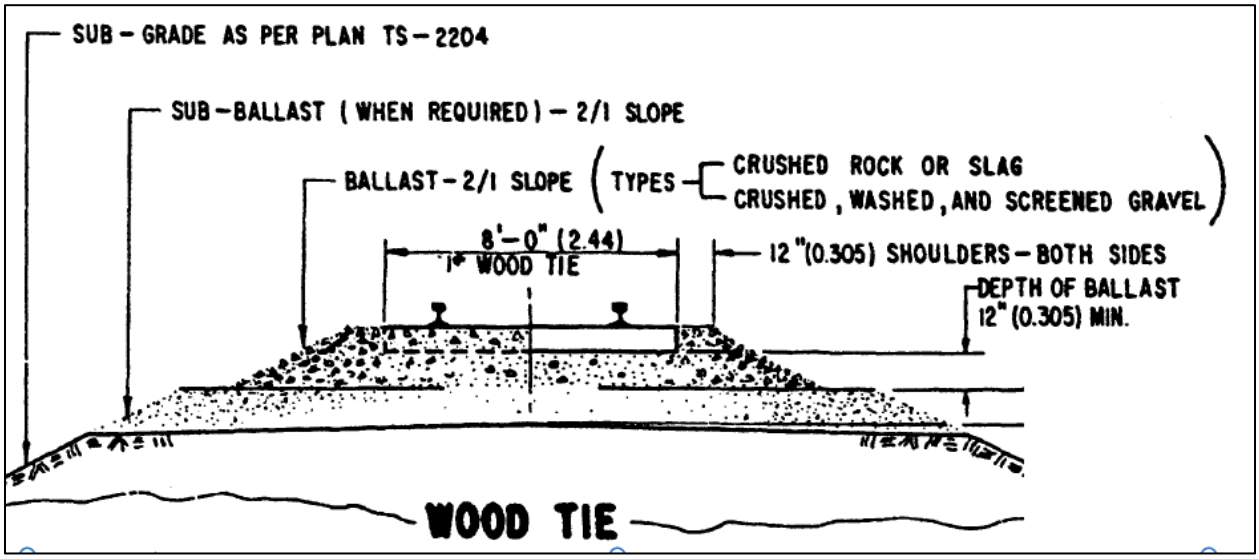


**Figure 4-2 Typical Track Structure Section – Extract from CN TS-2205S**

The main criteria are listed below:

- Tie: wooden, 8' long with a 20 3/8 inch spacing as per CN track standard for Class 3;
- Rail: 136 lb RE;
- Ballast shoulder: 300 mm;
- Ballast height: 30 mm;
- Sub-ballast height: 300 mm.

# 5 RAILWAY ALIGNMENT DEVELOPMENT PROCESS

In this section, the main drivers and the process used to establish Phase II and Phase III alignments are presented.

In developing Phase II and III railway alignments, in addition to respecting the Design Criteria presented in Section 4 of this report, the design team applied the following rules or key drivers:

- Respect, as much as possible, the natural site topography (mountains and plains);
- Consider the overall geology of the study area, including the locations of aggregate material deposits;
- Avoid, as much as possible, lakes and rivers; minimize the length of crossings and bridges where these are unavoidable;
- Avoid, as much as possible, existing and projected Protected Areas; minimize encroachment and provide mitigation measures where these are unavoidable;
- Minimize crossing and impacts on caribou migration corridors;
- Avoid, as much as possible, areas of cultural significance such as areas currently used by Cree land users, archeological sites, etc.; minimize encroachment and provide mitigation measures where these are unavoidable;
- Propose, wherever applicable, alignment variants that could offer added value, such as:
  - Locations that minimize environmental footprint;
  - Locations that minimize construction cost;
  - Locations that minimize the impacts on existing camps and facilities.
- Remain, as much as possible, in close proximity to existing and/or proposed roads;
- Remain within 1 km corridor centered on existing and/or proposed roads when surrounded by recognized Protected Areas on both sides;
- Minimize the number of times the railway crosses existing and/or proposed roads.

Using the key drivers presented above, while at the same time respecting the retained Design Criteria, a railway alignment was developed first in plan, and then in profile. As is sometimes the case, once the alignment is developed in both plan and profile, opportunities for improvement become evident. The Design of any linear project is an iterative process. The track alignment is developed at a pre-feasibility stage with some limitations due to the accuracy of information available, such as maps, survey, aerial photos, topography, environmental & social constraints. The various railway alignments shown on maps and figures as part of this mandate should be considered as a potential corridor and will need to be optimized in a future feasibility study.

These key drivers are briefly explained in the sub-sections below.

## 5.1 MAIN KEY DRIVERS

### *5.1.1 AVOID LAKES AND RIVERS*

For both ecological and economic reasons, wherever possible, lakes were avoided by adjusting the railway alignment to go around them rather than through them. Rivers were also avoided unless a crossing was inevitable.

Figure 5-1 below provides an example of the use of a more winding alignment to avoid several lakes.

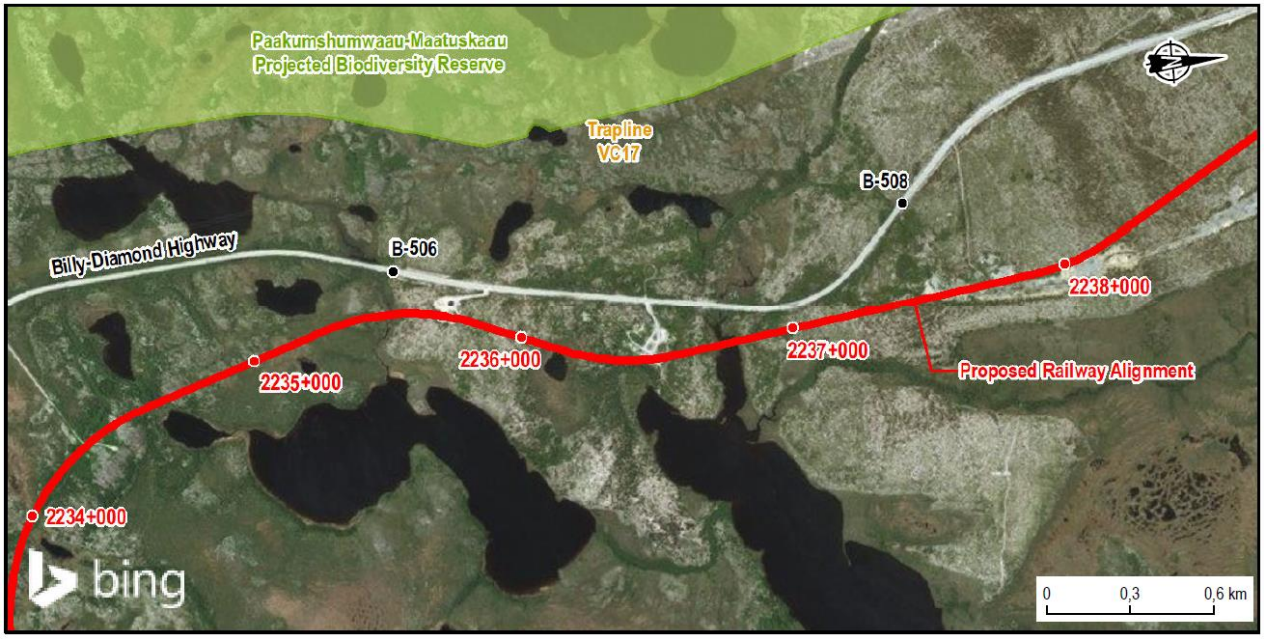


**Figure 5-1 Example of Winding Alignment to Avoid Several Lakes (CH 2234+000 to 2239+000)**

### *5.1.2 MINIMIZE BRIDGE LENGTH*

To reduce the anticipated cost for major river crossings, the crossing location was selected to reduce the overall bridge length. In the case of Phase II, the major rivers crossed are the Eastmain and Opinaca Rivers. For Phase III, the major rivers crossed are La Grande and Great Whale Rivers. Bridges are also required where there are major valleys.

A total of 36 railway bridges are proposed for Phase II - Rupert to La Grande.

**Table 5-1 Proposed Railway Bridges – Phase II - Rupert to La Grande**

| NUMBER OF BRIDGES | RAILWAY BRIDGE LENGTH | | % IN QTY |
|---|---|---|---|
| 28 | Short | 10 to 50 m | 78% |
| 3 | Major | 51 to 100 m | 8% |
| 4 | Long | 101 to 500 m | 11% |
| 1 | Extra Long | 501 m and more | 3% |
| **36** | **Total - Bridges** | | |

A total of 66 railway bridges are proposed for Phase III - La Grande to Whapmagoostui/Kuujjuarapik.

**Table 5-2 Proposed Railway Bridges – Phase III - La Grande to Whapmagoostui/Kuujjuarapik**

| NUMBER OF BRIDGES | RAILWAY BRIDGE LENGTH | | % IN QTY |
|---|---|---|---|
| 39 | Short | 10 to 50 m | 59% |
| 9 | Major | 51 to 100 m | 14% |
| 13 | Long | 101 to 500 m | 20% |
| 5 | Extra Long | 501 m and more | 8% |
| **66** | **Total - Bridges** | | |

### *5.1.3 REMAIN IN PROXIMITY TO THE BILLY-DIAMOND HIGHWAY*

To reduce the occurrence of enclaved areas between the proposed railway and the existing and/or proposed roads, a 50-metre minimum offset was implemented wherever possible. This offset was chosen as a minimum distance from the existing highway where railway construction would not interfere with the existing highway, while the proximity to the highway would facilitate railway construction activity.

For Phase II, approximately 70% of the railway is within 100 metres from the existing Billy-Diamond Highway, measured from the centerline of the proposed railway to the centerline of the BDH.

For Phase III, approximately 75% of the railway is within 100 metres from the proposed roadway extension to Whapmagoostui/Kuujjuarapik. For this Phase III, it is important to note that it is feasible to reduce the percentage of railroad offset to almost none if we adjust the proposed road to the track alignment. Adjusting the road to the track alignment may result in higher road cost, but lower impact.

The offset is mainly due to the difference in the curve design criteria. The railway minimum curve radius is 1150 m (or 800 m with speed restriction) and the road minimum curve radius is 250 metres. This results in longer railway curves, which could not follow the sharpest roadway curves.

Figure 5-2 shows a stretch of the proposed railway alignment where it was possible to meet this key driver.

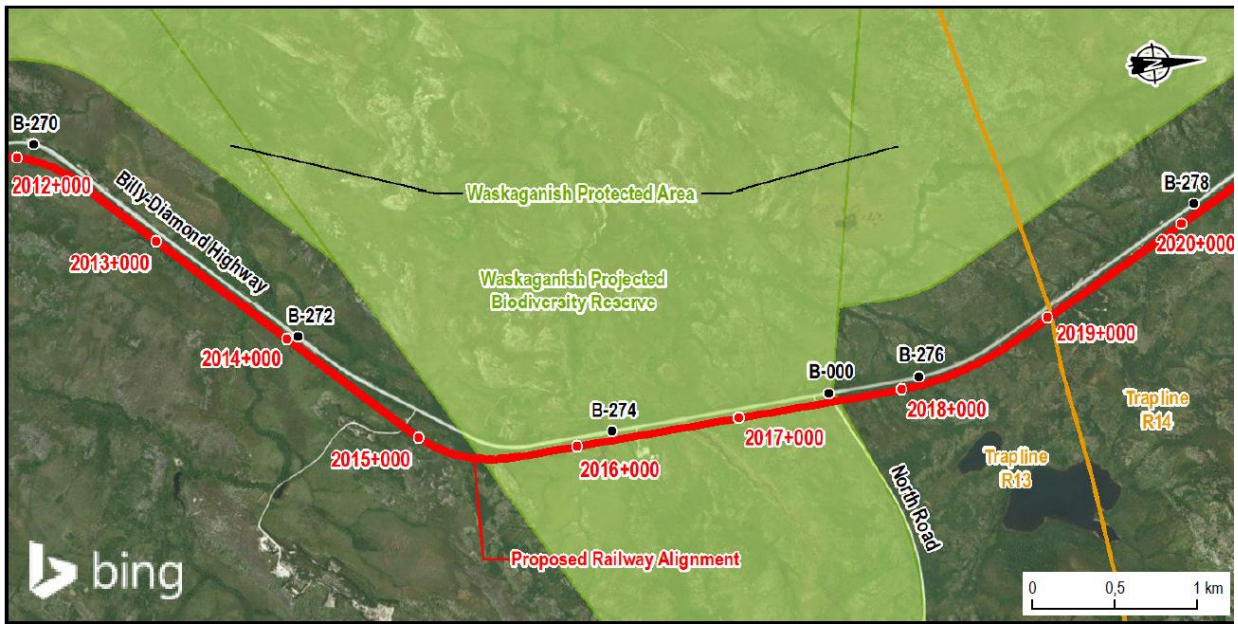


**Figure 5-2 Example of Proposed Railway Alignment in Proximity of the BDH (CH 2012+000 to 2020+000)**

### *5.1.4 AVOID PROTECTED AREAS*

When existing and/or proposed roads are surrounded by recognized Protected Areas on both sides, the railway design team endeavoured to remain within 500 m of the roadway.

Figure 5-3 provides one of several examples where this constraint was successfully met.

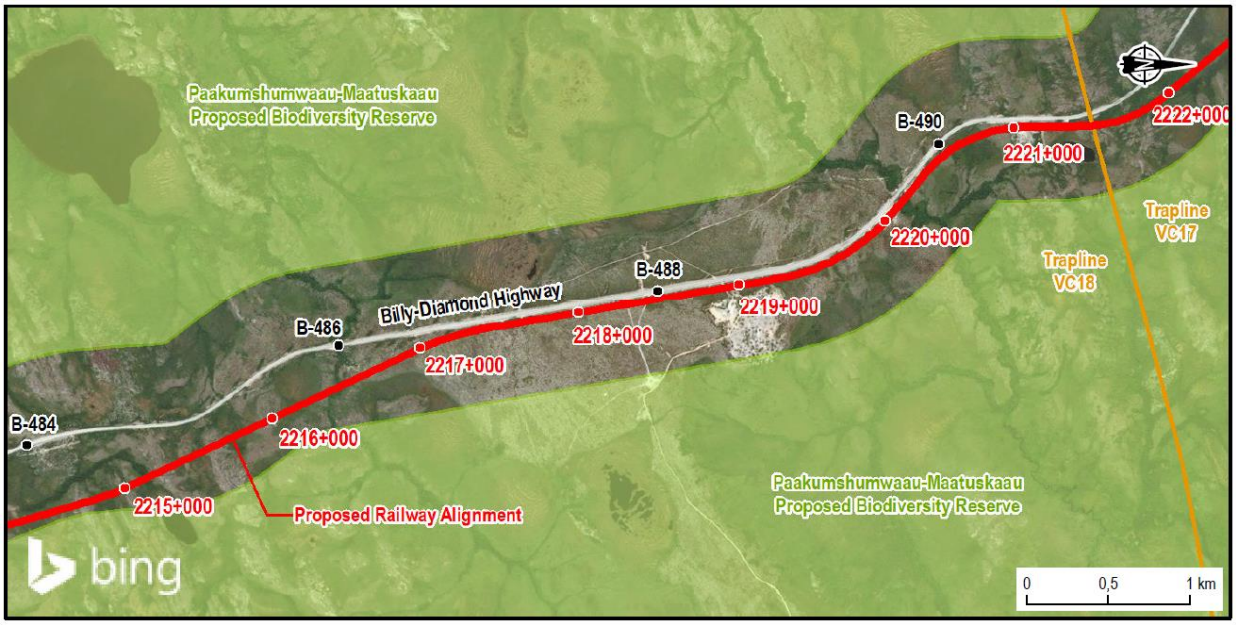


**Figure 5-3 Example of Railway Alignment within a 1 km-wide Corridor to clear Protected Areas (CH. 2214+000 to 2222+000)**

### 5.1.5 MINIMIZE LEVEL CROSSINGS

For cost and safety reasons, crossings should be avoided as much as possible. However, they are inevitable to ensure continuity of other transportation corridors such as roads, snowmobile, VTT Trail, private access, etc., however their occurrence should, as much as possible, be minimized. The projected daily traffic flow on each of the proposed road and railway are not sufficient to require over bridge crossings which are expensive. That projected traffic flow does not either required crossing to be equipped with barriers that require regular and specialized workforce. However, lights and bells will be minimally required. Therefore, each crossing will require electric power.

**Table 5-3 Number of Crossings – Proposed railway Phase II and Phase III**

| LOCATION | TOTAL NUMBER OF CROSSINGS |
|---|---|
| Phase II - Rupert to La Grande | 23 |
| Phase III - La Grande to Whapmagoostui/Kuujjuarapik | 12 |

Figure 5-4 provides an example of a location where a level crossing was required.

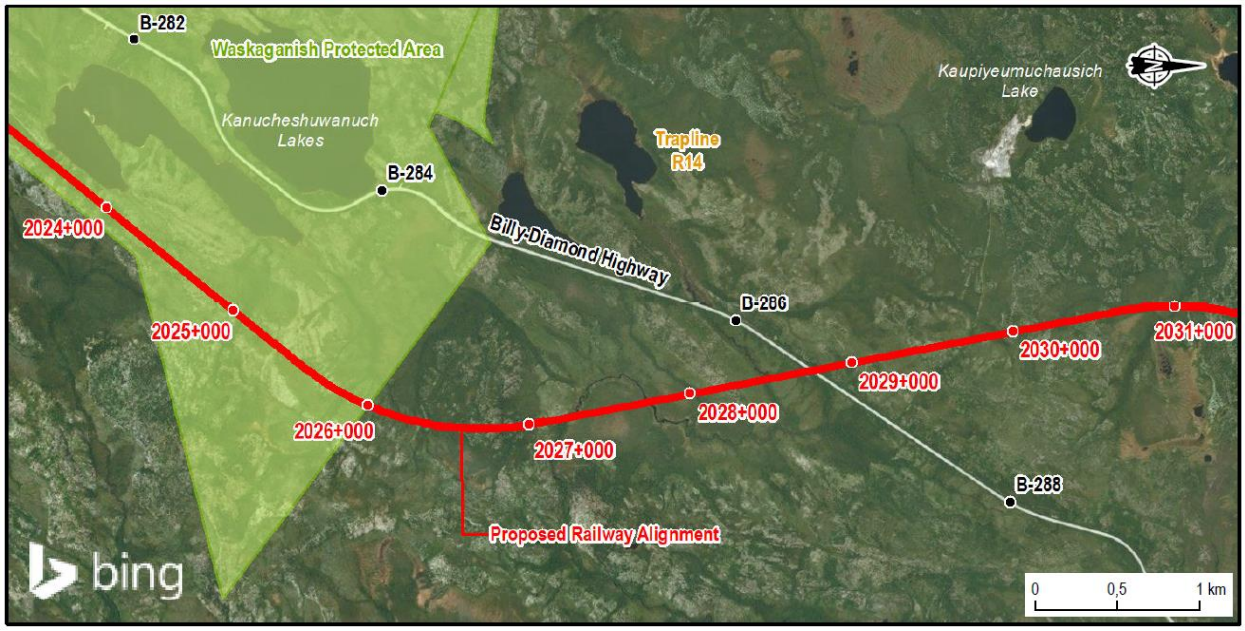


**Figure 5-4 Example of Required Level Crossing (CH 2023+000 to 2030+000)**

# 5.2 ALIGNMENT REVISION DUE TO PHYSICAL CONSTRAINTS

## *5.2.1 EASTMAIN RIVER AT KM 2128 – PHASE II*

The Eastmain River crossing at km 2128 poses a challenge in terms of alignment development as on either side of the river, there are significant elevation drops. To reduce earthworks quantities, what was a more direct approach became a more winding one.

Even with the proposed alignment, a major 480-metre-long structure will be required considering the width of the river at the crossing's elevation. An arch bridge may be considered for this site.

For comparison, the adjacent existing roadway bridge is approximately 280 meters long. This potential railway bridge was therefore targeted as a zone for future optimization to be done in the next steps of the study.

Figure 5-5 presents both the original and revised alignment at this location.

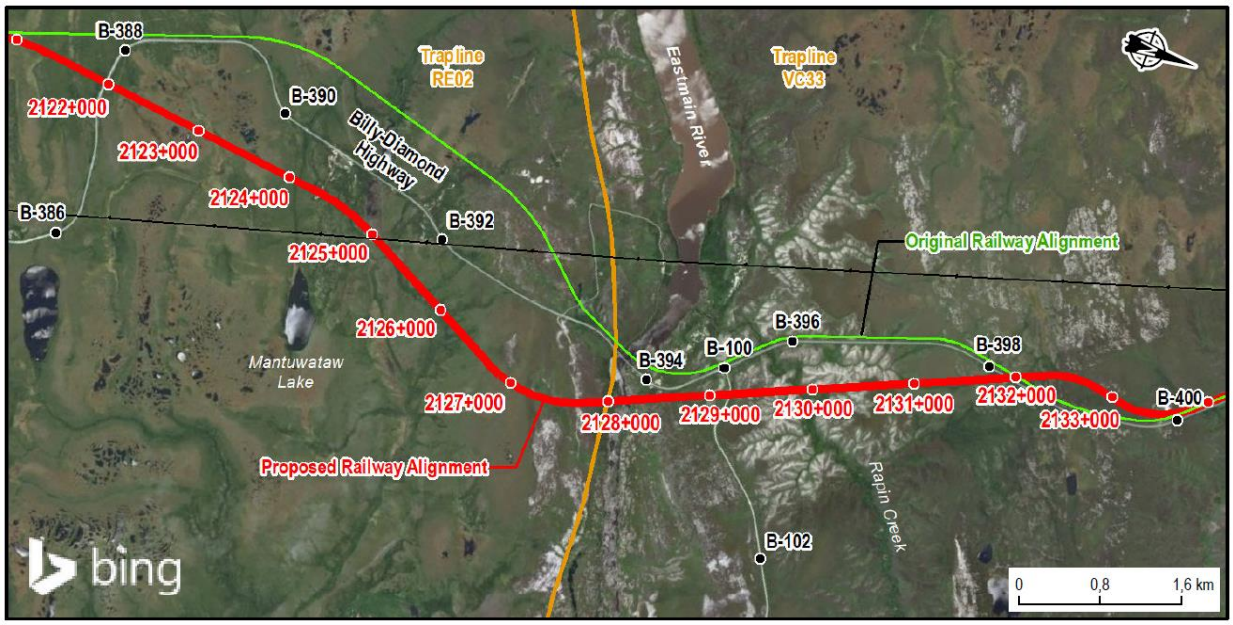


**Figure 5-5 Original and Revised Eastmain River Crossing Railway Alignment (CH 2121+000 to CH 2134+000)**

### 5.2.2 SIGNIFICANT HILL AT KM 2325

At this location, near the turnoff for the Chisasibi Road, it is not a river crossing but rather a significant hill that gave rise to large volumes of cuts. Once again, by introducing a slightly more sinuous alignment, cut quantities were reduced. Figure 5-6 presents both the original and revised alignment at this location.

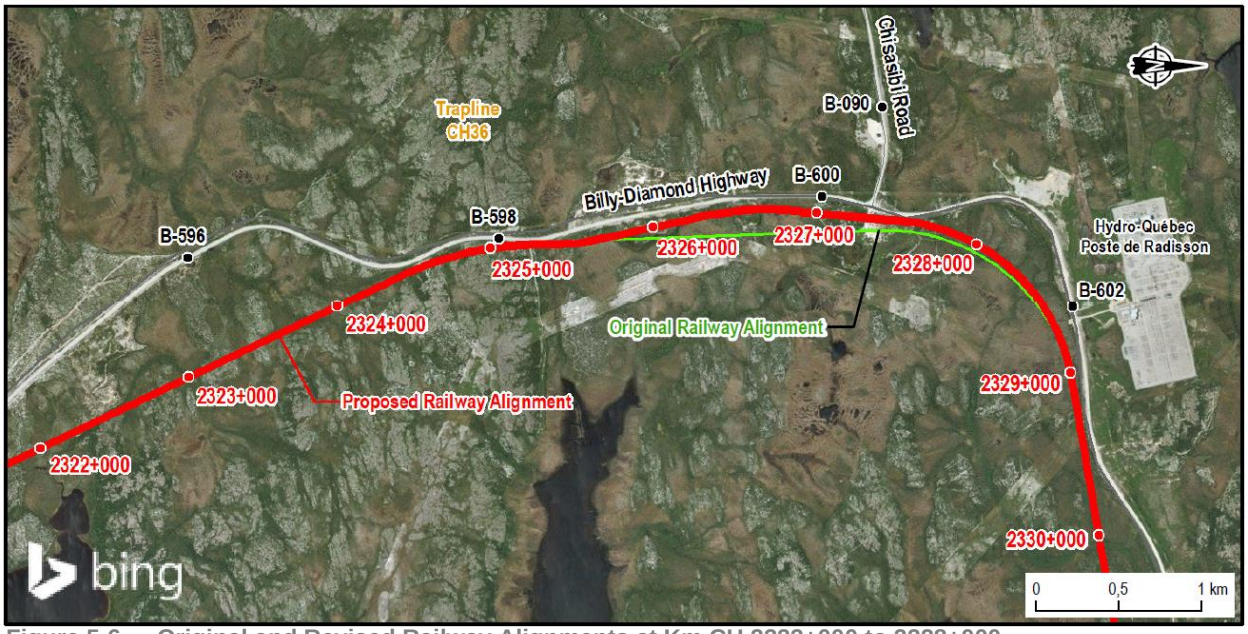


**Figure 5-6 Original and Revised Railway Alignments at Km CH 2323+000 to 2328+000**

### 5.2.3 SPEED RESTRICTION DUE TO PHYSICAL CONSTRAINTS

It should be mentioned at this point that Phase II and Phase III's morphology is hard to follow when it comes to railway design at speeds as high as 80 mph and 60 mph. Moreover, Phase III's territory has many more waterbodies than Phase II area. In order to avoid these waterbodies and to minimize the offset from the road corridor, the design speed in considerable parts of Phases II and III is reduced to 60 mph (±97 km/h) for passengers and 50 mph (80 km/h) for freight, instead of 80 mph (±128 km/h) and 60 mph (±97 km/h) respectively.

**Table 5-4 Reduced speed zones – Proposed railway Phase II and Phase III**

| LOCATION | TOTAL KM | % OF RAILWAY LENGTH |
|---|---|---|
| Phase II - Rupert to La Grande | 48 | 14% |
| Phase III - La Grande to Whapmagoostui/Kuujjuarapik | 69 | 31% |

For Phase II, the horizontal curves needing reduced speed are spread along the whole alignment.

For Phase III, the horizontal curves needing reduced speed are concentrated in the first 110 km of the alignment and in the last 11 km.

Figure 5-7 below illustrates one of the locations where the design speed is reduced to avoid waterbodies and to minimize the offset from the road corridor.

**Figure 5-7 Example of Sharp Railway Curves with Speed Reduction to Avoid Lake**

### *5.2.4 BRIDGES REQUIRING ALIGNMENT OPTIMIZATION*

The impossibility, in railroad design, of implementing sharp curves and steep slopes as opposed to road design, leads to longer bridges. The rugged morphology of the land in some areas also leads to longer railroad bridges. As a next step of optimization, it is recommended that the railway alignment be reworked to aim for a reduction of the length of bridges that are over 100 metres long. This reworking could as well be called alignment optimization and it is a normal process in any linear infrastructure design.

**Table 5-5 Phase II – List of Long and Extra Long Bridges that Require Alignment Optimization**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 2047+800 | R-09 | Pontax River | 150 |
| 2128+100 | RE-02 & VC-33 | Eastmain River | 480 |
| 2129+900 | VC-33 | Important Valley and watercourse | 200 |
| 2144+600 | VC-33 | Opinaca River | 500 |
| 2195+400 | VC-18 | Du Vieux Comptoir River | 600 |

**Table 5-6 Phase III – List of Long and Extra Long Bridges that Require Alignment Optimization**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3001+014 | CH-36 | Unidentified river | 250 |
| 3009+349 | CH-09 | La Grande River | 1,100 |
| 3037+944 | CH-09 | Unidentified river | 200 |
| 3060+003 | CH-10 | Important valley – Pamigamachi lake | 150 |
| 3062+400 | CH-10 | Unidentified lake | 150 |
| 3067+343 | CH-11 | Roggan river | 160 |
| 3069+600 | CH-11 | Atawataweats river | 150 |
| 3083+600 | CH-11 | Unidentified lake | 150 |
| 3092+600 | CH-11 | Unidentified lake | 140 |
| 3106+000 | CH-12 | Important valley | 600 |
| 3119+351 | CH-07 | Important valley | 200 |
| 3132+700 | CH-07 | Unidentified lake/river | 110 |
| 3140+656 | GW-05 | Vauquelin river | 400 |
| 3156+300 | GW-20 | Unidentified lake | 130 |
| 3163+191 | GW-03 | Sucker river | 800 |
| 3201+300 | GW-03 | Unidentified river | 120 |
| 3208+575 | GW-03 | Important valley | 1,900 |
| 3210+202 | GW-01 & GW-03 | Great Whale River | 1,100 |

## 5.3 SUMMARY OF RAILWAY TRACK INFRASTRUCTURE

**Table 5-7 Summary of Railway Track Infrastructure**

| | PHASE II RUPERT TO LA GRANDE | PHASE III LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK |
|---|---|---|
| Total length of railway track | 340 km | 219 km |
| Total length of railway track in curves | 113 km | 81 km |
| % of track in curves | 33% | 36% |
| Slope max (%) | 1.46% | 1.96% |
| % of track with slope greater than1% | 23% | 24% |
| Number of bridges | 36 | 66 |
| Total length of bridges | 2.6 km | 9.4 km |
| % of railway on a bridge | 1 % | 4 % |
| Number of tunnels | None | None |
| Excavation volume | 12.7 million $m^3$ | 12.7 million $m^3$ |
| Fill volume | 12.5 million $m^3$ | 14.0 million $m^3$ |
| % of the railway within 100 metres from the BDH or proposed road extension. | 70 % | 75 % |

# 6 PHASE II – RUPERT TO LA GRANDE

The Phase II pre-feasibility railway proposed alignment begins just west of the Rupert River crossing, as an extension of the Phase I railway alignment and ends at approximately 3 km south of La Grande River. The overall length of the Phase II proposed alignment is 340 km, and its sinuous nature reflects the many lakes and the varying topography encountered.

As requested, to minimize the environmental impacts, the railway alignment generally follows the Billy-Diamond Highway (70% of the total length). The remaining 30% which is not within 100 meters from the BDH is due to the railway design criteria that do not allow the railway to follow the highway curves. The proposed railway alignment generally heads steadily north, up to its termination point approximately 3 km south of the La Grande River.

A total of 47.7 km were designed with reduced speed of 65 mph for passenger trains to allow the alignment to be closer to the BDH and to avoid waterways. This represents 14% of the railway's total length.

The ground condition within a two-kilometre-wide corridor along the railway alignment is composed of the following types of soil:

**Table 6-1 Types of Soil – Phase II (Value from Technical Note 10 – Geotechnical)**

| TYPES OF SOIL | % OF RAILWAY CORRIDOR ON THIS TYPE OF SOIL |
|---|---|
| Organic soils | 26% |
| Silt and clay | 15% |
| Sand and gravel | 28% |
| Till | 16% |
| Rock | 15% |

For the Phase II, the alignment starts at km 2000+000 up to km 2339+000. It would be worth mentioning here that the Phase II alignment has its independent stationing from Phases I and III alignments.

The reader is also referred to the plans for Phase II and III alignments in Appendix A.

Phase II proposed railway is broken down into segments for which more detailed information is provided in the next sections (see introductory section for explanation on station).

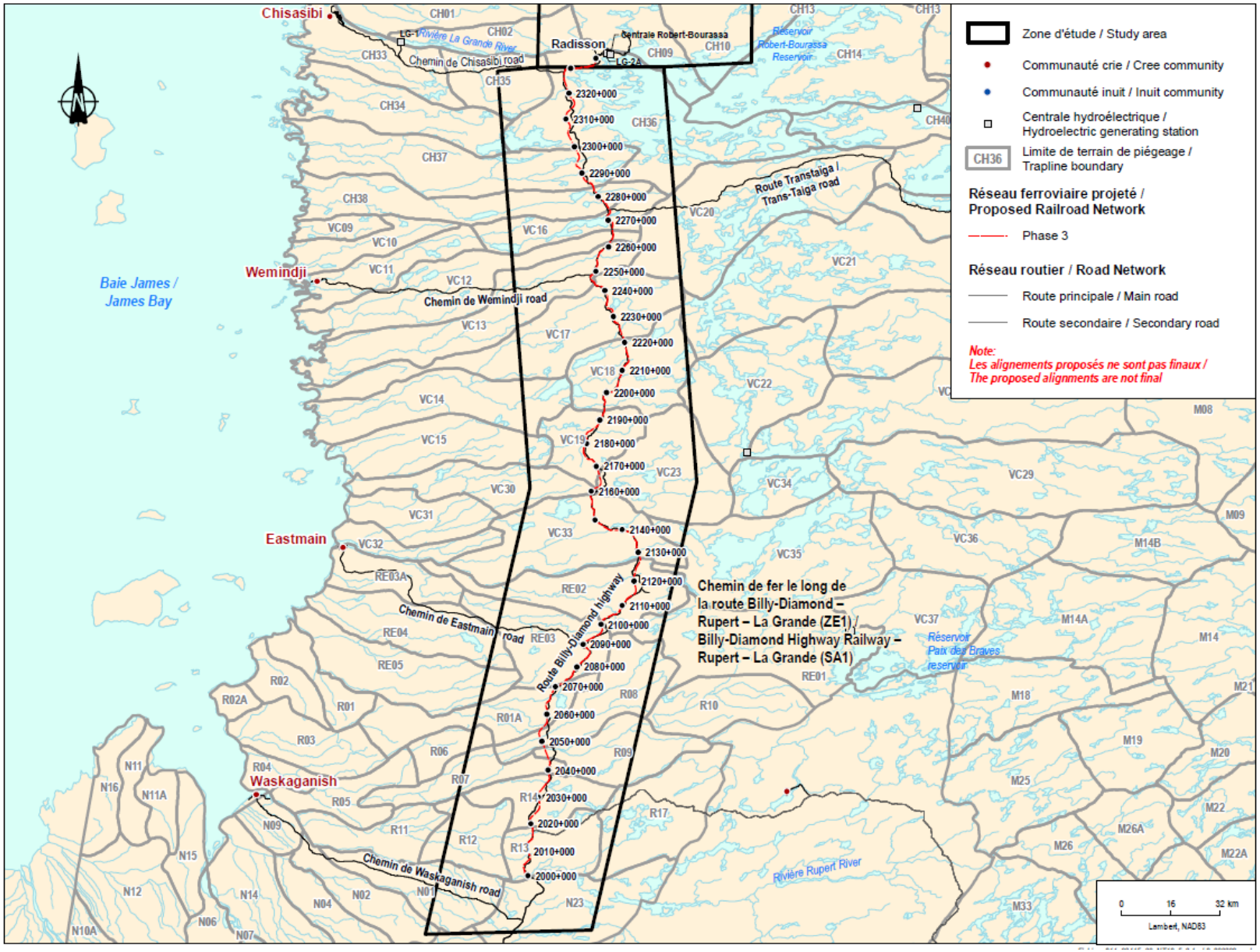


**Figure 6-1 Phase II Alignment with Traplines**

## 6.1 KM 2000+000 TO KM 2060+000 (BDH: KM 258 TO KM 320)

From the connection point with the Phase I railway alignment west of the Rupert River, the Phase II railway alignment heads towards La Grande following the Billy-Diamond Highway but certain stretches such as between km 2044 and km 2056, a 12 km segment, run two to three kilometres away from the Billy-Diamond Highway.

There are existing or proposed protected areas to the west of the proposed alignment between km 2008 and km 2014 (6 km), and between km 2018 and km 2021 (3 km).

Two notable river crossings occur in this segment: the Miyapiskau River is crossed near km 2048, and the Enistuwach River is crossed at km 2051.5.

Impacted traplines: R13, R14, R07, R09, R08 and R01A.

Number of horizontal curves with speed reduction: 5 (3.3 km).

Please find below a list of potential major bridges from TN 14.

**Table 6-2 List of Potential Major Bridges - km 2000+000 to km 2060+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 2047+800 | R-09 | Pontax River | 150 |
| 2051+400 | R-08 | Enistuwach River | 60 |

## 6.2 KM 2060+000 TO KM 2120+000 (BDH: KM 320 TO KM 384)

The proposed Phase II railway alignment generally follows the Billy-Diamond Highway.

According to available mapping, there are no existing or proposed protected areas in this segment.

There are no major river crossings in this segment nor major bridges.

Impacted traplines: R01A, RE03, RE02.

Number of horizontal curves with speed reduction: 10 (7.2 km).

## 6.3 KM 2120+000 TO KM 2180+000 (BDH: KM 384 TO KM 449)

The proposed Phase II railway alignment generally follows the Billy-Diamond Highway but certain stretches such as between km 2159 and km 2169, a 10 km segment, run one to three kilometres west from the Billy-Diamond Highway.

According to available mapping, there are no existing or proposed protected areas in this segment.

Two important river crossings occur in this segment: the Eastmain River, the most significant crossing on the Phase II railway alignment, is crossed near km 2128, and the Opinaca River is crossed at km 2144.5. Note that the proposed railway bridge at Eastmain River is located to the east of the roadway bridge and the proposed railway bridge at Opinaca River is located to the west of the roadway bridge.

Impacted traplines: RE02, VC33, VC30, VC23 and VC19.

Number of horizontal curves with speed reduction: 8 (7.0 km).

Please find below a list of potential major bridges from TN14.

**Table 6-3 List of Potential Major Bridges - km 2120+000 to km 2180+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 2128+100 | RE-02 & VC-33 | Eastmain River | 480 |
| 2129+900 | VC-33 | Important valley and watercourse | 200 |
| 2144+600 | VC-33 | Opinaca River | 500 |
| 2178+700 | VC-19 | Important valley and watercourse | 70 |

## 6.4 KM 2180+000 TO KM 2240+000 (BDH: KM 449 TO KM 511)

The proposed Phase II railway alignment generally follows the Billy-Diamond Highway.

There are existing or proposed protected areas to the east and west of the railway alignment over most of this segment: starting at km 2189, these areas extend on the west side from this point to beyond the end of this segment, and on the east side to km 2232. As such, these areas extend over 51 kilometres of this 60 km segment.

There are no major river crossings in this segment. However, 735 metres of track are proposed to be on bridges due to the presence of many small rivers and the topography.

Impacted traplines: VC19, VC18 and VC17.

Number of horizontal curves with speed reduction: 22 (16.3 km).

Please find below a list of potential major bridges from TN 14.

**Table 6-4 List of Potential Major Bridges - km 2180+000 to km 2240+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) | |
|---|---|---|---|---|
| 2195+400 | | VC-18 | Du Vieux Comptoir River | 600 |

## 6.5 KM 2240+000 TO KM 2300+000 (BDH: KM 511 TO KM 571)

Even tough this segment is particularly sinuous, it generally follows the Billy-Diamond Highway.

The protected areas west of the railway alignment encountered for most of the previous segment extend into this segment until km 2256 (16 km) while east of the alignment, a protected area extends from km 2251 to km 2257 (6 km).

Two waterways are crossed in this segment: the Yasinki lake is crossed near km 2271, and the Ekomiak lake is crossed near km 2282.

Impacted traplines: VC17, VC13, VC12, VC16, VC06/CH38 and VC05/CH37.

Number of horizontal curves with speed reduction: 14 (12.2 km).

Please find below a list of potential major bridges from TN14.

**Table 6-5 List of Potential Major Bridges - km 2240+000 to km 2300+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 2281+650 | CH-38 | Unidentified river (effluent of lake Ekomiak) | 75 |

## 6.6 KM 2300+000 TO KM 2340+300 (BDH: KM 571 TO KM 614)

The proposed Phase II railway alignment continues to generally follow the Billy-Diamond Highway until the Phase II termination point at approximately 3 km south of the La Grande River.

According to available mapping, there are no existing or proposed protected areas in this segment.

There are no major river crossings in this segment, and no major bridge.

Impacted traplines: VC04/CH36.

Number of horizontal curves with speed reduction: 2 (1.7 km).

## 6.7 LEVEL CROSSINGS

The projected daily traffic flow on each of the proposed road and railway are not sufficient to require barriers at crossings. However, based on the anticipated road and railway speeds, lights and bells will be minimally required. Therefore, each crossing will require electric power.

**Table 6-6 List of Level Crossings – Phase II**

| ID | TRAPLINE | CHAINAGE | ROAD |
|---|---|---|---|
| 1 | R-13 | 2006+854 | Billy-Diamond Highway |
| 2 | R-14 | 2020+580 | North Road |
| 3 | R-14 | 2028+750 | Billy-Diamond Highway |
| 4 | RE-03 | 2089+000 | Access road to the village of Eastmain |
| 5 | RE-02 | 2121+975 | Billy-Diamond Highway |
| 6 | VC-33 | 2129+200 | Unpaved access road |
| 7 | VC-33 | 2131+937 | Billy-Diamond Highway |
| 8 | VC-33 | 2158+500 | Unpaved access road |
| 9 | VC-19 | 2191+923 | Billy-Diamond Highway |
| 10 | VC-18 | 2207+500 | Unpaved access road |
| 11 | VC-18 | 2218+500 | Unpaved access road |
| 12 | VC-17 | 2226+400 | Unpaved access road |
| 13 | VC-17 | 2233+000 | Unpaved access road |
| 14 | VC-17 | 2234+300 | Unpaved access road |
| 15 | VC-17 | 2241+300 | Unpaved access road |
| 16 | VC-16 | 2274+000 | Trans-Taiga Road |
| 17 | CH-38 | 2282+150 | Unpaved access road |
| 18 | CH-37 | 2286+675 | Billy-Diamond Highway |
| 19 | CH-36 | 2302+000 | Unpaved access road |
| 20 | CH-36 | 2314+220 | Billy-Diamond Highway |
| 21 | CH-36 | 2332+400 | Unpaved access road |
| 22 | CH-36 | 2337+300 | Unpaved access road |
| 23 | CH-36 | 2338+175 | Billy-Diamond Highway |

It should be noted that at this early stage of the study, roadway profiles were not considered in the review of crossings, as all crossings are assumed to be on-grade. Coordination in the next phases of the proposed infrastructure design will be required and overpass bridges may be needed in some locations, but this is less likely.

## 6.8 RAILWAY - POWER LINES CROSSINGS

A few power lines are present along the proposed alignment. They mostly cross the railway alignment in its northern half, as shown in Table 6-7. Crossings with power lines are important to investigate early in the next phases of the proposed infrastructure development. For example, if the alignment elevation is too high at the power line crossing, this may result in the need to either shift the alignment or to lower the profile. Pylon displacement is also a possibility which would need coordination with the appropriate owner and authorities.

**Table 6-7 List of Intersections Between Railway Alignment and Power Lines – Phase II**

| ID | TRAPLINE | CHAINAGE | TYPE |
|---|---|---|---|
| 1 | RE-02 | 2125+150 | TBD |
| 2 | VC-33 | 2137+150 | TBD |
| 3 | VC-18 | 2203+650 | TBD |
| 4 | VC-17 | 2241+500 | TBD |
| 5 | VC-13 | 2257+750 | TBD |
| 6 | VC-16 | 2269+150 | TBD |
| 7 | VC-16 | 2273+000 | Hydro-Quebec 735 kV |
| 8 | CH-38 | 2375+500 | Hydro-Quebec 735 kV |
| 9 | CH-37 | 2286+900 | TBD |
| 10 | CH-37 | 2289+250 | TBD |
| 11 | CH-37 | 2289+800 | TBD |
| 12 | CH-37 | 2295+200 | TBD |
| 13 | CH-36 | 2328+900 | TBD |
| 14 | CH-36 | 2329+200 | Hydro-Quebec 735 kV |
| 15 | CH-36 | 2336+900 | Hydro-Quebec 735 kV |
| 16 | CH-36 | 2338+600 | Hydro-Quebec 735 kV |

## 6.9 PASSENGER STATIONS

In coordination with Phase I traffic study, three (3) potential passenger stations were identified between Rupert and La Grande:

- Eastmain;
- Wemindji;
- La-Grande.

Those potential passenger station were located close to the Cree communities, as shown in Figure 6-2. Their characteristics are not yet defined but since passengers per trip is estimated to be low, the proposed stations are currently considered to be minimalist, i.e., mainly composed of a platform adjacent to main railway track for passenger boarding, a small building, and a parking lot. The boarding platform, such as the one in Schefferville or in Senneterre, could be a simple paved surface along the track, with a prefabricated office building.

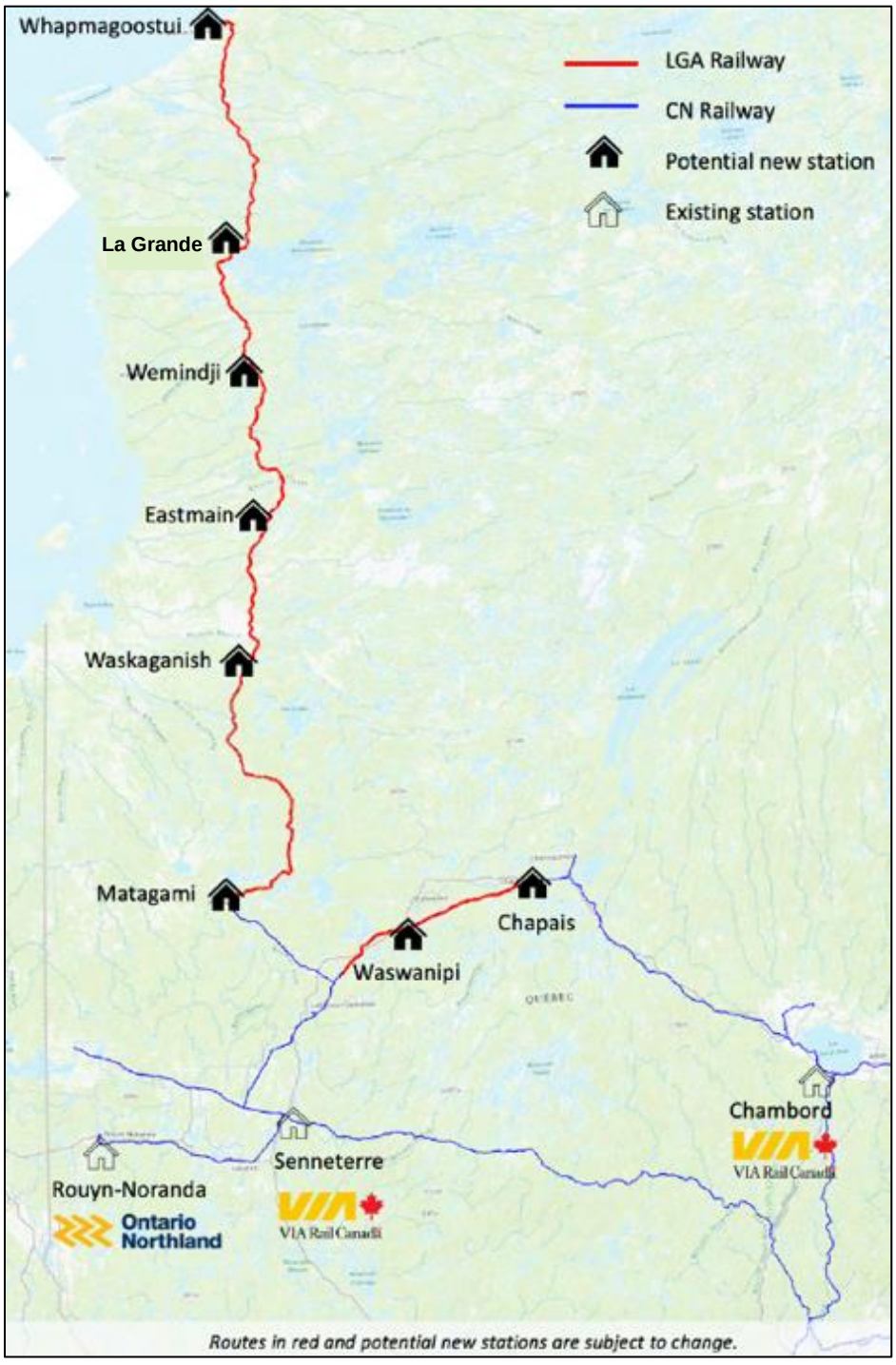


**Figure 6-2 Preliminary Locations for Passenger Stations**

# 7 PHASE III – LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK

The Phase III pre-feasibility railway proposed alignment begins approximately 3 km south of La Grande River, as an extension of the Phase II proposed railway and progresses northwards to the Whapmagoostui/Kuujjuarapik coastline between the mouth of Great Whale River and the location for the proposed harbour infrastructure.

The proposed Phase III railway is 219 km long, and its sinuous nature is a consequence of avoiding many lakes as well as the varied topography in the Study Area. To minimize environmental impacts, the railway alignment generally follows the proposed road to Whapmagoostui/Kuujjuarapik over approximately 75% of its length. The remaining 25% that is not within 100 meters from the studied road is a result of larger radius curves compared to what is permissible for roadways. However, it is believed that this percentage could be further reduced with refined detailed engineering via a combination of adjustments to the railway design criteria as well as road optimization to suit the railway. However, such adjustments will likely result in higher road infrastructure costs.

A total of 68.9 km were designed with reduced speed of 60 mph for passenger trains and 50 mph for freight trains to allow the alignment to be closer to the proposed roadway and to avoid waterways. This represents 31% of the railway's total length.

The ground condition within a two-kilometre-wide corridor along the railway alignment is composed of the following types of soil:

**Table 7-1 Types of Soil – Phase III (value from NT 10 – Geotechnical)**

| TYPES OF SOIL | % OF RAILWAY CORRIDOR ON THIS TYPE OF SOIL |
|---|---|
| Organic soils | 5% |
| Silt and clay | 17% |
| Sand and gravel | 10% |
| Till | 44% |
| Rock | 24% |

The reader is also referred to the Plans for the Phase II and Phase III alignments, which are in Appendix A.

Phase III alignment begins at end of the Phase II alignment (km 2339+000) near km 614 of the Billy-Diamond Highway. However, just to prevent that future optimization may affect the Phase II end point, Phase III alignment stations were arbitrarily started at km 3000+000.

Phase III proposed railway is broken down into segments for which more detailed information is provided in the next sections (see introductory section for explanation on station).

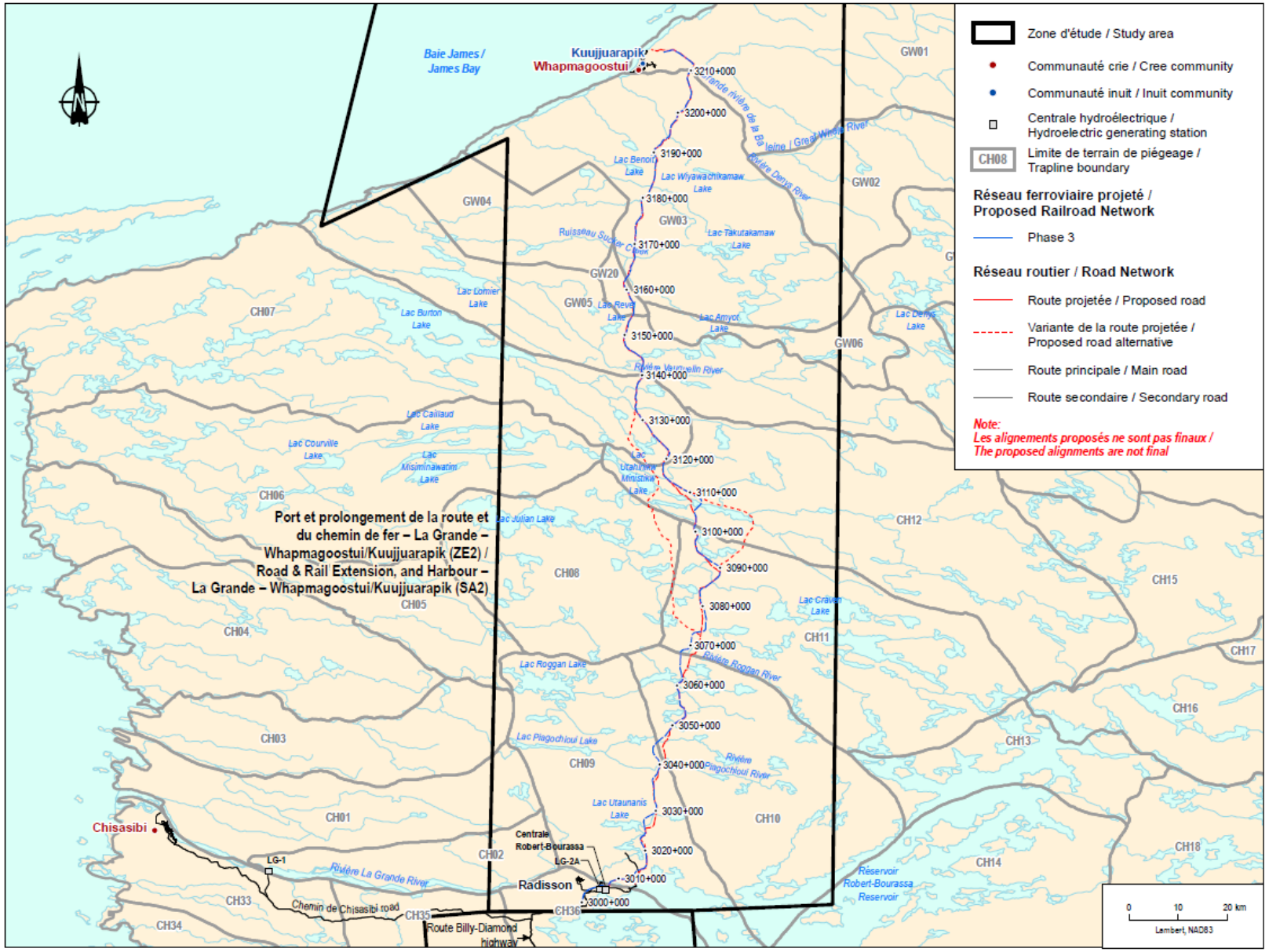


**Figure 7-1 Phase III Alignment with Traplines**

## 7.1 KM 3000+000 TO KM 3030+000 (BDH: KM 614 TO KM 18 OF PROPOSED ROAD EXTENSION)

From about 3 km north of the connection point with Phase II, the proposed phase III railway generally follows the proposed road to Whapmagoostui/Kuujjuarapik except at the La Grande River crossing. A major challenge is the La Grande River crossing: topographic conditions show that the best crossing point is located approximately 5.3 km east of Robert-Bourassa Spillway. Note that the existing spillway cannot be used by the railway due to the heavy axle load and vibration issues.

To minimize the bridge's length, the maximum allowable longitudinal compensated slope of 1.46% is used at both approaches.

After crossing La Grande River, the area presents with several lakes and streams. While the vertical alignment is mostly flat with no major cut and fill up to km 30, the horizontal alignment is very sinuous. The decision was made to reduce the design speed and to accept that there are some portions of the alignment where the rail does not respect the minimum 50 m offset from the proposed road.

Impacted traplines: VC04/CH36 and FG09/CH09.

Number of horizontal curves with speed reduction: 8 (18.6 km).

Please find below a list of potential major bridges from TN 14.

**Table 7-2 List of Potential Major Bridges - km 3000+000 to km 3030+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3001+014 | CH-36 | Unidentified river | 250 |
| 3009+349 | CH-09 | La Grande River (Overpass + bridge) | 1,100 |

## 7.2 KM 3030+000 TO KM 3050+000 (PROPOSED ROAD EXTENSION: KM 18 TO KM 37)

Due to the relatively mountainous area of this segment, the horizontal alignment was deviated from the proposed road alignment due to the railroad slope limits that are much more restrictive than those for roads.

There are no major water crossings on this segment although some bridges are required due to the rugged ground morphology, of which 2 are considered major structures.

Impacted traplines: CH-09 and CH-10.

Number of horizontal curves with speed reduction: 3 (2.8 km).

Please find below a list of potential major bridges.

**Table 7-3 List of Potential Major Bridges - km 3030+000 to km 3050+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3031+088 | CH-09 | Unidentified river | 60 |
| 3037+944 | CH-09 | Unidentified river | 200 |
| 3040+300 | CH-09 | Piagochioui River | 75 |

## 7.3 KM 3050+000 TO KM 3080+000 (PROPOSED ROAD EXTENSION: KM 37 TO KM 66)

Approximately at km 3050+200, the rail alignment crosses a considerable stream where a civil structure would be required. The alignment continues sinuously northwards with curves requiring restricted speed.

Along the first 10 km of this segment, the proposed rail alignment follows the proposed road alignment until km 3062, where the rail alignment begins to move further west from the road alignment until km 3080.

At km 3074+150, the railway intersects with the proposed road alignment.

At several locations along this segment, the maximum cut and fill criteria of 10 m is reached due to the ground rugged morphology.

Impacted traplines: FG10/CH10 and FG11/CH11.

Number of horizontal curves with speed reduction: 11 (21.5 km).

Please find below a list of potential major bridges.

**Table 7-4 List of Potential Major Bridges - km 3050+000 to km 3080+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3054+395 | CH-10 | Unidentified river | 100 |
| 3060+003 | CH-10 | Important valley - Pamigamachi Lake | 150 |
| 3062+400 | CH-10 | Unidentified lake | 150 |
| 3067+343 | CH-11 | Roggan River | 160 |
| 3069+600 | CH-11 | Atawataweats River | 150 |

## 7.4 KM 3080+000 TO KM 3110+000 (PROPOSED ROAD EXTENSION: KM 66 TO KM 94)

The proposed Phase III railway alignment continues northwards and remains relatively flat with no major earthworks. The proposed alignment, however, diverges from the proposed road alignment between approximately km 3105 and km 3115 due to a major waterbody crossing.

Impacted traplines: FG11/CH11 and FG12/CH12.

Number of horizontal curves with speed reduction: 9 (15.2 km).

Please find below list of potential major bridges from TN 14.

**Table 7-5 List of Potential Major Bridges - km 3080+000 to km 3110+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3083+600 | CH-11 | Unidentified lake | 150 |
| 3092+600 | CH-11 | Unidentified lake | 140 |
| 3106+000 | CH-12 | Important valley | 600 |

## 7.5 KM 3110+000 TO KM 3140+000 (PROPOSED ROAD EXTENSION: KM 94 TO KM 124)

This segment generally follows the proposed road to Whapmagoostui/Kuujjuarapik. This proposed alignment remains generally straight but considerable earthworks will be required due to the very rugged ground. Bridges will be required, of which four (4) are considered major structures.

Impacted traplines: FG12/CH12 and FG07/CH07.

Number of horizontal curves with speed reduction: 0 (0 km).

Please find below a list of potential major bridges from TN 14.

**Table 7-6 List of Potential Major Bridges - km 3110+000 to km 3140+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3119+351 | CH-07 | Important valley | 200 |
| 3125+300 | CH-07 | Unidentified river | 55 |
| 3132+100 | CH-07 | Unidentified lake/river | 110 |

## 7.6 KM 3140+000 TO KM 3180+000 (PROPOSED ROAD EXTENSION: KM 124 TO KM 164)

This segment starts with a major river crossing requiring a bridge at km 3140+600. The rail alignment continues in a northerly direction and remains relatively close to the proposed road alignment. Another significant bridges will be required on this segment, at km 3163+200.

On profile view, the railway elevation raises with a 1% slope over almost 4 km, from km 3143+400 up to km 3147+200. This allows the alignment to reach the top of a large hill that is over 13 km long, up to km 3160+160 where the rail profile gets down with a 1.46% slope.

Impacted traplines: GW05, GW20 and GW03.

Number of horizontal curves with speed reduction: 0 (0 km).

Please find below a list of potential major bridges from TN 14.

**Table 7-7 List of Potential Major Bridges - km 3140+000 to km 3180+000**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3140+656 | GW-05 | Vauquelin River | 400 |
| 3156+300 | GW-20 | Unidentified lake | 130 |
| 3161+163 | GW-20 | Valley/wetland | 100 |
| 3163+191 | GW-03 | Sucker river | 800 |
| 3167+300 | GW-03 | Unidentified river | 60 |
| 3178+450 | GW-03 | Unidentified river | 85 |
| 3179+600 | GW-03 | Unidentified river | 100 |

## 7.7 KM 3180+000 TO KM 3218+900 (PROPOSED ROAD EXTENSION: KM 164 TO KM 205)

The proposed Phase III railway alignment continues very sinuously over this segment in a northerly direction but remains close to the road alignment across a very rugged ground. Considerable earthworks are generated over this segment.

A major crossing over the Great Whale River will be required around km 3210+200.

On profile view, the vertical alignment remains relatively parallel to the ground except around the Great Whale River and at considerable hills at km 3187+400 and 3200+400.

Impacted traplines: GW03 and GW01.

Number of horizontal curves with speed reduction: 6 (10,9 km).

Please find below a list of potential major bridges from TN 14.

**Table 7-8 List of Potential Major Bridges - km 3180+000 to km 3218+900**

| STATION (KM) RAIL AXIS | TRAPLINE | OBSTACLE | APPROX. BRIDGE LENGTH (M) |
|---|---|---|---|
| 3197+500 | GW-03 | Unidentified river | 70 |
| 3201+300 | GW-03 | Unidentified river | 120 |
| 3208+575 | GW-03 | Great Whale River | 1,900 |
| 3210+202 | GW-03 & GW-01 | Unidentified river | 1,100 |

## 7.8 LEVEL CROSSINGS

The projected daily traffic flow on each of the proposed road and railway are not sufficient to require barriers at crossings. However, based on the anticipated road and railway speeds, lights and bells will be minimally required. Therefore, each crossing will require electric power.

In Phase III, there are a few occurrences where the railway crosses the road twice within a small distance. It was considered as a possible optimization for the next phase of the study and those locations were not identified as crossings in the table below.

**Table 7-9 List of Level Crossings – Phase III**

| ID | TRAPLINE | CHAINAGE | ROAD |
|---|---|---|---|
| 1 | CH-36 | 3002+800 | Avenue des Groseillers |
| 2 | CH-36 | 3004+300 | Unpaved access road |
| 3 | CH-36 | 3005+200 | Paved access road |
| 4 | CH-36 | 3005+600 | Paved access road |
| 5 | CH-09 | 3015+000 | Route de l'Évacuateur (LG-2) |
| 6 | CH-09 | 3035+300 | Proposed road, to Chisasibi |
| 7 | CH-10 | 3054+400 | Proposed road (phase II) |

| ID | TRAPLINE | CHAINAGE | ROAD |
|---|---|---|---|
| 8 | CH-10 | 3054+900 | Proposed road (phase II) |
| 9 | CH-10 | 3055+300 | Proposed road (phase II) |
| 10 | CH-10 | 3055+800 | Proposed road (phase II) |
| 11 | CH-11 | 3074+155 | Proposed road (phase II) |
| 12 | GW-03 | 3172+760 | Proposed road (phase II) |

It should be noted that at this early stage of the study, roadway profiles were not considered in the review of crossings, as all crossings are assumed to be on-grade. Coordination in the next phases of the proposed infrastructure design will be required and overpass bridges may be needed in some locations, but this is less likely.

## 7.9 RAILWAY-POWER LINES CROSSINGS

Only a few power lines are present along the proposed alignment. Most of them are concentrated in the southern portion, as shown in Table 7-10. Crossings with power lines are important to investigate early in the next phases of the development of the proposed infrastructures. For example, if the alignment elevation is too high at the power line crossing, this may result in the need to either shift the alignment or to lower the profile. Pylon displacement is also a possibility, which would need coordination with the appropriate owner and authorities.

**Table 7-10 List of Intersections Between Railway Alignment and Power Lines – Phase III**

| ID | TRAPLINE | CHAINAGE | TYPE |
|---|---|---|---|
| 1 | CH-36 | 3001+550 | Hydro-Quebec 735 kV |
| 2 | CH-36 | 3005+130 | TBD |

## 7.10 PASSENGER STATION

In coordination with Phase I traffic study, one (1) potential passenger station was identified between La Grande and Whapmagoostui/Kuujjuarapik and it is located in Whapmagoostui.

This potential passenger station was located close to the Cree community. Its characteristics are not yet defined but since passengers per trip is estimated to be low, the proposed stations are currently considered to be minimalist, i.e., mainly composed of a platform adjacent to main railway track for passenger boarding, a small building, and a parking lot. The boarding platform, such as the one in Schefferville or in Senneterre, could be a simple paved surface along the track, with a prefabricated office building.

# 8 CONCLUSIONS AND ADDITIONAL CONSIDERATIONS

Based on the results of this Technical Note 12, we have determined that it is possible to develop both proposed railway infrastructures that follow best practice Railway Design Criteria, social-environmental design drivers and in addition, respect the following technical drivers:

- Respect, as much as possible, the natural site topography (mountains and plains);
- Consider the overall geology of the study area, including the locations of aggregate material deposits;
- Avoid, as much as possible, lakes and rivers; minimize the length of crossings and bridges where these are unavoidable;
- Avoid, as much as possible, existing and projected Protected Areas; minimize encroachment and provide mitigation measures where these are unavoidable;
- Minimize crossing and impacts on caribou migration corridors;
- Avoid, as much as possible, areas of cultural significance such as areas currently used by Cree land users, archeological sites, etc.; minimize encroachment and provide mitigation measures where these are unavoidable;
- Propose, wherever applicable, alignment variants that could offer added value, such as:
  - Locations that minimize environmental footprint;
  - Locations that minimize construction cost;
  - Locations that minimize the impacts on existing camps and facilities.
- Remain, as much as possible, in close proximity to existing and/or proposed roads;
- Remain within 1 km corridor centered on existing and/or proposed roads when surrounded by recognized Protected Areas on both sides;
- Minimize the number of times the railway crosses existing and/or proposed roads.

The design speed was reduced to 60 mph for passenger trains for some horizontal curves to avoid zones of environmental interest such as lakes, and to follow the highway curves. The design speed has an impact on the track geometry and on construction and operation costs. A more detailed study with train operation simulations, including up to date railway freight customer needs and passenger needs, and with travel time should be performed to confirm the design speeds. Future feasibility activities should thus focus on all aspects of a railway project, including train operation, and optimize the infrastructure design. Moreover, the following phase should include more detailed studies of the railway/roadway crossings and of the railway/power lines crossings.

It must be also stressed that an operating railway is more than just infrastructure. As the proposed project moves forward, questions relating to ownership will need to be addressed – private or Cree-Quebec joint ownership, operations model. At one extreme with all management, operations, and maintenance services provided in-house versus at the other extreme, most of these services are contracted out. Depending on the operating model finally retained, if a stand-alone, fully self-staffed entity is privileged, the significant upfront requirement for training that will be required to provide the unique skillsets needed to manage, operate, and maintain a railway must not be underestimated. The lead time required to carry out the necessary training activities can rival the time required to construct such a railway.

It is important to note that an important proportion of the infrastructures proposed in Phases II and III are planned in undeveloped areas. For these areas, we have identified additional processes that further limit environmental risks impacts, with a view of accounting for the sensitivity of building new corridors in previously inaccessible areas (and entire regions), in line with the overall sustainable development objectives of the overall program which, it is hoped, will increase the overall social acceptability of these new corridors. Thus, for these areas the main objectives of the Pre-Feasibility Study is to identify and propose alignments and locations that present the least risk, especially from the perspective of environmental sustainability and overall social acceptability of the proposed infrastructure.

Using the key drivers presented above, while at the same time respecting the related infrastructure retained Design Criteria, an alignment was developed first in plan, and then in profile. The design of any linear infrastructure is an iterative process to maximize the opportunities for improvement as more detailed information becomes available with the project development.

Therefore, the alignment presented at the Pre-Feasibility stage alignments is somewhat limited by the accuracy of information available at the time, as the collection of field data shall be carried out at future stage. As knowledge about fauna and flora is continuously evolving, the environmental factors and considerations will have to be updated at every step of the study. The environmental updates might result in the need for alignment correction/displacement to avoid sensible areas or mitigate the risks. Nevertheless, the various alignments presented in this report show on maps and figures on this mandate should be considered as potential corridors that require further optimization in the future steps.

While it is recognized that building new corridors in previously inaccessible areas in the north needs to be done with extreme care for the environment and those who practice traditional activities in these areas, not to mention the uncertainty created by climate change and the potential social impacts of opening up the territory, we have nevertheless determined that it is possible to develop the proposed transportation infrastructures in a manner consistent with sustainable development.

# APPENDIX

# A

# PLANS FOR PHASE II AND PHASE III ALIGNMENTS

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CONCEPT. PRÉPARÉ PAR: / CONCEPT. PREPARED BY: L. SAHNOUNI ing.

CONCEPT. ASSISTÉ PAR: / CONCEPT. ASSISTED BY: L. SAHNOUNI ing.

CONCEPT. MODIFIÉ PAR: / CONCEPT. MODIFIED BY:

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LA GRANDE ALLIANCE
PREFEASIBILITY STUDY
PHASE II

PROJECT NO : / NO PROJET : 211-08415-00

TITRE:
TITLE:

TRACÉ FERROVIAIRE PROPOSÉ
CHAINAGES: 2000+000 - 2110+360

PROPOSED RAIL ALIGNMENT
STATION : 2000+000 - 2110+360

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PROPOSED RAIL ALIGNMENT
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PHASE II

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NO PROJET : 211-08415-00

TITRE:
TITLE:

TRACÉ FERROVIAIRE PROPOSÉ
CHAINAGES: 2220+720 - 2340+270

PROPOSED RAIL ALIGNMENT
STATION : 2000+000 - 2110+360

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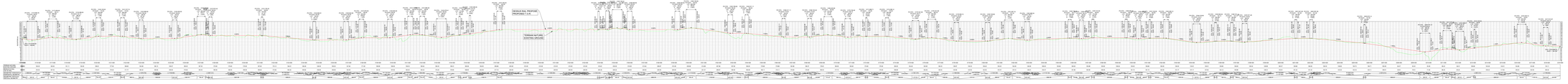
PREFEASIBILITY STUDY
PHASE III

PROJECT NO / NO PROJET : 211-08415-00

TITRE / TITLE:
TRACÉ FERROVIAIRE PROPOSÉ
CHAINAGE 3000+000 - 3114+935
PROPOSED RAIL ALIGNMENT
STATION : 3000+000 - 3114+935

NUMÉRO DU FEUILLET / SHEET NO : LGAPH3-WSP-ZZ-1000-D-V-0001_S1
REV. P02




| | |
|---|---|
| TRACÉ PROPOSÉ | |
| PROPOSED ALIGNMENT | |
| VOIE FERRÉE PROPOSÉE | |
| PROPOSED RAIL | |
| TERRAIN NATUREL | |
| EXISTING GROUND | |

DO NOT REFLECTED
NE PAS REPRODUIRE

CUSTOMER ID NOTES
NOTES DU CLIENT

wsp
WSP CANADA INC.
1600, BOUL. RENÉ-LÉVESQUE OUEST, 11E ÉTAGE
MONTRÉAL (QUÉBEC) H3H 1P9

CEM
CENTRE D'EXPERTISE MONTRÉAL

| | | | |
|---|---|---|---|
| 1 | 2021-12-17 | ÉMIS POUR APPROBATION | |
| 0 | 2021-11-26 | ÉMIS POUR APPROBATION | |
| NO. | DATE | DESCRIPTION | |

| | |
|---|---|
| DESIGNED | |
| DRAWN | |
| CHECKED | |
| APPROVED | |

| | |
|---|---|
| CLIENT | |
| PROJECT | |
| TITLE | |
| DWG. NO. | |
| SCALE | |

| | |
|---|---|
| CLIENT | LA GRANDE ALLIANCE<br>CITÉ DU HAVRE, MONTRÉAL (QUÉBEC)<br>PHASE 3 |
| PROJECT | LA GRANDE ALLIANCE<br>PHASE 3 – PROJECTION AU DÉBARCADÈRE<br>PHASE 3 PROJECTION AU DÉBARCADÈRE |
| TITLE | TRACÉ FERROVIAIRE PROPOSÉ<br>PROPOSED RAILWAY ALIGNMENT |
| DWG. NO. | 1 |
| SCALE | 1:2000 at 22" x 34" / 1:4000 at 11" x 17" |