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DÉVELOPPER, DANS LE RESPECT DES MILIEUX

Hydrogéologie - Université



# CANADIAN TRANSPORTATION AGENCY

Hydrogeological Expert Report  
Lac-Mégantic Railway Bypass  
Ref. No.: 000704-2149

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Date: June 8, 2026

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## REFERENCE

Groupe Conseil UDA inc., 2026. Hydrogeological Expert Report - Lac-Mégantic Railway Bypass. Reference 000704-2149. 71 pages + schedules



## EXECUTIVE SUMMARY

As part of the Lac-Mégantic Railway Bypass Project (Project), an independent analysis was conducted to understand the effects of the Project on groundwaters and natural environments that depend on them, as well as the measures planned to protect and monitor them.

### Overall finding

The analysis finds that the Project involves no water-related impact that would be simultaneously permanent, impossible to mitigate and significant enough to prevent the Project's execution.

However, certain negative effects are expected and uncertainties remain. Additional measures could increase the ability to prevent and manage risks for communities and ecosystems.

### Possible Project effects

The Project will result in certain changes, including:

- ▷ Permanent decrease of groundwater levels;
- ▷ Loss of wetlands and forested areas in the Project's right-of-way.

These changes may have indirect effects, such as:

- ▷ Modifying the quantity, flow and quality of groundwater;
- ▷ Impacting surrounding soils, tributaries and natural environments;
- ▷ Reducing important wetland and forest functions (e.g., water filtration, flood control, groundwater recharge).

On a larger scale and a longer term, these combined effects could lead to:

- ▷ Loss or degradation of natural environments;
- ▷ Disruption of watershed function;
- ▷ Issues such as erosion, landslides or floods;
- ▷ Land subsidence;
- ▷ Decreased access to quality drinking water in sufficient quantity;
- ▷ Impacts on fish and wildlife habitats.

### Assessment of measures planned

Overall, the documents analyzed properly cover the main effects of the Project. The proposed plans to manage and monitor these effects provide a sound basis.

However, they could be improved to:

- ▷ Better anticipate certain indirect, cumulative or long-term effects;
- ▷ Reinforce the response capacity in the event of a problem;
- ▷ Reduce uncertainties related to the Project's effects on water and natural environments.

### Main risk identified

The main risk is the loss of access to quality drinking or domestic water for certain residents who use private wells in Frontenac, Lac-Mégantic and Nantes.

This risk is linked to the decreased groundwater level. The planned measures, such as well as monitoring, are generally adequate and help manage this risk, but they could be fine-tuned to increase efficiency (e.g., response times). No risk was identified for municipal wells.

### Improvements recommended

Two significant improvements are proposed:

- ▷ Set out a clear response protocol in the event of a drinking or domestic water shortage;
- ▷ Extend groundwater, well and wetland monitoring to 25 years to better track long-term and unforeseen effects.

### Significant gap

The analysis shows that the Project lacks an overall assessment of its effects on wetlands and forests at the watershed scale.

In particular, the effects on their hydrological functions (water management) are not fully assessed. More specifically, there is not enough information to assess flood and soil erosion risks and there is not protection and mitigation measures for these potential effects.

### Other key recommendations

- ▷ Further studying wetlands and forested areas, including their role in water flow and storage;
- ▷ Targeting the most vulnerable or significant environments and protecting them;
- ▷ Improving the analysis of Project effects on water at the sensitive watershed scale;
- ▷ Defining clear thresholds to trigger corrective measures;
- ▷ Providing compensatory measures to replace loss functions of wetlands and forested areas;
- ▷ Optimizing the localization and design of these measures for effectiveness;
- ▷ Better framing land subsidence and possible infrastructure damage risks.

Modelling and simulation are also recommended to better anticipate:

- ▷ Erosion risks;
- ▷ Flood risks;
- ▷ The effect of groundwater transfer to tributaries;
- ▷ The capacity of water systems to absorb changes.

### Possible timelines for these improvements

The implementation of additional measures could take:

- ▷ Up to 24 months (comprehensive and precautionary approach)
  - step-by-step implementation with risk analysis at each stage;
- ▷ Approximately 15 months (optimized approach)
  - certain steps implemented concurrently with proper coordination;
- ▷ Approximately 9 months (faster, but less comprehensive approach)
  - prioritizes wetland protection and compensation, without a comprehensive risk analysis.

These lead times could be reduced if certain studies have already been completed or if additional data has become available since CPRC filed its authorization request with the CTA. In such case, other scenarios could be considered to achieve similar results.

### Conclusion

The Project has a sound basis, but certain improvements are deemed relevant to:

- ▷ Better understand long-term effects;

- ▷ Better integrated interactions between water, natural environments and human activities;
- ▷ Reduce uncertainties;
- ▷ Better protect communities and ecosystems.

These adjustments will provide a more proactive approach and quicker response times in the event of a problem, and they will reinforce the territory's resilience to changes.

It should be noted that upon CTA's request, UDA obtained comments from CPRC<sup>1</sup> and TC on the content of this report. However, these comments do not change in any way our findings and recommendations, which remain unchanged. They are based on the available information and data at the time of our analysis of the Project documents filed with the CTA. Our recommendations are set out as nine complementary measures, out of which three are conditional. We consider that these measures are relevant to reduce uncertainties related to the Project's environmental effects that were identified following the analysis of the Project's documents. Our recommendations are consistent with a proactive assessment and management approach for risks to communities and ecosystems that could arise from these effects. Finally, we acknowledge that since the filing of the Project documents with the CTA, further work has been conducted. Therefore, the data and outcomes obtained from this work could be used for implementing the complementary measures proposed as part of our assessment of the Project documents submitted by the CTA.

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<sup>1</sup> The Canadian Pacific Railway Company – CPRC, carrying on business as CPKC.



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**Abbreviations and acronyms**

CPRC..... Canadian Pacific Railway Company<sup>2</sup>

EIS..... Environmental Impact Statement

Fig..... Figures

LiDAR..... Laser imaging detection and ranging

MELCCFP..... Ministère de l’Environnement, de la Lutte contre les changements climatiques,  
de la Faune et des Parcs

MH..... Wetlands

MF..... Forested areas

MRNF..... Ministère des Ressources naturelles et des Forêts du Québec

CTA..... Canadian Transportation Agency

PACES..... Groundwater Knowledge Acquisition Project

PGEC..... Construction Environmental Management Plan

PSCDS..... Construction Surface Water Monitoring Plan

PSCF..... Compensatory Afforestation Tracking Plan

PSEEPPC..... Environmental Monitoring Plan for the Right-of-Way in the Post-Construction Phase

PSMH..... Wetland Monitoring Plan

PSPEPES..... Drinking Water Well and Groundwater Monitoring Plan

TC..... Transport Canada

SIGÉOM..... Geomining information system

HIS..... Hydrogeological information system

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<sup>2</sup> Carrying on business as CPKC.



# 1 INTRODUCTION AND SCOPE OF THE STUDY

## 1.1 Background

The Lac-Mégantic Railway Bypass Project, hereinafter referred to as “the Project”, follows the train derailment that occurred on July 6, 2013, in downtown Lac-Mégantic, which exacted a heavy human, environmental and social toll. In order to avoid the passage of trains through the downtown area and to foster collective well-being in the community, the Canadian and Québec governments announced in 2018 the funding of an approximately 12.5-km railway bypass project.

On September 19, 2025, upon Transport Canada’s request, the Canadian Pacific Railway Company (CPRC<sup>3</sup>) filed an application for Agency approval to construct this railway bypass, under section 98 of the *Canada Transportation Act*. This application is accompanied by several technical and environmental studies, including an environmental impact assessment, environmental management and monitoring plans mandated by the proponent, CPRC, and by Transport Canada. For convenience, the various management, monitoring and follow-up plans will be referred to, in the remainder of the text, by the general term “Plans” when referring to all these documents and not a specific plan.

A central element of this request is the potential impacts of the project on groundwater and dependent environments, i.e. communities and ecosystems. In this context, and given the role of the CTA as an independent regulatory body responsible for assessing the application for approval of the project, an independent hydrogeological analysis was required, to inform CTA decision-making on project issues related to groundwater and dependent environments and to inform CTA of uncertainties arising from a lack of existing knowledge.

## 1.2 Mandate:

The CTA has mandated Groupe Conseil UDA Inc. (UDA) to provide independent hydrogeological expertise to critically review the documents on file with the CTA and to assess the impacts and risks to communities and ecosystems arising from the Project’s effects on groundwater and dependent environments.

Specifically, the purpose of the study is to review the technical studies submitted by CPRC to the CTA, including draft drawings, a hydrogeological, hydraulic and geotechnical study, the assessment of environmental effects, and the plans produced by the proponent and Transport Canada (TC).

The objective of the study is to assess whether the effects of the project on groundwater and dependent environments, as well as the impacts and risks to communities and related ecosystems, have been correctly identified. In addition, the study aims to assess the robustness and effectiveness of mitigation measures and Plans, including the Drinking Water Well and Groundwater Monitoring Plan (PSPEPES) and the Wetlands Monitoring Plan (PSMH), in relation to the identified risks.

Finally, the objective of the study is to assess the irreversible, immutable or significant nature of the residual environmental impacts of the Project on communities and ecosystems and to recommend, if necessary, complementary measures to mitigate these impacts.

This study is therefore part of a technical and critical analysis approach, without replacing the CTA’s regulatory decisions, and aims to provide objective and independent insight into the hydrogeological issues of the project, in order to support the evaluation of the application for authorization to construct the project.

<sup>3</sup> Carrying on business as CPKC.

### 1.3 Limitations of the study

This study constitutes a hydrogeological and ecological assessment of the information presented in the documents submitted by the CTA in the context of the application for authorization to construct the Project as well as of the public scientific data relevant to the case. All the documents and sources used can be found in Section 2. They are either public data sources or documents provided by the CTA. The analysis focuses mainly on the Project's groundwater impacts, including:

- ▷ Existing aquifers;
- ▷ Groundwater flow processes at the local level;
- ▷ Drinking water wells listed;
- ▷ The risk of loss or contamination of groundwater;
- ▷ The effectiveness of mitigation measures and associated Plans, including the PSPEPES.

This expert report does not constitute a comprehensive review of aquifers and their hydraulic interconnections with dependent environments and does not include a reassessment of the areas of influence of the project on groundwater. However, the uncertainties arising from their determination and the associated risks are taken into account in the analysis. This study makes no finding on the quantification of the Project's effects likely to occur during the construction or operation phase, such as the effects of variations in groundwater levels on wetlands, nor on the potential impacts on existing watercourses during the completion of the work. Finally, as explicitly requested by the CTA, the input data used for hydrological modelling in the hydrogeological engineering study and the hydrological data processed in the PSPEPES (e.g., characteristics of private wells) were not fully assessed, several studies have already highlighted the limitations associated with the use of these data produced by different firms, at different times.

The study is not intended to carry out an exhaustive assessment of surface waters (rivers, bodies of water, surface hydrology), as these elements do not fall within the core of the mandate given. Surface water is considered to be an environment that may have a hydraulic connection to groundwater, in particular in the case of:

- ▷ Where stream beds are permeable and in contact with an aquifer and in discharge or recharge areas of aquifers;
- ▷ Where systems, including a surface water-water table interaction is likely to influence the quality or quantity of groundwater.

Thus, the study does not address in detail the hydraulic dynamics specific to watercourses, surface flow regimes or impacts that are strictly hydrological and independent of the hydrogeological context.

Wetlands are considered exclusively in terms of their functional relationship with groundwater, consistent with the objectives of the mandate and the PSMH.

The study does not aim to carry out a counter-expertise for the complete ecological characterization of wetlands or an analysis of their ecological functions, except to the extent that these elements are relevant to understanding hydrogeological interactions and risks arising from the direct and indirect effects of the Project on groundwater. Nor does the study aim to quantitatively assess the impacts of the project on soil structure, including soil settlements that could result from decreased groundwater levels. These issues have been addressed in technical studies submitted by third parties to the CTA.

The study aims to briefly identify the vulnerable areas and areas at risk of soil settlement resulting from the Project, as well as to verify in the Plans that mitigation measures are planned.

This expertise is based exclusively on the critical review of the technical studies of the Project in relation to groundwater produced by third-party experts, including a hydrogeological study, the

Plans filed by the proponent CPRC and TC and the field data available since 2021 made available to UDA by the CTA. The study is also based on the analysis of the regional hydrogeological context produced in the Estrie region (2022) as part of the Groundwater Knowledge Acquisition Projects (PACES).

No new field campaigns, hydrogeological testing, or detailed hydrogeological modelling were conducted under this mandate. This limit is recognized as a source of uncertainty, which is explicitly analyzed in the risk assessment as required by the Work Statement.

The purpose of this study is not to rule on the overall acceptability of the project, to recommend an alternative route, or to substitute for CTA regulatory decisions. Rather, it is intended to inform the CTA of the risks arising from the Project's effects on groundwater, the robustness of the proposed mitigation measures, and the level of residual uncertainty, related to groundwater and dependent environments, as required by the Terms of Reference.

This study is based solely on a review of the documents and plans submitted to the CTA to date. As a result, any plans, protocols or documents that will need to be produced at a later stage, but have not yet been submitted, could not be evaluated in this analysis. As such, soil and groundwater contamination following an accident or spill during the construction and operation phases has not been assessed herein, as the environmental protection plans (PPE) and environmental response plans (ERP) are not yet available. Particular attention should be paid to the development, content and applicability of these plans in order to cover all risks to the population, including users of drinking water samples.



## 2 CTA DOCUMENTS AND DATA SOURCES

### 2.1 Data sources – CTA inputs

As part of the mandate given to UDA, the CTA provided a series of technical documents, Plans and data deemed relevant to the analysis of the project's effects on groundwater and dependent environments. These inputs, filed with the Agency, constitute the official record for this expertise; they include study reports, draft drawings, Plans, as well as various schedules and field information available at the time of the analysis. The documents that have been forwarded to UDA are listed below:

#### Volume 1

- ▷ Transport Canada, September 2025. List of application documents prepared by TC (Schedule 1-1);
- ▷ Canadian Transportation Agency. CMQR concordance table (Schedule 1-2);
- ▷ CPRC, September 2025. Description of the existing corridor (Schedule 1-3);
- ▷ AECOM Canada Ltd., Feasibility Study and Route Selection. Reference 60344414 (Schedule 1-4);
- ▷ Transport Canada, September 2025. Project Overview (Schedule 1-6).

#### Volume 2

- ▷ AECOM Canada Ltd., May 2025. Design criteria for the Bypass. Reference 60642945 (Schedule 2-1);
- ▷ AECOM Canada Ltd., August 2025. Infrastructure design report (Schedule 2-2);
- ▷ AECOM Canada Ltd., April 2025. Draft drawings. Reference 60642945 (Schedule 2-3);
- ▷ EE Englobe, AECOM, June 2023. Complementary Geotechnical investigation (document in English). Reference 03-02005773.000-0300-0330-GS-R-0001-01 (Schedule 2-6);
- ▷ Englobe, June 2024. Hydrogeological investigation. Lac-Mégantic Railway Bypass. Reference 05-02005773.000-0300-0340-GS-R-1001-03 (Schedule 2-7);
- ▷ AECOM Canada Ltd., September 2023. Hydraulic study. Chaudière River (document in English). Reference 60642945 (Schedule 2-8);
- ▷ AECOM Canada Ltd., August 2025. Water management report (document in English). Reference 60642945 (Schedule 2-9).

#### Volume 3

- ▷ WSP Canada Inc., September 2025. Environmental Impact Statement (EIS). File No. 032-20143008-REV2 (Schedule 3-1);
- ▷ CIMA +, July 2025. Technical Advisory - Lac-Mégantic Railway Bypass Project (LMBP) and impact of work on wetlands and groundwater outside the proposed railway right-of-way – available documentation and potential additional studies. Reference T8015-190041/001/QCM-M06010A (Schedule 3-2a);
- ▷ Natural Resources Canada, Geological Survey of Canada, July 2025. Lac-Mégantic Railway Bypass, Quebec – Expert Opinion on Hydrogeology Geological Survey of Canada (GSC), Natural Resources Canada. Englobe, March 2022. Environmental Site Assessment Phase I, Schedule 3-4. Reference 17-02106591.000-0200-EN-R-0100-00 (Schedule 3-2b) Englobe, November 2022. Environmental Site Assessment Phase. Reference R117089.001-17-02106591.000-0200-EN-R-0300-01 (Schedule 3-5).

#### Volume 5

- ▷ WSP, September 2025. Construction Environmental Management Plan (PGEC). Reference: 044-20143008-REV2 (Schedule 5-3);
- ▷ WSP, August 2025. Construction Monitoring Plan for Surface waters (PSCES). Reference: 042-20143008-REV2 (Schedule 5-4);
- ▷ WSP, August 2025. Environmental Monitoring Plan for the Right-of-Way in the Post-Construction Phase (PSEPPC). Reference: 039-20143008-REV3 (Schedule 5-6);
- ▷ LNA, September 2025. Drinking Water Well and Groundwater Monitoring Plan (PSPEPES). Reference: 03-5585-5434 (Schedule 5-7);
- ▷ CIMA+, August 2025. Wetland Monitoring Plan (PSMH). Reference: M06010A (Schedule 5-8);
- ▷ CIMA+, September 2025. Forest Compensation Monitoring Plan (PSCF) (Schedule 5-9).

#### Additional documents

- ▷ CIMA+, October 31, 2024. Survey of wetlands in the future railway right-of-way. Project Reference: M06010A;
- ▷ NRCAN, July 24, 2025. Technical advice. Expert opinion in hydrogeology. Geological Survey of Canada (GSC), Natural resources Canada;
- ▷ CIMA+, 24 July 2025. Technical Advisory - Lac-Mégantic Bypass Project (LMBP) and impact of the work on wetlands and groundwater outside the proposed railway right of way – available documentation and potential additional studies;
- ▷ CPRC, September 2025. Application to construct a railway line. Case No. 20-08580;
- ▷ CPRC. 2025. CPRC's technical comments on expert advice letters from Natural resources Canada and CIMA+ regarding potential additional groundwater and related surface water studies.

## 2.2 Public domain data sources

In this study, the following publicly available sources of information were consulted and used to establish the hydrogeological context and support the analysis (e.g., scientific literature, government databases, geospatial datasets, and imaging). Consultation dates are specified, where applicable, in the references below:

- ▷ Blanchette M. and Rousseau A. N. et al. What would have been the impacts of wetlands on low flow support and high flow attenuation under steady state land cover conditions *Journal of environmental Management*, Volume 234. 2019. Pages 448-457. ISSN 0301-4797
- ▷ Bullock, A. and Acreman, M. The role of wetlands in the hydrological cycle. *Hydrol. Earth Syst. SCI.* 2003/06/30. Copernicus Publication. SN: 1607-7938 DOI: 10.5194/hess-7-358-2003;
- ▷ Ducks Unlimited Canada (DUC) : Detailed, potential and interest wetlands, consulted from February to May 2026;
- ▷ Convention on Wetlands - RAMSAR. Global Wetland Outlook 2025: Valuing, conserving, restoring and financing wetlands. Gland, Switzerland: Secretariat of the Convention on Wetlands. 2025 DOI: 10.69556/Fossey M. and Rousseau A.N. Can isolated and riparian wetlands mitigate the impact of climate change on watershed hydrology? A case study approach, *Journal of environmental Management*, Volume 184, Part 2, 2026. Pages 327-339, ISSN 0301-4797;
- ▷ Google Earth: Satellite imaging of the region, accessed from February to May 2026;
- ▷ Institut de recherche et de développement en agroenvironnement (IRDA) : Soil map, accessed from February to May 2026;
- ▷ Larocque Marie. Milieux humides et eau souterraine. Research Chair Water and Land Conservation. University of Quebec at Montreal. March 2026
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## 3 DESCRIPTION OF ANALYSIS CONCEPTS

### 3.1 Glossary

#### Environmental component

The environmental component is a component of the physical, biological or human environment that may be affected by or influence the effects of the Project. Environmental components are selected based on their ecological, social, economic, cultural or scientific significance, as well as their relevance for impact analysis.

The main environmental components considered in this project are :

- ▷ **Aggradation:** Increased elevation of the bottom of a stream caused by sediment deposition (dictionary);
- ▷ **Hydrogeomorphological study:** Analysis of terrain shapes, streams and flow processes to understand erosion, sedimentary transport, aggradation, incision and flood zone dynamics;
- ▷ **Wetlands:** Refers to places of natural or anthropogenic origin that are distinguished by the presence of water on a permanent or temporary basis, which may be diffuse, occupy a bed or saturate the soil and whose state is stagnant or moving. When the water is moving, it can flow with a regular or intermittent flow (LQE);
- ▷ **Forest environments:** Natural environments dominated by the forest, characterized by the presence of a tree canopy and associated plant and animal communities (dictionary);
- ▷ **Groundwater:** Water below the surface of the ground in aquifers (dictionary);
- ▷ **Surface water:** Standing or running water on the surface of the ground in contact with the atmosphere (dictionary);
- ▷ **Runoff:** Rainwater or melt water that flows to the surface of the ground when there is insufficient infiltration (saturated, frozen, compacted or impermeable soil) or when the intensity of precipitation exceeds the infiltration capacity (dictionary);
- ▷ **Ground:** Any terrain or underground space, even submerged in water or covered by a construction (LQE);
- ▷ **Cohesive soil:** Deposits predominantly composed of silt and/or clay with low permeability, apparent cohesiveness (dictionary);
- ▷ **Dependent Environment:** For the purposes of this study, a dependent environment is a dependent environmental component of groundwater. It may thus be specific environments as listed above.

#### Risk Analysis

The risk analysis carried out in this project involves several concepts from both the environmental impact study and civil security risk management. In order to clarify the meaning in which these terms are used and to facilitate the understanding of the following analysis, the concepts used are defined below:

- ▷ **Hazard:** Phenomenon or event that may occur and cause damage (dictionary);
- ▷ **Environmental effects:** A change in the properties of the dependent environment caused by a project activity whose effects may directly or indirectly lead to quantifiable impacts;
- ▷ **Cumulative effects:** Changes in the environment caused by the multiple interactions of human activities and natural processes that accumulate over time and space (Directive pour la réalisation d'une étude d'impact sur l'environnement, 2025);
- ▷ **Impact:** Quantitative or qualitative change experienced by a valued component of the environment in relation to the effects induced by a project activity. Impacts can be positive or

- negative and their significance is assessed according to their extent, frequency, duration, intensity or relative importance (sensitivity, uniqueness, rarity, reversibility and social values);
- ▷ **Mitigation measure:** measures aimed at avoiding, reducing the intensity, duration or extent of negative impacts. Also includes measures to maximize positive impacts (Directive pour la réalisation d'une étude d'impact sur l'environnement, 2025). Measures to avoid, reduce or control negative effects (EEE, WSP);
  - ▷ **Residual impact:** Impacts that remain after all avoidance and mitigation measures have been applied (Directive pour la réalisation d'une étude d'impact sur l'environnement, 2025);
  - ▷ **Risks:** Risk is expressed by quantifying the impacts associated with a probable event of known intensity, called hazard, on an exposed and sensitive dependent environment. In short, it corresponds to the possibility that an activity, event or condition associated with a project will have negative consequences on a component of the dependent environment, given its vulnerability. Risk is therefore a probabilistic notion resulting from a rigorous characterization of the dependent environment, hazard and vulnerability profiles;
  - ▷ **Residual risk:** corresponds to the risk resulting from the application of mitigation measures and the achievement of their objectives;
  - ▷ **Solute:** A substance dissolved in a solvent (e.g., dissolved ions such as calcium, magnesium, chlorides or nitrates in groundwater) (dictionary).

### 3.2 Groundwater and its interactions with dependent environments

The analysis of the impacts and risks associated with the project was carried out taking into account all the components of the Project likely to produce, in a proven or potential way, effects on groundwater, whether direct or indirect.

Thus, all the environmental effects on groundwater generated by the Project's interventions, in the short, medium or long term, were integrated into a systemic conceptualization aimed at representing the mechanisms of influence of the project on the hydrogeological environment.

In this perspective, the natural hydrogeological processes likely to be modified by the Project and induce effects on the environmental components of interest of the territory were described and linked. This approach makes it possible to qualitatively assess potential risks, particularly with regard to the protection of property and territory and the safety of persons. It should be noted that the environmental components of interest (or dependent environments) were identified in the Environmental Impact Statement (EIS) carried out by WSP (September 2025). To facilitate the understanding of the observed processes, a reminder of the key theoretical concepts is presented below.

In the hydrological cycle, groundwater forms a buffer reservoir that stores part of precipitation and meltwater, and then releases it in a delayed manner to dependent environments, for example, surface water (ditches, streams and lakes), wetlands and forests. The main processes to consider are as follows:

- ▷ **Interception and infiltration:** A fraction of precipitation is captured (intercepted) by vegetation and returned to the atmosphere by evaporation and transpiration, while the surplus seeps into the soil as long as the infiltration capacity is not exceeded. Infiltration depends in particular on soil permeability, saturation, slope, vegetation cover and rainfall intensity. When this infiltration capacity is exceeded, excess water flows to the surface as runoff, moving to outlets such as wetlands and streams and entrains particles with it;
- ▷ **Transfer in the unsaturated zone (percolation):** water infiltrated into the soil moves downward under the effect of gravity through the unsaturated zone (vadose zone). During this transit, the water can be temporarily stored, redistributed laterally, and undergo physico-chemical transformations (exchanges with the soil, dissolution/alteration) before reaching the saturated zone;

- ▷ **Aquifer recharge:** Recharge corresponds to the net water supply that crosses the unsaturated zone and joins the saturated zone (water table). It can be diffuse over large areas or concentrated (e.g., local recharge from a stream, preferential infiltrations, fracture zones);
- ▷ **Storage and piezometric fluctuations:** Once in the aquifer, water is stored in empty spaces, i.e. pores in aquifers composed of granular materials (sand, gravel, pebbles) and/or fractures in rocky aquifers. The surface of the table (piezometric level) fluctuates according to the alternating recharge-discharge;
- ▷ **Groundwater flow (transit):** Groundwater flows from recharge areas (often topographically higher) to discharge areas (valleys, lakes, rivers, wetlands) due to hydraulic gradients (groundwater slope);
- ▷ **Discharge (exfiltration) to surface environments:** The water table can feed watercourses (base flow), springs and certain wetlands. This discharge supports surface water flows in low-lying periods and contributes to the hydrological resilience of ecosystems;
- ▷ **Groundwater-surface water interactions:** Depending on local gradients, a stream can be a *winner* (fed by groundwater) or a *loser* (recharging groundwater). Exchange zones (beds and banks, flood plains) control water and sediment transfers and can change over time (seasonality, flood episodes, sampling);
- ▷ **Capillary rise and evapotranspiration:** In the context of a shallow water table, water can rise by capillarity toward the root zone and be consumed by evapotranspiration, constituting an additional discharge pathway and influencing the dynamics of wetlands and soils.

Figure 3-1 illustrates the different groundwater-dependent environments and their complex interactions. These environments do not function in isolation, but are an interconnected system characterized by continuous flows of water, matter and energy. Groundwater occupies a central position in this system, acting as a reservoir, transport vector and source of supply for other media.

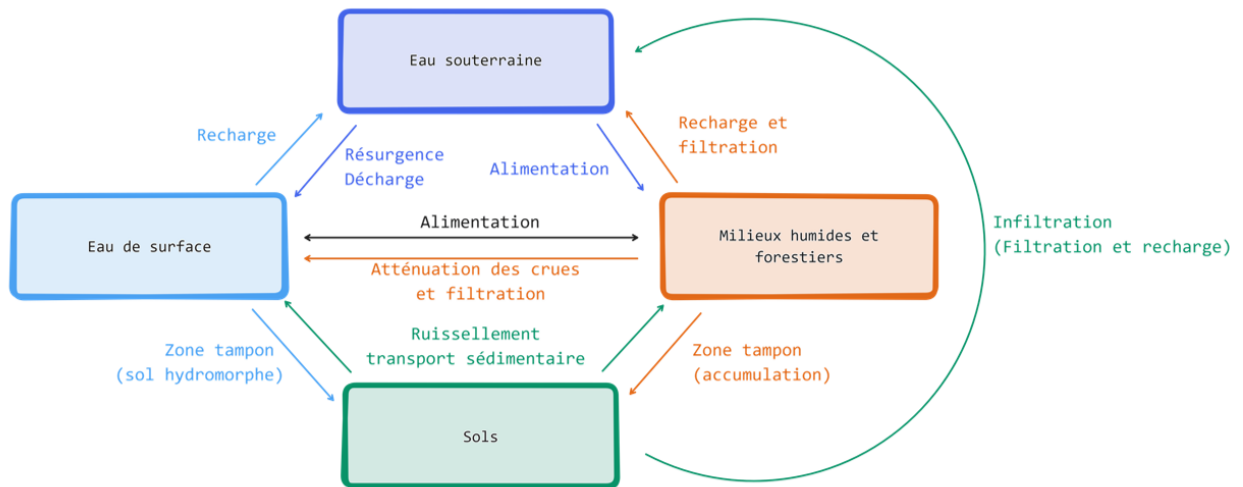
Surface waters, such as rivers and lakes, play an important role in groundwater dynamics, their relationship being strongly influenced by hydrogeological conditions such as piezometric level, environmental permeability and topography.

Wetlands promote infiltration and recharge of water tables due to their high water saturation (Mansell et al., 2000), the generally porous nature of their soils, often composed of peat or organic horizons, and a hydraulic gradient conducive to percolation. Water gradually infiltrates into the saturated zone, contributing to water filtration and aquifer recharge. Wetlands also play an important role in temporary storage of surface water, allowing both flood mitigation and gradual restoration of water in drier periods. Several studies show that wetlands play an essential role in regulating the flow rate of rivers (Walker & Krug of 2003, Fossey & Rousseau of 2016, Bullock & Acreman of 2003), flood control (Jutras & Plamondon of 2021, Bullock & Acreman of 2003, Blanchette & al. 2019) and climate resilience (RAMSAR Convention on Wetlands, 2025). These studies demonstrate the importance of maintaining wetlands and their ecological function. They thus act as hydrological regulators, accumulating water and releasing it gradually according to water conditions. For their part, forest environments also promote groundwater recharge, notably through runoff control.

In addition, wetlands and forests play an essential role in the filtration and transformation of chemical compounds, including sediment retention and the application of biochemical processes. These mechanisms contribute to improving water quality before it is infiltrated into the ground towards the groundwater table or before it is transferred to watercourses.

Finally, soils are a pivotal environment between surface water and groundwater, controlling both infiltration and runoff processes and the biogeochemical transformations that occur there. They act as a temporary water reservoir, a filtration medium and a true biogeochemical reactor, directly influencing the recharge of the water table as well as the quality of the infiltrated water.

Figure 3-1 Interactions of groundwater-dependent media



### 3.3 Analysis scale – Hydrogeological Assessment Units (UEH)

Considering the hydrological processes described above, it appears that a comprehensive assessment of the environmental effects of the Project on groundwater and dependent environments and the risks that this represents for communities and ecosystems can only be ensured by considering a scale of analysis consistent with those processes.

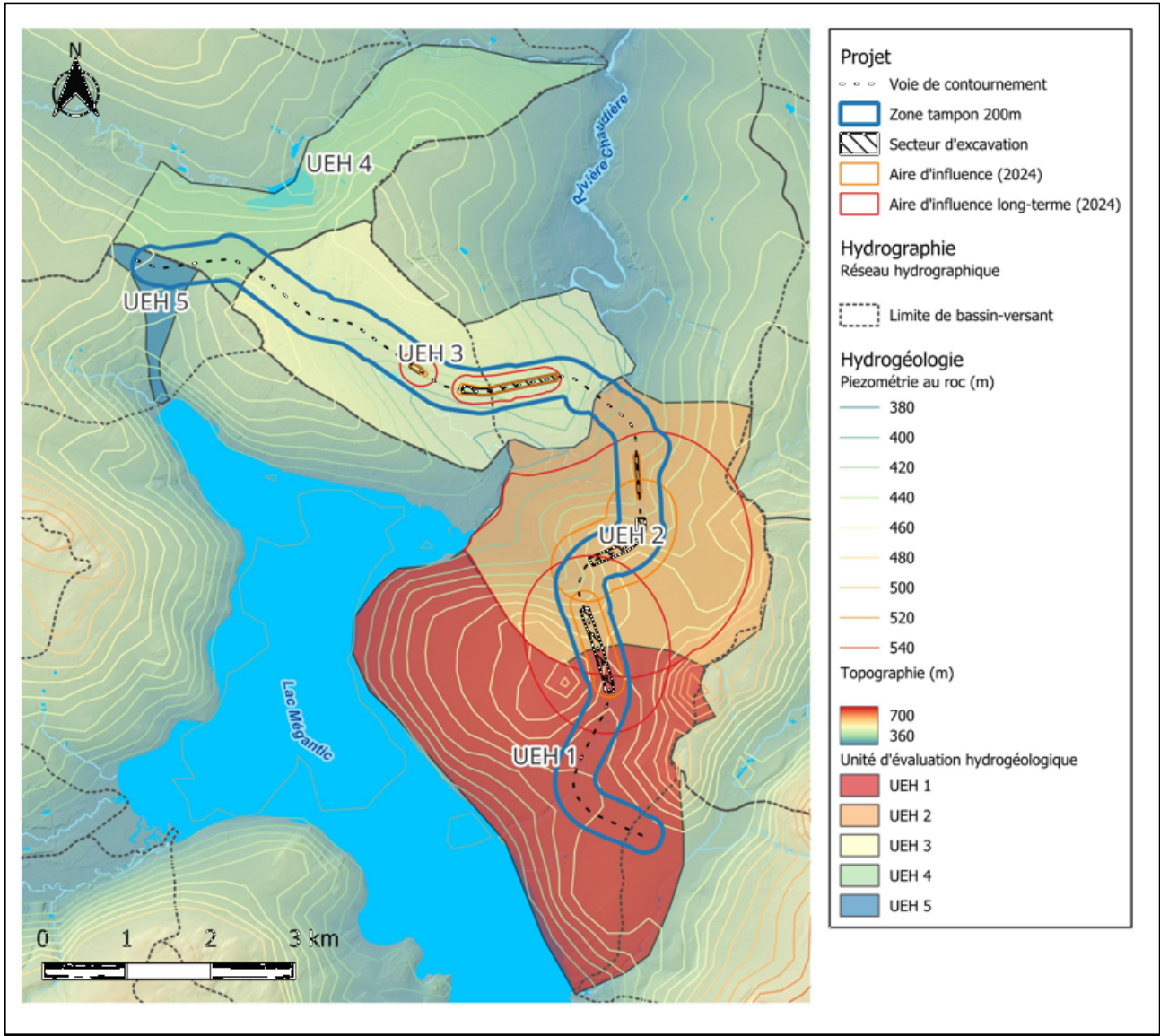
**Hydrocoherent units, or Hydrogeological Assessment Units (UEH), have therefore been defined on the project territory in order to spatialize the analysis, distinguish the hydrological processes in place and locate the potential impacts of the Project on groundwater and dependent environments. These units were delineated using information on directions and contexts of groundwater flow, interpreted from PACES Estrie, and surface water flow, watershed limits defined by the GRHQ and corrected based on data from AECOM’s water management report, as well as groundwater recharge and discharge zones, interpreted from PACES Estrie. Taking into account the local flow contexts, the topographic and piezometric ridge lines, established from groundwater elevation data from PACES Estrie, were used to define the upper limits of the UEHs, while the shores of watercourses and lakes to which groundwater discharges have been retained as lower limits. In total, five UEHs have been delineated and are presented in Figure 3-2. This figure also shows the layout of the Project and the different impact assessment areas selected in the EIS and in the Plans. In addition,**

Table 3-1 shows, for each of the UEHs, the municipalities concerned, the planned excavations and a comparative assessment of the presence of environmental components at risk. These components include private groundwater users identified in the PSPEPES, buildings located in the buffer zone or in the area of influence of the works, where the presence of cohesive soils has been reported, and wetlands.

**The effects of the Project on groundwater, dependent environments and environmental components will be further discussed in Chapter 4. However, the information summarized in**

Table 3-1 already shows that UEH 1 to 3 contains the highest concentration of at-risk environmental components, with a particularly marked sensitivity in the area of the city of Lac-Mégantic.

**Figure 3-2 Location of Project components within hydrogeological assessment units (UEH)**



**Table 3-1 Description of selected Project components and environmental components assessed in the UEH**

Unit	Municipality or city	Presence of excavation	Groundwater user density of the PSPEPES	Presence of at-risk buildings in the buffer zone and influence area*	Presence of MH (Cima+) along the buffer zone	Notes
UEH 1	Frontenac Lac-Mégantic	Yesi	Moderate	Low	High	
UEH 2	Frontenac Lac-Mégantic	Yes	High	Moderate	High	Residential areas to the west and east but non-cohesive soil
UEH 3	Lac-Mégantic Nantes	Yes	Moderate	High	High	Centre of an industrial zone
UEH 4	Lac-Mégantic Nantes	No	Low	Low	High	
UEH 5	Lac-Mégantic Nantes	No	Low	Low	Low	

\* The density of the presence of at-risk buildings in the buffer zone and area of influence is the result of a subjective analysis of UDA in relation to the presence of cohesive soil interpreted by drilling reports (AECOM) in the assessment zones.



## 4 IDENTIFICATION OF THE INITIAL EFFECTS OF THE PROJECT

In this chapter, we evaluate the documents submitted by the CTA to verify that the Project’s effects on groundwater and dependent environments have been adequately identified. The recognition of these effects by the project proponent is essential, since it conditions their consideration in the development of targeted mitigation measures and commitment in the Plans, and, if necessary, in the identification of functional or financial compensation mechanisms.

To this end, the documents examined are:

- ▷ AECOM’s draft reports and drawings;
- ▷ The preliminary technical expert reports, namely the hydrogeological study of Englobe as well as the geotechnical and hydraulic studies of AECOM;
- ▷ The Environmental Impact Statement (EIS) study of the Project produced by WSP.

The evaluation of the documents submitted by the CTA is first based on an understanding of the Project components planned for the pre-construction, construction and post-construction (operation) phases. For this purpose, AECOM’s draft reports and drawings, related technical expert reports and Englobe’s hydrogeological study were consulted. Their analysis identified the effects of the Project on groundwater and dependent environments, some of which were quantified.

Specifically, the EIS produced by WSP describes the direct and indirect effects of the project on groundwater and dependent environments. In the absence of mitigation measures, these effects, taken individually or in combination, are likely to generate impacts that pose risks to ecosystems and communities.

In this chapter, the direct and indirect effects of the Project on groundwater and dependent environments are presented in order to show their interrelationships, to highlight the uncertainties related to their quantification and to identify the impacts and risks resulting from them. Some of these risks can be mitigated, in particular for groundwater users, by applying the measures provided for in the Plans, which are assessed in Chapter 5.

### 4.1 A general description of the Project’s effects on groundwater and dependent environments, impacts and associated risks

The diagram in

Figure 4-1 illustrates the direct (D) and indirect (I) effects of the project, as well as the associated impacts and risks, grouped according to the environment concerned. A colour code is used to facilitate reading of the following descriptive text: Blue for groundwater, orange for surface water, green for wetlands and forests, and purple for soils. Grey elements correspond to potential impacts on natural environments, while risks to ecosystems and communities are highlighted in red boxes.

The most important direct effect of the Project on groundwater is the lowering of the groundwater table. From this initial effect, a series of cascading effects is likely to occur on ecosystems and different resources, resulting in various impacts and risks to them and to communities. In concrete terms, lowering the water table could reduce the availability of groundwater resources and change

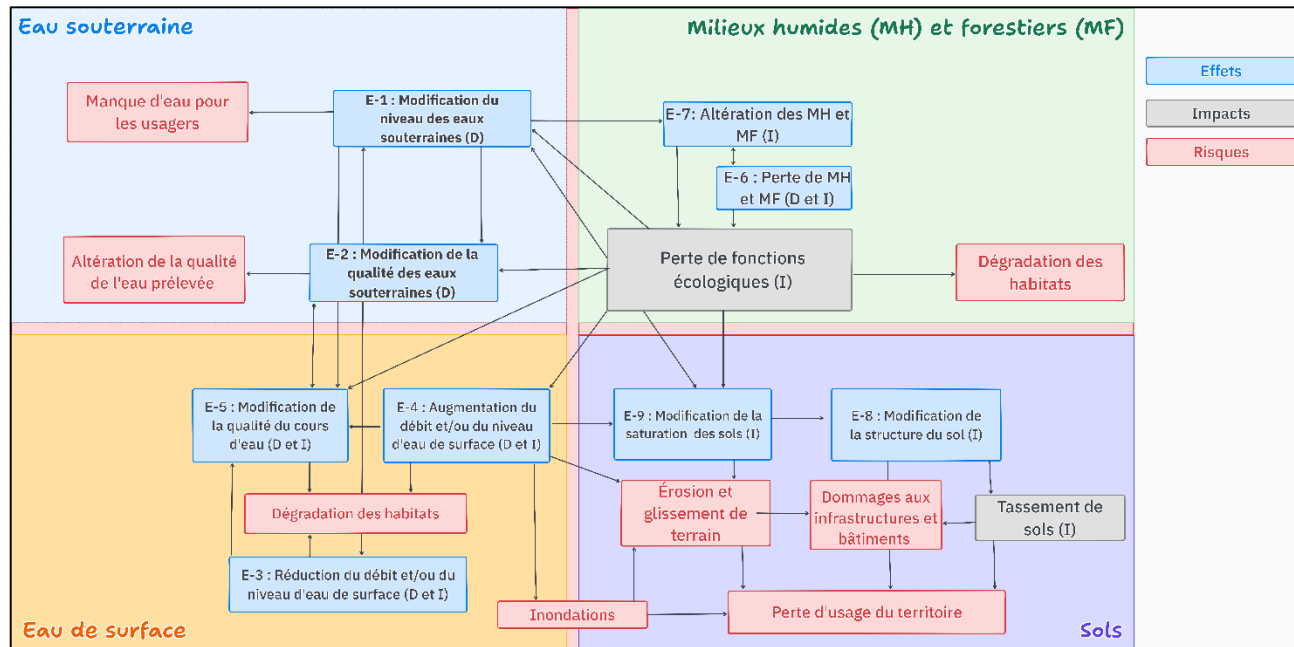
the quality of groundwater resources for users, especially those located near planned excavation areas. These impacts involve a major risk, namely the loss of access to drinking water, which could require either deeper catchment or, in some cases, the shutdown of catchment works when the water level falls below that of the facilities.

In addition, a decrease in piezometric levels leads to a decrease in interactions between groundwater and surface media, including surface water, wetlands and forests, and soils. In areas where groundwater contributes to the supply of rivers, lakes, wetlands and forests, this decline can reduce or even reverse water exchanges. Base flows then tend to decrease and surface water can locally infiltrate toward the water table instead of being fed by it. In wetlands, when the piezometric level drops below a critical threshold, the water table no longer supports saturation conditions, resulting in a gradual drying up of these ecosystems and soils. In forest environments, lowering the table favors deep-rooted plant species, which can alter vegetation cover and habitats.

The alteration and loss of wetlands and forests due to the Project could also result in a decrease in their hydrological functions at the watershed level, including river flow control, runoff and erosion control, water filtration and groundwater recharge. In turn, this decrease in hydrological functions could further reduce groundwater resources and increase risks to ecosystems and communities that depend on them. This situation appears all the more likely in a context of climate change, where more intense rainfall is expected, with the effect of accelerating runoff at the expense of groundwater recharge. At the watershed level, wetlands and forests play a key role in ecosystem resilience to climate change, intercepting and storing runoff before transferring it to surface and groundwater. These indirect effects attributable to the project could evolve over several decades (Laroque. M, 2026).

For surface waters, the decrease in hydrological functions of wetlands and forests within watersheds could lead to increased river flows and transported sedimentary load, resulting in altered water quality. This could result in various impacts, such as the destabilization of banks and land, saturation or submersion of land (flooding), and degradation of surface water quality. These impacts could result in moderate to significant risks for communities, particularly in the presence of assets to be preserved or civil security issues in the watersheds affected by the Project.

**Figure 4-1 Diagram of the anticipated direct and indirect effects of the project on groundwater-dependent environments**



## 4.2 Effects, impacts and associated risks of the Project on groundwater

As mentioned previously, the Project will result, temporarily or permanently, in a lowering of the groundwater table at the railway track. This effect will therefore be greater near the track and its extent will depend in particular on the hydraulic properties of the intercepted aquifers, their degree of connectivity, the presence of structures promoting groundwater flow (for example the Bella fault, in UEH 2) as well as the extent of the drawdown induced at the railway track level. Lowering the water table will thus lead to a change in the flow regime of groundwater, as well as its quality.

A first quantification of this effect was carried out in Englobe's hydrogeological study, the objective of which was to estimate the dewatering flow rates associated with the excavation areas planned for the Project. Based on these estimates, Englobe delineated areas of influence for dewatering for the construction phase (3 years) and for the long term (10 years), within which the groundwater table could drop by more than 2 metres. The areas thus defined appear conservative in view of the input data used in the calculation models, which were deliberately overestimated, in particular the water levels to be lowered and the hydraulic conductivity values of the intercepted aquifers. This conservative nature is also based on the use of recognized calculation models and the application of safety factors.

It is therefore expected that the effects of the Project on groundwater will be greater within these areas of influence.

In summary, two direct effects of the Project on groundwater are considered in the assessment of the robustness of the Plans, as well as proposed mitigation measures:

- ▷ E-1: Changes in groundwater levels;
- ▷ E-2: Changes in groundwater quality.

#### 4.2.1 Changes in groundwater levels - E-1

The change in groundwater levels attributable to the project is closely related to the dimensions of the planned excavation areas, particularly their depth and length. Thus, the areas most likely to be affected by a lowering of the water table, presented by hydrogeological assessment unit in Figure 3-2, are as follows, in order of importance:

- ▷ UEH 2: Community of Mégantic (south of the Chaudière River);
- ▷ UEH 1: Community of Frontenac.

The UEH 2 sector will include three of the four excavation trenches that are more than 8 metres deep planned for the project. As such, it is the most vulnerable sector to the effects of the Project on groundwater and dependent environments. It should also be noted that this sector is the most densely populated in the area under study and that it has the largest number of users of groundwater not served by the municipal water system. The direct impact of lowering groundwater is the decrease in the availability of the resource to users and ecosystems. For users, this impact would be particularly marked in the case of shallow or less efficient structures located near excavation areas.

For the drinking water supply wells in Lac-Mégantic, Nantes and Frontenac, they capture groundwater outside the long-term dewatering influence areas associated with planned excavation areas. As such, they should not be significantly affected by the project. In addition, the municipal wells of Lac-Mégantic and Nantes draw from water tables found in granular aquifers benefiting from significant recharge. With regard to the Mégantic municipal wells, the aquifer being operated is fed by Lake Mégantic (EIS and PSPEPES), while the Frontenac well operates an aquifer fed by surface water flowing into a watershed adjacent to the Project.

#### 4.2.2 Modification of groundwater quality - E-2

A lowering of groundwater in some areas can affect not only the quantity of water available, but also its quality. Indeed, a decrease in the piezometric level can modify the directions of underground flow and, consequently, change the origin of the water locally supplying an aquifer or catchment structure.

These effects are particularly likely to occur in areas where aquifers are shallow, interact with surface waters, fractured or exposed to potential sources of contamination. In such contexts, the lowering of the water table can increase the vulnerability of the groundwater resource and justify a particular monitoring of its qualitative evolution.

The areas where these effects are most likely to occur, in order of importance, are the same as those previously identified for the E-1 effect.

### 4.3 Direct and indirect effects, impacts and associated risks of the project on surface waters

AECOM's preliminary hydrological study was carried out with the aim of sizing drainage channels and culverts to manage surface water flows intercepted by the Project. However, on reading the studies completed, it appears that the hydrological model developed for the sizing of drainage structures did not consider the following elements:

- ▷ The volumes of groundwater from excavation areas, which will be added to the runoff to be drained;
- ▷ The direct loss of wetlands and forests and their alteration, which will reduce their hydrological functions within watersheds, including runoff water flow control, watercourse flow and level control, and groundwater recharge.

The absence of these considerations in the hydrological model developed by AECOM makes it impossible to assess, before the project is carried out, the impacts and risks that could result for ecosystems and communities. It appears essential that they be assessed to their proper significance in order to foresee and design mitigation measures or functional compensation to be applied during the construction of the Project.

Within the EIS, the identified direct effects of the Project on surface waters are changes in flow patterns and changes in water quality. These changes will result from the distribution of water in the river system from the drainage of the railway track. Depending on the sector, watercourses could thus experience an increase or decrease in their base flow, which in turn would modify hydraulic exchanges between surface water and groundwater.

These effects could be combined with those indirectly exerted by the Project on groundwater, including lowering of the water table, as well as on wetlands and forests through their loss or alteration. Anticipated negative impacts include the erosion of river beds and banks, damage to drainage infrastructure, decreased water quality, loss of drainage capacity or soil drying, land submersion and soil instability. These impacts are likely to create risks for ecosystems and communities, including the degradation of fish habitat, the loss of enjoyment of and access to land resources, the loss of infrastructure built along watercourses, as well as risks to the safety of residents in flood-prone areas.

In summary, three direct and indirect effects of the Project on surface waters are considered in the assessment of the robustness of the Plans, as well as the proposed mitigation measures. These effects are:

- ▷ E-3: Reduction of surface water flow and/or level (direct and indirect);
- ▷ E-4: Increase in surface water flow and/or level (direct and indirect);
- ▷ E-5: Modification of surface water quality (direct and indirect).

#### 4.3.1 Reduction of surface water flow and/or level – E-3

The reduction in surface water flow and/or level will occur in a watershed where a portion of surface water inputs and groundwater resurgence will be diverted by the Project to a nearby watershed. This transfer could significantly reduce the base flows of the streams in the original watershed. This effect could be compounded by the loss of hydrological functions of wetlands and forests within the affected watershed, as well as by the decrease in groundwater recharge.

It is expected that impacts and risks associated with decreased surface water flow and/or level, including degradation of fish habitat, land drying, soil compaction and decreased groundwater recharge, may occur in UEH-1 (Frontenac), where a surface water and groundwater deficit is anticipated. This deficit would be attributable to the interception of surface water and groundwater at the top of the watershed, and then their transfer to UEH-2 (Mégantic, south of the Chaudière River) by the drainage of the railway track.

#### 4.3.2 Increase in surface water flow and/or level – E-4

The increase in flow and/or water level will occur in a watershed where the streams will receive drainage water from the railway track. These waters will come from both the interception of runoff from the relevant and neighbouring catchment areas and from the groundwater collected. This effect could be amplified by the loss of hydrological functions of wetlands and forests within the affected watershed.

The impacts and risks associated with this effect, including degradation of river beds and banks, land saturation, land instability, land submersion (flooding), degradation of fish habitat, and loss of built assets and civilian infrastructure, are expected mainly in UEH-2 (Mégantic, south of the

Chaudière River). In this area, the hydrographic system will accommodate runoff and groundwater intercepted by the railway track drainage system from UEH-2 and UEH-1 (Mégantic, south of the Chaudière River and Frontenac). In addition, UEH-2 (Mégantic, south of the Chaudière River) will have the most wetlands and forest areas likely to be lost or altered. Ultimately, the loss of their hydrological regulatory function at the watershed level could also result in an increase in river flows and/or water levels.

### 4.3.3 Modification of surface water quality – E-5

Changes in stream flow regimes within river systems will also result in changes in surface water quality and connected groundwater. For example, increased sediment loading resulting from erosion of streams and adjacent grounds could contribute to both the degradation of fish habitat and the quality of surface and groundwater.

Although this type of effect could occur at different levels in the UEH, it is expected to be more significant in UEH-2 (Mégantic, south of the Chaudière River) due to the contribution of track drainage water from both this unit and UEH-1 (Frontenac).

## 4.4 Direct and indirect effects, impacts and associated risks of the Project on wetlands and forest environments

Under the EIS, it is indicated that the Project will directly and indirectly affect wetlands and forest areas within the right-of-way as well as beyond it. According to the assessment conducted by CIMA+, the construction of the railway track will result in the permanent loss of 33 hectares of wetlands, consisting of wooded peatlands (47%), marshes (33%), shrub marshes (18%) and open wetlands (2%). The Project also foresees the loss of approximately 55 hectares of forest areas located within the right-of-way, mainly consisting of mixed forest stands (60%). In addition, there are projected losses of 9 hectares of herbaceous environments and 3 hectares of shrubs. Furthermore, the EIS anticipates that the Project will also impact wetlands and forest areas located beyond the right-of-way, notably due to local disturbance of their water supply. This disturbance would result from both the loss of connectivity caused by the fragmentation of the environment by the railway track and the permanent lowering of the water table at the level of the railway track drainage. However, the spatial and temporal scope of these effects has not been assessed in the pre-project engineering studies or in the EIS. In addition, the characterization of wetlands and forests carried out by CIMA+ was not used to identify the most vulnerable areas to the Project. However, the EIS indicates that the effects of the Project on these environments could have significant consequences for ecosystems and communities.

At the watershed level, wetlands and forests generally perform water regulation and filtration functions and are often connected to groundwater (Laroque, M., 2026). In watersheds with a small surface area on a hilly terrain, such as those crossed by the Project, the presence of these environments is therefore of high significance in terms of their hydrological functions. In addition to alteration and loss of habitat in ecosystems directly affected by the Project, indirect loss and alteration of wetlands and forests, as well as their loss of hydrological functions, are likely to result in hydrological and hydrogeological imbalances. Expected impacts on water resources include, on the one hand, a decrease in groundwater recharge and an alteration in groundwater quality. This could lead to risks for the drinking water supply for private users. On the other hand, the increase in flow rates and levels of watercourses receiving drainage water from the railway track could cause ground instabilities (erosion of banks and flow bed, landslides, submersion, flooding) and an alteration in surface water quality.

In summary, two direct and indirect effects of the Project on wetlands and forests are considered as part of the assessment of the robustness of the Plans and monitoring, as well as the proposed mitigation measures. The two effects are:

- ▷ E-6: Loss of wetlands and forests (direct and indirect);
- ▷ E-7: Alteration of wetlands and forests (indirect).

#### 4.4.1 Loss of wetlands and forests – E-6

The construction of the railway track will result in a direct and permanent loss of wetlands and forest in the Project's right-of-way, due to deforestation, land clearing and soil stripping.

Other direct losses could also result from the temporary encroachment of work outside the right-of-way and temporary diversions of watercourses. Direct effects on wetlands and forests will occur throughout the route where these habitats are found. However, it is expected that the impacts and risks associated with their loss are greater, in order of significance, in the following UEH (Figure 3-2):

- ▷ UEH-2: Community of Frontenac and Lac-Mégantic (south of the Chaudière River);
- ▷ UEH-3: Community of Mégantic and Nantes (north of the Chaudière River);
- ▷ UEH-1: Community of Frontenac and Lac-Mégantic.

UEH-2 and UEH-3 have the largest areas of wetlands and forest that will be destroyed by the Project, compared to UEH-1. However, UEH-2 appears to be more vulnerable to the effects of the loss of these environments and their hydrological functions, particularly due to increased water flows and levels in streams. This effect could be exacerbated by the input of groundwater collected during the deep excavations planned in this unit. Moreover, UEH-2 has the highest density of private users of groundwater resources.

In addition to direct losses within the right-of-way, the Project could result in indirect losses of wetlands and forest beyond it. These losses would result from the disruption of connectivity between environments on either side of the railway track, the fragmentation of habitats and the modification of their water supply due to the lowering of groundwater levels. In areas where wetlands and forests depend on a shallow water table or sustained groundwater exchange, these disturbances could lead to a gradual degradation of their water conditions, resulting in partial drying, ecological alteration or, ultimately, functional loss.

#### 4.4.2 Alteration of wetlands and forests – E-7

The construction of the railway track will result in the fragmentation of wetlands and forest areas found around the track, which will alter their hydraulic connectivity. Combined with the anticipated groundwater drawdown around the track, this effect can significantly alter the water supply to these environments.

Consequently, a gradual and permanent alteration of wetlands and forests, as well as their hydrological functions, is anticipated beyond the Project's right-of-way.

Considering the causes of these anticipated alterations, it is expected that impacts and risks to ecosystems and communities will be greater in UEH-2, followed by UEH-3 then UEH-1. The same rationale presented in Section 4.3.1, relating to loss of wetlands and forests, applies.

### 4.5 Indirect effects, impacts and associated risks of the Project on soils

Englobe's hydrogeological study and AECOM's geotechnical study identified the Project's effects on groundwater, which could result from changes in soil saturation and structure. These effects could have impacts on soils, including increased erodibility or instabilities such as settlement, which could pose risks to built heritage and exposed communities. The EIS recognizes that the latter effect could occur in cohesive soils predominantly composed of silt or clay, whereas it would be more limited in granular soils composed mainly of sand, gravel or pebbles.

In summary, two indirect effects of the Project on soils are considered as part of the assessment of the robustness of the Plans and the proposed mitigation measures. The two effects are:

- ▷ E-8: Change in soil structure (indirect);
- ▷ E-9: Change in soil saturation (indirect).

#### 4.5.1 Soil Structure Modification – E-8

The direct effects of the Project on groundwater, including the groundwater drawdown in excavation areas, will result in soil desaturation, which, depending on its nature, whether cohesive or granular, could cause subsidence. Therefore, this impact on soils is anticipated to be greater in areas where deep excavations are expected and where a groundwater drawdown is expected, in order of significance, in UEH-2 (Lac-Mégantic and Frontenac, south of the Chaudière River) and UEH-1 (Frontenac and to a lesser extent Lac-Mégantic).

In addition, geotechnical drilling carried out by AECOM along the bypass route indicates that the till deposits observed are mainly composed of a sandy-silty or silty-sandy matrix, which could make them less sensitive to compaction. However, drilling north of the Chaudière River, in UEH-3, within an industrial zone, reveals the presence of predominantly silty soils, which are more sensitive to soil compaction. The main risk associated with soil compaction is damage to existing infrastructure and buildings. In this regard, Englobe's hydrogeological study identified buildings within areas where groundwater drawdown due to the Project is anticipated.

#### 4.5.2 Change in soil saturation – E-9

The groundwater drawdowns directly or indirectly induced by the Project will contribute to modifying soil saturation, in particular by causing them to dry up near excavation areas. This effect could result in the following impacts:

- ▷ Increased soil erodibility;
- ▷ Decreased soil infiltration capacity and consequently decreased groundwater recharge;
- ▷ In the longer term, this effect can be combined with the Project's effects on groundwater, surface water, wetlands and forest. Impacts resulting from soil saturation change are expected mainly in watersheds where deep excavations are expected, in order of significance, in UEH-2, UEH-1 and UEH-3. The effects concerned are: Alteration of wetlands and their hydrological functions;
- ▷ Increase in the base flows of watercourses and alteration of their quality.

This could amplify the impacts and risks already anticipated for ecosystems and communities.

### 4.6 Lay summary of the initial effects of the Project

This section explains the main effects that the Project could cause to water and natural environments near the railway track to be built and more broadly across the territory of the towns and municipalities of Lac-Mégantic, Frontenac and Nantes. The general idea is simple: the Project will locally modify groundwater levels through the drainage of the railway track. In certain places, changes are expected to be significant and will result in changes in groundwater flow processes and alter exchanges with the natural environments that depend on it, including wetlands, woodlands and soils. The main effects affecting groundwater and dependent environments are :

- ▷ E-1: Decrease in groundwater levels;
- ▷ E-2: Change in groundwater quality;
- ▷ E-3: Decrease in surface water flow or level;
- ▷ E-4: Increase in surface water flow or level;

- ▷ E-5: Change in surface water quality;
- ▷ E-6: Loss of wetlands and forests;
- ▷ E-7: Alteration of wetlands and forests;
- ▷ E-8: Change in soil structure;
- ▷ E-9: Change in soil saturation.

The first significant effect expected is a decrease in groundwater levels at some locations (E-1). This can reduce the amount of water available in certain private wells, particularly those located near the railway track. Depending on the case, this can also change the quality of well water (E-2). This risk is especially significant near areas where deep excavations are planned.

The Project may also increase or decrease the flow and level of surface water flowing into ditches, streams and rivers (E-3 and E-4). These changes can cause risks such as stream erosion, flooding, drainage or land drying problems, landslides and deterioration of water quality (E-5).

Wetlands and forests may also be affected (E-6 and E-7). Some will be destroyed directly by the work activities. Others could be altered more slowly if their water supply changes. However, these environments are important because they help retain and filter water on the territory, and thus help reduce the risks mentioned earlier and recharge groundwater.

Soils may also be affected (E-8 and E-9). If groundwater drops, some soils can dry out or settle. This can weaken the land and, in some areas, create a risk to buildings or infrastructure. In summary, Section 4 shows that the effects of the Project on groundwater have impacts on the natural environments that depend on it. They can spread to several interconnected environments and in combination create short- or long-term risks to ecosystems and communities.



## 5 ASSESSMENT OF PLANS AND MITIGATION MEASURES

To reduce the anticipated adverse effects of the Project on groundwater and dependent environments, mitigation measures have been included in the EIS and are described as commitments by CPRC and TC. The implementation conditions of these measures are documented in the Project's general management plans as well as in the monitoring or follow-up plans dedicated to the environments and communities that will be impacted by the Project. Those assessed as part of this mandate focus on environments and communities related to groundwater. Plans are defined as follows:

- ▷ General project management plans:
  - ▶ PGEC: Construction Environmental Management Plan;
  - ▶ PSEPPC: Environmental Monitoring Plan for the Right-of-Way in the Post-Construction Phase;
- ▷ Specific monitoring or tracking plans:
  - ▶ PSPEPES: Drinking Water Well and Groundwater Monitoring Plan;
  - ▶ PSMH: Wetland Monitoring Plan;
  - ▶ PSCES: Construction Monitoring Plan for Surface Waters;
  - ▶ PSCF: Compensatory Afforestation Tracking Plan.

The planned mitigation measures may be applied in due course directly to the affected environments, but also indirectly through financial compensation or functional compensation within the affected watersheds, for example tree planting or the creation of wetlands outside the Project's right-of-way.

As part of this mandate, we assessed the robustness of the proposed mitigation measures to reduce the adverse effects of the Project on groundwater and dependent environments identified in the EIS, as well as other effects identified in our analysis as reported in Chapter 4. These measures are, for the most part, detailed in the Plans. Several of them are conditional on compliance criteria and the achievement of specific threshold values. Therefore, our assessment of the robustness of the mitigation measures proposed for the Project is intrinsically linked to our assessment of the Plans submitted to the CTA.

The assessment of the Plans and mitigation measures includes the following:

- ▷ Objectives and duration of the plan;
- ▷ Quantifying the vulnerability of ecosystems or communities to Project effects;
- ▷ Monitoring or follow-up methodology;
- ▷ Monitoring criteria and action thresholds;
- ▷ Actions applicable or resulting from the achievement of thresholds.

As a preamble to the assessment of each of the above-mentioned Plans, a summary will present the Project effects to which each Plan responds. The assessment will initially focus on specific monitoring or tracking plans and, secondly, on general environmental management plans.

### 5.1 Specific plan

#### 5.1.1 PSPEPES: Drinking Water Well and Groundwater Monitoring Plan

##### Effects to be covered by the plan

It is expected that the PSPEPES will primarily address the direct effects of the Project on groundwater, by directly targeting risks related to changes in groundwater level and quality, i.e. loss of access to drinking and domestic water, particularly existing private users in Mégantic (south of the Chaudière River) and Frontenac. It should therefore focus on the E-1 effect (change in groundwater level) and the E-2 effect (change in groundwater quality).

### **Announced objectives and duration of the plan**

The PSPEPES is in response to the potential effects of excavation and groundwater dewatering work. It aims to ensure the maintenance of an adequate drinking water supply for the users concerned, in quantity and quality, during the construction and operation phases. The plan is based on an initial risk analysis of the wells, followed by an adapted and evolving monitoring program incorporating response thresholds and corrective measures. It relies on a network of existing wells and piezometers to monitor the evolution of the groundwater and anticipate the potential impacts related to the work. It is therefore part of an approach to managing risks for users and provides for measures to mitigate them. This plan addresses mitigation measures TC-SES-01 to TC-SES-10 and TC-SES-12.

Operationally, the plan must be implemented six months before construction begins. Its minimum application period is two years after Project construction is completed and may, on the recommendation of a hydrogeological expert, be extended until the water table has stabilized.

Although these mechanisms are consistent with the objective of the plan, it seems to underestimate the possibility of effects beyond the two-year deadline, particularly in the context of climate change and changes in groundwater recharge within watersheds. This issue appears all the more important since the notion of water table stabilization is not precisely defined and there is not clear consensus about it.

### **Quantifying the vulnerability of ecosystems or communities to Project effects**

The PSPEPES is based on an assessment of vulnerabilities and risks to which users are exposed in relation to the Project components. This analysis is based on a comprehensive inventory of users and works concerned (152 wells in total) in the Project's influence areas and beyond. The methodology chosen is clearly defined and is based on relevant indicators (e.g., minimum available water column, hydraulic location of the structure, water quality, use, etc.). This gives the risk analysis for loss of water access for each of the structures identified, both in quality and quantity, appreciable robustness. The risk categorization, combined with the vulnerability assessment of each structure, allows the PSPEPES to propose a detailed analysis of the potential impacts of the Project.

### **Monitoring and Tracking Methodology**

The plan documents the initial condition of all structures likely to be affected and, on this basis, significantly reduces uncertainties regarding the achievement of its main objective. Depending on the vulnerabilities and risks identified, it provides for appropriate tracking mechanisms, whether automated or not, as well as adjusted and clearly defined response thresholds, supported by a structured and robust chain of actions.

The uncertainties related to the delineation of the Project's areas of influence and the partial knowledge of the characteristics of the aquifer under operation are mitigated by the extent of the monitoring network put in place. This extends beyond the areas of influence and provides, in the event of detection and reaching certain thresholds, additional extensions of the network.

### **Monitoring criteria and response thresholds**

The plan provides for the continuous piezometric monitoring of wells and the establishment of a sampling and chemical analysis program. It incorporates response thresholds triggered by changes

in level or findings of water quality degradation. The identification and assessment of the initial condition of the structures produced appear to be exhaustive and consistent. In addition, the clear definition of monitoring mechanisms and response thresholds (four in total) suggests that the plan can be effectively implemented, especially since roles and responsibilities are clearly established. The levels of intervention defined, in relation to the vulnerability degree of the structures, seem realistic.

The plan specifies the roles and responsibilities of each stakeholder in groundwater monitoring and provides a series of relevant tools to ensure continuous monitoring of impacts on communities (watchdog committee, call line, etc.). It ensures rapid detection of impacts on groundwater and provides assistance in the event of a proven risk.

However, the plan does not explicitly provide for response following a report of lost water access by a user. As a result, it may not allow for a sufficiently rapid response in the event of a Project impact on groundwater availability that has not been detected by the monitoring network.

### **Actions applicable or resulting from the achievement of thresholds**

The nature of the actions resulting from meeting the thresholds, by risk level, is clearly defined based on the extent and nature of the problems affecting the water quantity and quality among users.

The actions planned for each of the response thresholds are built on a solid science-based foundation and allow for proactive action before the impacts become too significant for the communities. However, the absence of an emergency response protocol, in the event of a loss of access to water or alteration of water quality, appears to be a flaw in the PSPEPES. Considering the monthly monitoring intervals of indicators, an emergency condition could arise between the monitoring intervals and require immediate actions to restore the water supply to the impacted users.

Moreover, since the plan's deadline is a weakness in terms of the adjustment times of the systems under study, no explicit commitment is set out for monitoring and response beyond the two-year period or after theoretical stabilization of the water table has been achieved.

### **Residual effects and risks**

The PSPEPES reduces the Project's groundwater-related risk to communities through monitoring, early detection and corrective action, but it does not eliminate the Project's effects on groundwater and dependent environments. As a result, the effects will remain present beyond the period currently covered by the PSPEPES and could increase under the combined effect of other effects attributable to the Project (E-3 to E-9), as well as climate change, expected to evolve over a longer period.

Furthermore, in the absence of an emergency plan in the event of loss of access to water or alteration of its quality, the plan partially fails its objective of ensuring access to drinking and domestic water for the users identified in the monitoring plan.

## **5.1.2 PSMH: Wetland Monitoring Plan**

### **Effects to be covered by the plan**

In relation to the initial effects identified, the PSMH will have to respond primarily to effects E-6 (direct and indirect loss of wetlands and forests) and E-7 (alteration of wetlands and forests).

Considering the central role of wetlands in hydrological processes of water regulation and filtration within watersheds, the plan should also contribute to responding to the effects of the project on the quality and quantity of groundwater and surface water (E-1, E-2, e-4 and E-5).

Finally, the plan should cover part of the project's effects on soils (E-8 and E-9).

### **Announced objectives and effective duration of the plan**

The Wetland Monitoring Plan aims to document the initial state, monitor the evolution and detect the impacts of the work on wetlands adjacent to the right-of-way. It is based on an adaptive and reactive approach, based on continuous monitoring (water levels, vegetation, soils) and comparison with a reference condition. The plan is not intended to prevent all Project impacts on wetlands and does not propose monitoring and protection of forest environments. Nor is it intended to directly assess the overall effects of the Project, but rather to detect deterioration and propose corrections or compensations if necessary. This plan aims to address mitigation measure TC-SES-04.

The effective period of the plan is one year prior to the start of construction, to establish the initial state of wetlands characterized by the EIS, up to 10 years after the completion of construction. It covers the pre-construction phase, construction phase and post-construction period.

The plan is intended to document any deterioration of wetlands and to guide, where necessary, the completion of complementary characterizations, the implementation of corrective measures or the use of compensation measures. Nevertheless, the stated objectives remain general. The lack of flexibility over the final 10-year timespan suggests that the longer-term adverse effects of the Project may not be fully taken into account and therefore corrected.

### **Quantifying the vulnerability of ecosystems or communities to Project effects**

The vulnerability of wetlands is not sufficiently explicitly addressed in the framework of the PSMH. Rather, it is based on the wetland characterization study conducted by CIMA+, which documents, within its assessment area, the characteristics of the environments and some of their ecological functions at the watershed level. However, this work remains imprecise in assessing the vulnerability of wetlands to Project components and, by extension, in terms of its impact on groundwater and water supply sources. Furthermore, the study does not provide an assessment of the vulnerability of the various wetlands located outside the Project's right-of-way or of the potential effects of the Project on their hydrological functions. The PSMH only considers monitoring within a 20-metre band surrounding the bypass route and does not provide for the use of control sites that would allow for the assessment of the causal link between the observed effects and the Project.

From a community perspective, the PSMH does not incorporate risk assessment associated with wetland loss or alteration at the watershed level. Moreover, the value of hydrological functions rendered by wetlands, whether destroyed, vulnerable or exposed, has not been appreciated at any time. More fundamentally, the proposed compensatory measures are mainly part of a regulatory logic at the RCM level and are mainly financial in nature, which seems inadequate to reduce risk and uncertainty at the watershed level. Furthermore, although mitigation measures are planned in the event of confirmed wetland degradation, their effectiveness will likely remain limited once degradation processes have begun.

A more detailed characterization of the hydrological vulnerabilities and functions of wetlands at the watershed level is therefore essential in order to anticipate the true extent of hydrological risks to communities. This characterization should also guide the establishment of the initial status and monitoring plan, so as to allow effective monitoring of degradation of certain vulnerable wetlands, potentially beyond the initial 20-meter band and using control sites, and making essential functions for watershed communities.

### **Monitoring and Tracking Methodology**

The PSMH identifies several elements of wetland monitoring. It describes the indicators selected, the frequency of measurements and the monitoring mechanisms. The proposed biophysical indicators, such as water levels and vegetation status, appear to be relevant. Their usefulness, however, depends on their comparison with the baseline values established in the initial state. This

initial state must be documented prior to the implementation of the plan. However, the document remains imprecise on several points. It does not clearly determine whether these indicators are sufficient to account for the connectivity between wetlands and groundwater. It also does not specify how the water supply to wetlands will be assessed. Finally, the wetlands that will actually be monitored are not clearly identified.

The plan also provides no clear identification of monitoring stations or rationale for prioritizing wetlands to be monitored. However, such prioritization should be based on a prior assessment of the vulnerability of wetlands to Project components, as well as the importance of the hydrological services they provide at the watershed level. In addition, the plan does not include monitoring of control wetlands not influenced by the Project, which would nevertheless make it possible to distinguish the causes of degradation of certain indicators when these are not attributable to the Project's effects on groundwater.

Overall, the plan appears unrobust and remains imprecise as to the methodology to be deployed.

### Monitoring criteria and intervention thresholds

The PSMH uses a single variability threshold of 15% for all indicators monitored. Reaching this threshold would trigger an analysis of the need to implement corrective measures. Such a threshold therefore constitutes a uniform approach applicable to all wetlands, regardless of their level of vulnerability, their relative importance to the community, and all indicators.

UDA considers that, as is adequately documented and planned in the PSPEPES, the PSMH should specify, for each indicator, threshold values as well as the measures to be implemented when they are reached, adapting them to the ecological function concerned.

### Actions applicable or resulting from meeting thresholds

The proposed actions appear to be relevant to the recovery objectives. However, given the lack of specific identification of the actual functions of wetlands lost, or likely to be lost due to their vulnerability, possible interventions when thresholds are reached may be insufficient or inconsistent. In addition, although the plan documents some changes in the hydrological functioning of the environments, it does not provide a direct preventive mechanism for them.

UDA also considers that the Project proponent should, rather than consider financial compensation for lost wetlands, provide for compensation for lost ecological functions from the onset of the project. Similarly, if some wetlands are considered vulnerable, the PSMH should provide, within the Project's construction, for the application of effective protection measures for wetlands of interest in reducing risk to communities.

### Residual effects and risks

The PSMH documents and monitors wetland evolution over a 10 -year period, but it does not aim to prevent impacts, assess all ecological functions, or fully qualify their ecological value. In short, this plan is essentially reactive and does not reduce the uncertainties associated with the vulnerability of wetlands and their role in reducing certain risks to communities.

The residual risks associated with the effects of the Project remain significant despite the implementation of the PSMH. For effects E-2 (groundwater quality) and E-5 (surface water quality), a residual risk persists due to a lack of functional appreciation of wetlands, in particular their hydrological filtering role. The assessment of ecological functions remains partial and based on simplified, essentially biotic criteria, which limits the ability to anticipate the loss of essential hydrological services at the watershed level.

For effects E-3 and E-4 (surface water regime), residual effects mainly concern unquantified indirect changes in drainage regimes (groundwater input) and interactions of groundwater, surface water and wetlands, since current analyzes do not allow to assess the extent of loss of hydrological functions at the relevant scale (watershed) or their consequences.

Residual risks are particularly high for effects E-6 (direct or indirect loss of wetlands) and E-7 (alteration of wetlands), since the PSMH is not intended to prevent losses of wetlands and forests, but primarily to document their evolution and, if necessary, to guide corrective or compensatory measures. In addition, there is a structural gap: The plan is not based on a detailed functional assessment of wetlands, and the lack of awareness of their importance limits the ability to prioritize interventions and adapt monitoring according to the real sensitivity of the wetlands. The plan therefore does not explicitly monitor the evolution of their functions such as water regulation, filtration or habitat support. This limitation reduces the scope of the risk analysis to communities and the relevance and efficiency of corrective measures that could be implemented.

In addition, several methodological elements accentuate the residual uncertainties:

- ▷ Lack of test stations to distinguish project effects from natural variations;
- ▷ Arbitrary threshold of 15% not adapted to the dynamics of natural environments;
- ▷ Lack of assessment of indirect and cumulative impacts on wetlands;
- ▷ Failure to take into account flood zones and watercourse mobility.

Finally, the plan does not address residual effects on groundwater and soils (E-1 to E-2 and E-8 to E-9), although degradation of wetlands and forests may affect aquifer recharge and infiltrated water quality.

### 5.1.3 PSCES: Construction Monitoring Plan for Surface Water

#### Effects to be covered by the plan

Based on the assessment of the Project effects, the PSCES should primarily address the Project-related environmental effects on the modification of the surface water flow regime (E-3 and E-4). Similarly, the plan is expected to incorporate monitoring of effects on surface water quality (E-5) and soil erosion and modification issues (E-8).

Indirectly, the plan is expected to also consider the Project's effects on surface water and the impacts on dependent and connected media such as groundwater levels (E-1) and soil saturation (E-9). In doing so, it should contribute to the assessment and management of the effects on groundwater quality (E-2) by, for example, regulating the discharge of pumped water.

Still considering the centrality of the drainage network and the qualitative and quantitative links to dependent environments, the plan should take into account the effects of the Project in relation to wetlands and forests (E-6 and E-7).

#### Announced objectives and effective duration of the plan

The purpose of the PSCES is to ensure the environmental monitoring of surface water during the construction phase in order to quickly detect, control and correct the anticipated adverse effects of the Project, by verifying compliance with water quality criteria and the stability of watercourses affected by the work. This is an operational plan applicable during the construction of the Project, particularly during temporary diversions, watercourse crossings, channel realignments and dewatering activities.

The plan is deployed in two phases: First during construction, from the start of diversion and excavation work, and then during the post-construction phase, over a two-year period corresponding to restoration.

It is based on two main components:

- ▷ Monitoring of water quality and erosion/sedimentation control measures (inspections, physical-chemical measures, response levels);
- ▷ Monitoring of the stability of realigned channels and rivers, with the possibility of corrective action in case of degradation.

### Quantifying the vulnerability of ecosystems or communities to Project effects

The plan alone does not include a detailed assessment of the vulnerability of the dependent environment or communities. In addition, there is no assessment of the initial state of water environments, which constitutes a limitation, as the document does not provide a detailed plan of planned discharge sites.

However, the conditions and procedures for the management of water pumped during dewatering activities are satisfactorily described in the PSCES. Particular attention is paid to criteria for the location of discharge points, their interactions with surface waters and wetlands, as well as preventive control measures for the quality of discharged waters.

### Monitoring and Tracking Methodology

The mechanisms for monitoring water quality and channel stability are adequately described in the PSCES. The plan provides protocols for monitoring bypasses, work-related water inputs, and receiving channel capacity. It requires operators to ensure frequent monitoring, upstream and downstream of each hydraulic structure, of variations in the transport of solid matters as well as of the quality of water transported to dependent environments.

To this end, the plan provides for:

- ▷ Daily visual inspections, including for water sheen;
- ▷ Physicochemical measurements using portable devices, including turbidity and pH;
- ▷ During the construction phase, two inspections per day, which seems appropriate;
- ▷ In the restoration phase, monitoring is carried out twice a year on both sides of the hydraulic infrastructure and derived channels.

Monitoring of channel stability is also planned twice a year for the duration of the plan. The monitoring mechanisms of the realignment work appear to be clearly defined and adequate in this respect.

### Monitoring criteria and intervention thresholds

Discharge monitoring criteria are based on thresholds established by the Canadian Council of Ministers of the Environment (CCME) and natural background levels. The latter can be determined from the results of the PSPEPES. Exceeding any of these thresholds must lead to the implementation of response measures.

The plan clearly specifies the triggering conditions and the sequence of actions to be taken, including systematic pre-treatment of the water prior to discharge. However, although this type of contamination is not the one mainly anticipated, except in the event of an undetected accident, the absence of organic parameters in the monitoring is a notable limitation.

Nor does the plan specify the thresholds or response mechanisms applicable to monitoring channel stability. With regard to erosion, the only elements foreseen in the plan are the production of monitoring reports and the management, by CPRC, of the resulting recommendations.

### Actions applicable or resulting from meeting thresholds

With regard to the quality of discharged water, the actions planned when the thresholds are reached appear to be relevant and well structured. The plan establishes clear conditions for intervention and provides, in particular, for the control of discharges, their onsite treatment and, if necessary, the cessation of pumping and work. These provisions allow for rapid response during the work.

In summary, when it comes to water quality monitoring, the plan is mostly reactive, it detects exceedances (e.g. turbidity, pH) and triggers adjustments or suspension of work if necessary.

On the other hand, with regard to channel stability, the deployment of corrective actions is not described with the same level of precision. However, the plan indicates that it will be up to CPRC to rely on stability monitoring reports in order to develop and implement appropriate stabilization plans.

### **Residual effects and risks**

The residual effects associated with the PSCES remain significant due to the temporary (mostly the construction phase) and local nature of the plan.

Although the plan provides for monitoring the stability of channels and culverts, as well as downstream flow conditions, it does not allow for the assessment of the Project's impacts at the watershed scale or its long-term effects on surface waters. In addition, no specific corrective action or clear commitment is foreseen when signs of degradation of watercourses or drainage structures are observed. It will therefore be up to CPRC to determine whether corrective measures need to be implemented. Like the PSMH, the PSCES is based on a reactive approach based on field observations. In this context, the lack of knowledge on the hydrological effects of the Project at the watershed level could limit the effectiveness of locally applied remedial measures.

In addition, the plan does not take into account the indirect effects that the Project could have on stream runoff. For example, the loss of hydrological functions provided by wetlands and forest in watersheds, combined with the Project's effects on groundwater, could further alter surface water flows and levels. As a result, impacts and risks associated with the E-4 effect (increased surface water flow and/or level) and the E-7 effect (wetland and forest alteration) may persist.

Finally, regarding the E-5 effect (surface water quality), the residual risk is lower but remains present. Temporary exceedances may occur before detection and monitoring is limited to certain physicochemical parameters, leaving uncertainty about other contaminants or cumulative effects. In addition, the parameters and thresholds used for sampling are not expressly specified.

## **5.1.4 PSCF: Compensatory Afforestation Tracking Plan**

### **Effects to be covered by the plan**

The plan is expected to address forest losses in a targeted manner (E-6 and E-7 for forest environments only) and provide indirect benefits on some physical components. However, it is also expected that it will not address hydrological effects or associated ecological functions, given its strict positioning as a compensation tool rather than an impact analysis tool.

### **Announced objectives and duration of the plan**

The Compensatory Afforestation Tracking Plan aims mainly at compensating for the permanent losses of forest area caused by the project, at a ratio of 1:1, by implementing reforestation works and monitoring over a period of 10 years to ensure a minimum survival rate of 80% of plantations. It is based on a structured mitigation sequence (avoid, minimize, restore, compensate) and is

above all a compensation and monitoring tool, with no objective of assessing the environmental impacts or ecological functions of forest environments.

The document clarifies that the PSCF does not aim to assess impacts related to ecological functions or disturbances such as groundwater fluctuations, nor does it address hydrological interactions or water quality, these elements being addressed by other plans or by the assessment of environmental effects.

### **Quantifying the vulnerability of ecosystems or communities to Project effects**

The plan details precisely the forested areas that will be cleared, temporarily or permanently, as part of the Project deployment. It identifies the species concerned and those to be replaced afterwards.

However, the plan does not assess the relationships between forest and wetland, water and hydrogeological environments. It therefore does not allow to assess the vulnerability of these environments to a total or partial loss of groundwater connection, the level of which could be lowered in some excavation areas of the Project. Similarly, it does not take into account their exposure or sensitivity to changes in surface drainage. Finally, from the perspective of communities, the plan does not include any assessment of the functions performed by these forest environments, particularly with regard to their role in slowing down and regulating components of the hydrological cycle, such as interception, runoff and infiltration.

### **Monitoring and Tracking Methodology**

The plan clearly details how to monitor the reforested areas following the construction of the Project. The estimated areas of sectors to be reforested and monitored are equivalent to a width of 5 or 12.5 metres from the railway's right-of-way.

Nevertheless, the plan does not propose monitoring the integrity of forest environments vulnerable to changes in hydrogeological conditions located within the zone of influence of the bypass construction.

### **Monitoring criteria and intervention thresholds**

The monitoring and associated criteria relate only to deforested forest environments. The current plan does not provide for monitoring or thresholds for riparian forest environments that could be affected, such as water-table retraction or drainage modification in excavated areas.

### **Actions applicable or resulting from meeting thresholds**

Again, the actions undertaken specifically concern forest areas reforested as a result of the work. They do not consider compensation for forest area that could be affected by the groundwater drawdown caused by drainage of excavation works. In this sense, no action can be taken to rectify the losses of forest cover that may result, directly or indirectly, from the effects of the Project on the environment.

### **Residual effects and risks**

The residual effects associated with the Compensatory Afforestation Tracking Plan (PSCF) remain significant, as the plan is primarily aimed at compensating for lost areas, without ensuring the full restoration of ecological functions or taking into account systemic impacts. For effects E-6 and E-7 (loss and alteration of wetlands only), a major residual effect persists. Even if reforestation compensates for the area at a ratio of 1:1, there is a temporary and prolonged loss of ecological functions (biodiversity, forest structure, connectivity, hydrological role) as long as plantations reach

a comparable functional state, which is not guaranteed. In addition, compensation is based on artificial plantations whose composition, maturity and ecological complexity differ from the environments of origin.

For E-8 (erosion and soils) and E-9 (soil saturation) effects, indirect residual effects remain and will evolve in the short, medium and long term, related to initial deforestation and changes in surface conditions (soil exposure, change in infiltration). Reforestation helps mitigate these effects over time, but does not allow for immediate recovery, and no specific assessment of these processes is incorporated into the plan.

In this sense, the PSCF is not a tool for assessing the loss or alteration of ecological functions associated with deforestation, particularly those related to the hydrological regulation of environments. Therefore, it does not assess the effects of reduced forest cover on increased runoff, decreased precipitation water infiltration and, consequently, aquifer recharge in some areas.

More broadly, the lack of a monitoring plan associated with these functions limits the ability to detect and document indirect effects of deforestation on the hydrological functioning of environments and the environmental components that depend on them. The impacts and risks resulting from these effects on ecosystems and communities have therefore not been assessed and remain moderately uncertain.

## 5.2 General plans

### 5.2.1 PGEC: Construction Environmental Management Plan

#### Effects to be covered by the plan

It is expected that the plan will cover all the initial effects of the Project, but with a partial and variable scope depending on the components concerned. For the E-1 effect (groundwater level change), it is expected to help mitigate some of the impacts associated with dewatering, excavation and drainage, notably through water level control measures and by adjusting interventions according to observed conditions. For the E-2 effect (modification of groundwater quality), its contribution is expected to remain partial, since it controls certain contamination risks, in particular those related to spills, fuel handling and soil management, while providing for some monitoring of water and well quality.

For effects E-3 and E-4 (changes in surface water flows and levels), the plan is expected to intervene to some extent through the management of diversions, drainage and in-water works, to limit hydraulic disturbances and to better control flows. With respect to the E-5 effect (change in surface water quality), it is expected to include measures to control erosion, sediment and discharges, as well as provisions governing the management of site water.

For the E-6 effect (loss of wetlands and forests), the plan is expected to contribute to reducing disturbed areas, restoring certain areas and compensating for losses. For the E-7 effect (alteration of wetlands and forests), it is expected to include targeted protection of sensitive environments, construction management and ecological restoration in response to observations to be made under the HSSP. Finally, for E-8 and E-9 effects (modification of soil structure and saturation conditions), it is expected that it will provide for various stabilization, soil management and erosion control measures, as well as indirect water monitoring to detect certain variations that may affect the soil.

### Announced objectives and effective duration of the plan

The PGEC aims to oversee all construction activities in order to prevent or reduce negative effects on the human and biophysical environment, based on mitigation measures, monitoring and environmental control integrated into all phases of the Project. It is also intended to describe the environmental commitments made by CPRC, its contractor and subcontractors during the construction and post-construction phase of the project, in order to eliminate or reduce the potential adverse environmental effects of the project. This plan meets the requirements of compensation measures CPK-QQES-23 and CPK-QQES-27.

This plan is divided into three distinct phases corresponding to the life phases of the Project: Pre-construction (6 months) and construction (3.5 years) + restoration and commissioning (6 months). For each of these phases, it defines the applicable mitigation measures, general or specific.

### Applicable Mitigation Measures

In addition to the specific plans listed above, the PGEC includes, among other things, the following mitigation measures:

- ▷ Management of vibrations generated during project construction:
  - ▶ Measure CPRC-BV-6: Detailed inspection of buildings will be carried out in areas deemed to be at risk prior to the start of blasting work (therefore at least 6 months);
  - ▶ Measure CPRC-BV-7: Implement the Vibration and Building Monitoring Plan (PSVB) during construction and comply with the conditions set out in it;
- ▷ Wetland protection and monitoring:
  - ▶ Measure CPRC-QQES-03: Do not pile up organic matter or embankments within 20 metres of a stream or wetland;
  - ▶ Measure CPRC-QQES-04: Limit deforestation as close to streams and wetlands as possible, within a distance of 20 metres or less from the high water line, preserving vegetation mat and stumps where possible;
  - ▶ Measure TC-VMH-03: Measure to conduct a targeted ecological inventory to identify at-risk wetlands and of greater ecological importance. This will identify sites where monitoring will be carried out (no reference sites);
- ▷ Accidental spill management:
  - ▶ Measure CPRC-SES-11: Deployment of the Environmental Response Plan (ERP - not assessed);
- ▷ Work on watercourses:
  - ▶ Measure CPRC-PH-06: All Project work and activities will be carried out in a manner that avoids adverse effects on fish and fish habitat by following measures enacted by DFO to protect fish and fish habitat;
- ▷ Cleaning and restoration work:
  - ▶ Measure CPRC-QQES-24: Implement the post-construction right-of-way monitoring plan (described below);
  - ▶ Measure TC-VMH-01: Implement the compensatory afforestation plan;
  - ▶ Measure TC-QQES-01: Contributions to water and wetland loss compensation funds;
  - ▶ Measure TC-VMH-02: Contributions to compensation funds for losses of water and wetlands.

The PGEC refers to two plans that are significant in terms of risk management and uncertainty reduction:

- ▷ The Environmental Protection Plan (PPE);

▷ The Environmental Response Plan (ERP).

The first, to be developed by the contractor, describes the construction procedures to meet the requirements of the PGEC. The second, which must be prepared by CPRC prior to the start of the work, aims to define the environmental response procedures applicable in the event of a spill during the construction phase. However, these two plans, which are critically important for reducing uncertainties and risks in the construction and operation phases, were not produced at the time of the analysis. Therefore, they could not be reviewed, which is a major deficiency in the assessment of uncertainties and residual risks.

### Residual effects and risks

On reading the PGEC, and in line with the previous analysis of specific plans, UDA believes that the document does not sufficiently anticipate, upstream of construction, the anticipated net losses of wetlands and forest areas (E-6), this limits the ability to quantitatively assess the design needs required to compensate for possible alterations in the hydrological regime of watersheds. This gap results in a residual effect associated with insufficient consideration of the hydrological impacts resulting from these losses on the overall functioning of watersheds.

Furthermore, the plan does not explicitly address the relationship between groundwater (E-1, E-2) and, directly or indirectly, the dynamics and water budget of watersheds (E-3, E-4, E-5). This omission results in a residual effect due to the lack of integration of interactions between different components of the water system, thus limiting the understanding and control of cascading effects between groundwater, surface water and dependent environments, such as wetlands and forests (E-6 and E-7) and soils (E-8 and E-9).

Consequently, this lack of integrated analysis results in insufficient consideration of the hydrological and hydrogeological functions of affected environments (wetlands and forests – E-6, E-7) in the listing and description of mitigation measures, which constitutes another significant residual effect of the plan.

Finally, although the PSMH is intended to address these issues, the proposed measures do not clearly distinguish the monitoring of wetlands that may be permanently affected by the operation of the project (E-6, E-7). The proposed restoration also appears to be limited to wetlands affected temporarily, leaving a residual effect related to the lack of consideration and monitoring of permanent losses and alterations of wetlands and their hydrological functions. The impacts and risks to ecosystems and communities resulting from these effects not assessed by the Project therefore remain unmitigated.

With regard to the effects of the Project on soil, the plan (PGEC) appears to be based on the implementation of measures CPRC-BV-6 and CPRC-BV-7 associated with vibration monitoring and buildings under construction. However, buildings could be damaged as a result of settling in the soil induced by the lowering of the water table in excavation areas where no blasting is planned, for example in UEH-3 north of the Chaudière River. There remains uncertainty about the buildings that will be monitored to protect them from settling in the soil that could be generated by the Project.

## 5.2.2 PSEPPC: Environmental Monitoring Plan for the Right-of-Way in the Post-Construction Phase

### Effects to be covered by the plan

It is expected that the plan will directly cover the initial E-1 and E-2 effects, by monitoring groundwater and wells in related watersheds, to document variations in level and quality, but without directly acting on their causes. It is also expected to cover effects E-3 and E-4, by

monitoring surface water flow in ditches, culverts and the deck, in order to maintain flows and prevent hydraulic disturbances, erosion and flooding.

It is also expected that the plan will cover the E-5 effect, relating to surface water quality, by means of the same monitoring measures, by making it possible to detect malfunctions likely to affect water quality, in particular those related to erosion, sedimentation or obstruction of structures. It is also expected to cover E-6 and E-7 effects, i.e. loss and alteration of wetlands and forests, by monitoring the success of revegetalization and control of invasive species, in order to promote restoration of disturbed environments and limit degradation, but without directly compensating for permanent losses.

Finally, it is expected that the plan will cover the E-8 effect, relating to soil structure, by monitoring the stability of the ground, in order to detect erosion and instability related to the works and to allow, if necessary, the implementation of corrective measures. It is also expected to contribute, indirectly and partially, to covering the E-9 effect, relating to soil saturation, by monitoring the stability of the terrain in order to identify certain effects associated with changes in saturation, but without directly controlling the causes.

### **Announced objectives and effective duration of the plan**

The PSEPPC aims to ensure the monitoring of physical and biological environments after construction and strictly within the railway right-of-way, in addition to the PGEC, in order to verify the effectiveness of the mitigation measures put in place. It aims to monitor the effects of the post-construction project on certain identified environments: Soils, surface waters, wetlands and invasive alien species.

The duration of this plan varies according to the media identified. This plan is based in particular on other follow-up plans identified previously such as the PSMH or the PSCEC. As such, only the complementary elements are analyzed in this section. This plan responds to the CPRC-QQES-24 commitments.

### **Applicable mitigation measures.**

The PSEPPC acts in the continuity of the PGEC and points to certain prerogatives of the specific plans cited in the previous sections such as the PSPEPES. In short, the plan provides few complementary mitigation measures, but allows for the setting of objectives for specific plans following construction. It thus specifies the specific objectives of several of these plans and the monitoring intervals and provides several corrective actions that may result from these monitoring measures. The plan primarily calls for the implementation of monitoring of the Project's drainage infrastructure, such as culverts. It proposes reactive rather than preventive corrective measures.

As with the PGEC, hydrological risks of flooding or erosion are not really anticipated by the PSEPPC.

In addition to turbidity and erosion monitoring, this plan could, for example, consider the systematic acquisition of quantitative data on discharge flows of drainage water from excavation areas or flowing through major culverts in order to confirm the capacity of drainage systems to contain anticipated flows. The creation of retention basins in the Project's right-of-way or the increase in culvert diameters to prevent, upstream, excessive flows in the networks would be another category of preventive actions based on the acquisitions made under the PGEC.

### **Residual effects and risks**

The residual effects selected here result from the combination of residual effects identified in the analysis of the different plans outlined above. Their size also depends on the expected performance of the various infrastructures, in particular functional compensation structures such as retention basins, whose design and dimensioning will have to be verified to ensure that they adequately

reduce the risk of flooding. It is also important to note that this plan is primarily a monitoring and correction tool, rather than a tool for preventing or demonstrating the effectiveness of the proposed measures. Consequently, its evaluation remains more limited, since it depends largely on the monitoring that will be carried out and on the nature, extent and location of the alterations that will actually be observed on the ground during the post-construction phase of the Project. In other words, the actual scope of the plan can only be assessed in the light of the impacts observed and the ability of the corrective measures to respond adequately to them.

### 5.3 Summary of effects and residual risks

Table 5-1 presents a summary of the residual effects and risks that remain after the implementation of the mitigation measures provided in the various Plans for the identified initial effects. It identifies, for each initial effect, the plan(s) that aim to address them, as well as the residual effects and risks resulting from them despite the proposed prevention, mitigation, monitoring, correction or compensatory measures. This table thus provides an integrated reading of the effects that may remain following the implementation of the analyzed plans, while taking into account their limitations, associated uncertainties and the expected effectiveness of the planned measures.

**Table 5-1 Assessment of Project residual effects (RE) related to groundwater**

E-1: Changes in groundwater levels E-2: Changes in groundwater quality						
Plans assessed related to the RE	Magnitude of the RE	Length of the RE	Consequence of the RE	Reversibility of the RE	Rationale for the assessment of the RE	Residual risks to communities and ecosystems
PSPEPES and PGEC	Low to high	Low to high	Low to high	Irreversible	Lack of a strategy for deploying actions to ensure the supply of drinking and domestic water in the event of a reported shortage of drinking water  The deadline for the PSPEPES does not cover risks that may arise in the long term of the project to the availability and quality of the groundwater resource	Private groundwater users may not be supplied quickly in the event of a drinking water shortage  Private users may experience drinking water shortages beyond the term of the PSPEPES  Loss of community confidence in the Project  Alteration and loss of groundwater-dependent environments
E-3: Reduction of water flow and/or level (surface) E-4: Increase in water flow and/or level (surface) E-5: Change in surface water quality						
Plans assessed related to the RE	Magnitude of the RE	Length of the RE	Consequence of the RE	Reversibility of the RE	Rationale for the assessment of the RE	Residual risks to communities and ecosystems
PSCES, PGEC AND PSEPPC	Low to high	Low to high	Low to high	Reversible	Lack of assessment of hydrological and hydrogeological impacts of watercourse diversions, drainage works, groundwater transfers to surface water and loss and alteration of	Private users may experience drinking water shortages beyond the term of the PSPEPES  Communities located near waterways could be at risk of flooding, alteration and loss of land use (erosion and landslides), damage to

					hydrological functions within watersheds The PSCES will not be effective in mitigating the risks of residual effects	infrastructure and civil security issues Degradation of fish habitat Loss of community confidence in the Project
<b>E-6: Loss of wetlands and forests</b>						
Plans assessed related to the RE	Magnitude of the RE	Length of the RE	Consequence of the RE	Reversibility of the RE	Rationale for the assessment of the RE	Residual risks to communities and ecosystems
PSMH, PSCF, PGEC and PSEPPC	Moderate to high	Low to high	Moderate to high	Irreversible	Absence of assessment of the hydrological functions of wetlands and forests destroyed in the right-of-way at the watershed scale and the repercussions of their loss on the hydrological balance of the Project  The PSMH will not be effective in mitigating the risks of residual effects	Same as for effects E-3 to E-5 Degradation of wildlife habitats
<b>E-7: Alteration of wetlands and forests</b>						
Plans assessed related to the RE	Magnitude of the RE	Length of the RE	Consequence of the RE	Reversibility of the RE	Rationale for the assessment of the RE	Residual risks to communities and ecosystems
PSMH, PSCF, PGEC and PSEPPC	Moderate to high	Low to high	Moderate to high	Partially reversible	Absence of assessment of the hydrological functions of wetlands and forests that could be altered (extent beyond the right-of-way) at the watershed scale and the repercussions of their alteration on the hydrological balance of the Project. The PSMH will not be effective in mitigating the risks of residual effects  The term of the PSMH (10 years) cannot cover the long-term effects of the project on wetlands and forests that can evolve over decades	Same as for effects E-3 to E-5 Degradation of wildlife habitats Risks to ecosystems and communities that may arise decades after the term of the PSMH
<b>E-8: Change in soil structure</b>						
Plans assessed related to the RE	Magnitude of the RE	Length of the RE	Consequence of the RE	Reversibility of the RE	Rationale for the assessment of the RE	Residual risks to communities and ecosystems

PSVB and PGEC	Low to moderate	Low to high	Low to moderate (soil compaction)	Irreversible (soil compaction)	Uncertainties in the consideration in the PSVB and PGEC of buildings located in areas of influence of the construction where soil compaction could occur	Buildings in construction areas could be damaged  Loss of community confidence in the project
E-9: Change in soil saturation						
Plans assessed related to the RE	Magnitude of the RE	Length of the RE	Consequence of the RE	Reversibility of the RE	Rationale for the assessment of the RE	Residual risks to communities and ecosystems
PSVB and PGEC	Low to high	Low to high	Low to high	Reversible	Lack of assessment of the effects of the Project in relation to groundwater that may impact soil saturation and structure  No consideration in the PGEC	Communities located near waterways could be at risk of flooding, alteration and loss of land use (erosion and landslides), damage to infrastructure and civil security issues  Loss of community confidence in the project

## 5.4 Lay summary of plans

This section summarizes the main Plans to monitor the environmental effects of the Project and respond as required. Each Plan plays a specific role. Some are used mainly during the construction phase. Others continue after construction. Together, they form an essential basis for supervising the Project's activities, monitoring and tracking its effects on the environment with the intent to protect it through the implementation of mitigation measures. Nevertheless, some plans could be improved to better monitor long-term effects or better protect certain environments.

**PSPEPES – Drinking Water Well and Groundwater Monitoring Plan:** This Plan aims to monitor private wells and groundwater to detect, diagnose and resolve any water quantity and quality problems that may arise at private wells. The Plan begins prior to work to assess well capacity and water quality, continues during construction, and goes on for at least two years after construction. Overall, it is a strong and well-structured plan for identifying problems and recommending solutions, but it could be improved to anticipate a faster response to water shortages and to cover a longer period of time.

**PSMH – Wetland Monitoring Plan:** This plan is used to monitor the condition of wetlands near the Project route to see if they change over time. It begins before the work and continues during construction, then until 10 years later. It documents the evolution of wetlands, but it remains quite general. It could be enhanced to better target the most sensitive media, better monitor their water-related functions and better take into account the long-term effects of their loss and alteration on dependent media.

**PSCS – Construction Monitoring Plan for Surface Waters:** This plan is mainly used during the construction phase. It aims to monitor watercourses (flow, level), water quality and signs of erosion during construction. It helps to quickly detect certain problems and correct the situation if necessary. It is a useful plan for managing the immediate effects of the work, but it alone does not provide a clear understanding of all the larger-scale or longer-term effects of the Project.

**PSCF – Compensatory Afforestation Tracking Plan:** This plan is used to monitor the reforestation planned for the compensation of forest environments that will be destroyed as part of the Project. It applies after work in areas where reforestation is planned, with monitoring over 10 years to check if plantations survive well. This plan is useful for replacing lost areas, but it does not really allow for tracking the hydrological functions of forest environments or the indirect effects of the Project on these environments outside the railway’s right-of-way.

**PGEC – Construction Environmental Management Plan:** This plan provides a general framework for site activities to reduce adverse environmental effects during preparation, construction and restoration. It applies before the work, during construction and for a short period thereafter. It combines several useful measures, but it remains general. It helps to manage the project, without addressing in detail all the risks arising from the Project effects related to water, wetlands, forests or soils.

**PSEPPC – Environmental Monitoring Plan for the Right-of-Way in the Post-Construction Phase:** This plan is used after construction to verify that certain elements in the Project right-of-way are advancing as planned, such as ditches, culverts, restored lands, some wetlands bordering the right-of-way, and some vegetated areas. Its duration varies depending on what is being monitored. It complements the other Plans and helps to correct some problems observed after construction. It is therefore a useful monitoring plan, but it is especially effective after the fact and depends mostly on what will actually be observed on site.



## 6 COMPLEMENTARY MEASURES

The evaluation of the Plans and mitigation measures planned for the Project to reduce the resulting environmental effects has highlighted the presence of residual risks to ecosystems and communities. The complementary measures proposed here are intended to address separately those risks, on the one hand, those related to the direct effects of the Project on groundwater (measures 1 and 2) and, on the other hand, those resulting from indirect effects of the Project related to groundwater (measures 3 to 9), as well as to minimize them. The following section presents the objective of each of these measures and the expected impacts. A summary of these measures in tabular form is presented in Section 6.10. Implementation mechanisms, deployment conditions and timelines are then specified in Chapter 7, based on three baseline scenarios.

### 6.1 Provide conditions for implementing response measures in the event of a drinking water shortage – M1

#### 6.1.1 Finding and objective

In the PSPEPES, the current approach consists of monitoring certain structures deemed representative in the current Project area (wells, monitoring points) and triggering interventions when a threshold is reached in order to reflect the state of the exploited aquifers and to detect drawing conditions deemed critical for users. This approach aims to monitor the state of the operated aquifers and to detect critical conditions for users. However, although the roles of the agent and the watchdog committee are well defined and a call centre for users is provided for in section 7 of the PSPEPES, the plan does not include an emergency protocol describing the interventions to be deployed to provide, without delay, the quantities of water required by groundwater users in the communities of Mégantic, Frontenac and Nantes in the event of a drinking or domestic water shortage. This deficiency limits the ability of the system to ensure a rapid, consistent and operational response in the field.

At the end of the evaluation conducted as part of this study, UDA recommends that the project proponent strengthen the PGEC (measures TC-SES-9 and TC-SES-10) by specifying the procedure to be followed when a user reports a loss or alteration in the quality of his drinking water, even if no intervention threshold has been reached. These mechanisms should be detailed in the PSPEPES to ensure the supply of drinking water to users likely to be affected by the direct effects of the Project on groundwater. Mechanisms should also allow for intervention in less than 24 hours, in order to ensure a transitional solution until the problem is diagnosed and appropriate mitigation measures are implemented.

#### 6.1.2 Expected outcomes

The expected outcomes of this measure are important for communities, since it strengthens the supply reliability for users by planning a response even before the problem is diagnosed by a professional and the causality with the Project is validated. This safety net would help strengthen the confidence of groundwater users in the Project by ensuring that any negative Project impact on users, loss of access to water or deterioration of its quality, can be dealt with quickly and the required responses are maintained until supply is restored.

This measure provides a concrete safety net for residents who depend on groundwater for their drinking and domestic water supply. It would ensure prompt action if a water supply or quality problem arises, even before a formal link with the project is confirmed. It would thus help reassure

users, reduce the impact on daily life and strengthen confidence in the planned monitoring mechanisms.

### 6.1.3 Implementation

This first measure should be implemented before construction. It requires little effort, as it consists mainly of enhancing sections of the PSPEPES and strengthening mitigation measures TC-SES-9 and TC-SES-10 provided for in the PGEC. It should take about two weeks to complete and does not require any additional fieldwork.

### 6.1.4 Risks in case of non-implementation

In the absence of this measure, residents could find themselves without drinking or domestic water for a certain time before a solution is put in place. While monitoring can identify some problems, it alone does not guarantee immediate action when the situation becomes urgent. Without a clear protocol, response times may be too long to meet the basic needs of impacted households. This situation could have a concrete impact on the daily lives of those affected and undermine public confidence in the Project and the monitoring mechanisms planned.

The complementary measure proposed in this case is simple to implement, since it consists mainly in planning in advance how to respond quickly. Failure to implement it could also result in significant costs to temporarily provide drinking water to affected citizens until the cause of the problem is confirmed and a permanent solution is achieved.

Therefore, despite the planned mitigation measures, residual risks could prove to be low to significant for communities dependent on groundwater and vulnerable to the effects of the Project.

## 6.2 Extend water monitoring for a minimum duration of 25 years following the completion of the bypass construction – M2

### 6.2.1 Finding and objective

The PSPEPES currently provides for a minimum groundwater monitoring period of two years or until the groundwater has stabilized. The plan recognizes the complexity of the aquifer systems being exploited by conditioning the termination of groundwater monitoring on the advice of a hydrogeology professional. Before the termination of monitoring is confirmed, this advice should demonstrate that the hydrogeological system studied has achieved both quantitative and qualitative stabilization.

UDA considers that such stabilization cannot be confirmed solely on the basis of inter-seasonal variability observed over a short period. Given climate change and anticipated changes in groundwater recharge and the high inertia of fractured systems, the effects of the Project on groundwater can be manifested gradually, over several years or even decades, before a new balance is established. Moreover, since stabilization also depends on climate trends, thresholds that could affect groundwater availability or quality could be reached beyond a limited observation period. Therefore, the PSPEPES should be maintained for a minimum duration that reflects the hydrological and hydrogeological processes involved. In this respect, a period of 25 years seems appropriate to assess stability at the inter-annual and inter-seasonal scale.

This recommendation aims to retain a monitoring timeframe compatible with hydroclimatic variability and aquifer response times. The World Meteorological Organization (WMO) defines climate from normals calculated over 30 years, illustrating the value of a multi-decennial timeframe for distinguishing natural fluctuations from background trends. Moreover, a 20-year period is considered in Quebec to analyze the recurrence of extreme events. Considering these references,

a minimum 25-year duration makes for a pragmatic compromise for assessing inter-annual and inter-seasonal stability, while remaining consistent with the reference climatological scale.

In addition, the PSPEPES should be linked to other monitoring and surveillance plans (PSMH, ERP, PSEPPC, etc.) and the protocols and observations resulting from them. This alignment would be aimed at ensuring consistency of methodologies, sharing findings and making full use of available data. If necessary, it would allow monitoring networks to be adjusted and response thresholds to be reviewed to improve the effectiveness of the systems. Monitoring and support efforts could thus be prioritized toward the most sensitive sectors, both in terms of the Project's effects on groundwater and the associated indirect effects.

### 6.2.2 Expected outcomes

This measure would contribute to reducing risks for groundwater users by taking into account, over a sufficient timeframe, hydroclimatic uncertainties, potential impacts of the Project on groundwater recharge and possible variations in water quality. By extending monitoring, it would improve the ability to detect gradual trends and trigger responses as needed, before a shortage or degradation situation develops. It would thus offer long-term protection to resource users and, in addition to measure 1, would strengthen the community's confidence in the monitoring and support system proposed by the Project proponent. Depending on the option chosen by the Project proponent, this measure could take two forms, either a revision of the term and content of the PSPEPES, or the development of a second monitoring plan for the operation phase. In both cases, implementation could be completed after construction, but before the current PSPEPES expires, i.e. no later than two years after completion of the work.

### 6.2.3 Implementation

The implementation of this measure is expected to require little effort, as it is essentially a matter of updating the monitoring plan. No additional fieldwork would be required and a period of about one month should be sufficient for its completion.

### 6.2.4 Risks in case of non-implementation

Without this measure, groundwater monitoring could stop too early and prevent the detection of Project effects on groundwater resource availability and quality. As a result, some residents may experience a drinking or domestic water supply problem related to the project after the end of the originally planned monitoring period. Failure to provide sufficient follow-up could delay interventions, limit the ability to adjust follow-up actions, and increase risks to groundwater users. In the long term, this situation could also maintain significant uncertainties about the actual effects of the Project and reduce community confidence in the monitoring system.

Therefore, despite the planned mitigation measures, residual risks could prove to be low to significant for communities dependent on groundwater and vulnerable to the long-term effects of the Project.

Conversely, extending the follow-up over 25 years would better identify incremental changes, distinguish natural variations from lasting Project effects, and respond at the right time. This would strengthen the protection of users and improve community confidence while ensuring long-term risk management.

### 6.3 Improve the characterization of wetlands in terms of how they relate to groundwater and surface water – M3

This measure builds on the previous findings and has two complementary objectives. First, it identifies the wetlands most vulnerable to the Project, particularly those that could lose part of their water supply (groundwater or surface water). Second, it aims to better characterize the hydrological functions of wetlands and wetland complexes likely to be influenced by the Project. This complementary measure should make it possible to anticipate the consequences of alteration or loss of these functions on the hydrological balance of catchment areas, in particular as regards drainage, temporary storage of runoff and groundwater recharge.

#### 6.3.1 Finding and objective

As mentioned, this measure has two complementary objectives. The first is to identify wetlands that are most vulnerable to the Project, including those exposed to a loss of supply due to a break in connection with groundwater or surface water. The second aims to better define the hydrological functions of wetlands and wetland complexes that may be influenced by the Project, in order to anticipate the possible impacts of their alteration or loss on the hydrological balance of watersheds.

Improving the characterization of wetlands within the CIMA+ ecological value assessment area in the EIS will have several major benefits. It will first allow for the definition of more robust indicators of sensitivity and exposure to the loss of hydrological and hydrogeological connection than those currently available. This will help better estimate the potential for degradation or loss of wetlands affected, directly or indirectly, by the Project, and thus to estimate their vulnerability. It will also help to better characterize the hydrological functions of wetlands at the watershed level, by leveraging existing data already produced, including vegetation and soils, photo analyzes and geomatics data. The cross-referencing of this information according to a structured methodology should enable a better appreciation of the role and importance of wetlands with regard to flow dynamics, both in terms of surface water and groundwater.

#### 6.3.2 Expected outcomes

Ultimately, this measure constitutes a key input to measure 4 and a condition for the deployment of measure 5 and, as the case may be, measures 6 and 7. It will specify which wetlands will need to be monitored as part of the PSMH, as well as the ecological functions to be monitored, preserved or compensated for. It will also be used to prioritize wetlands to be protected under measure 5, identifying wetlands whose hydrological functions are deemed essential. The results obtained will therefore guide the design of mitigation measures to be applied directly to vulnerable wetlands and, where appropriate, functional compensatory infrastructures (measure 7).

This measure is all the more essential as it reduces uncertainty about the extent of wetland losses associated with the Project and the possible effects involving impacts and risks to ecosystems and communities. Combined with subsequent measures, it will contribute to a more robust civil security risk assessment by linking the vulnerability of the natural environment to its ability to regulate hydroclimatic hazards.

This is essential because it provides a better understanding of the real role of wetlands in controlling surface and groundwater flows and their quality at the watershed level. It will help to better target the environments to be protected, monitored or compensated, and to design more effective measures to reduce risks to ecosystems and communities. It will also serve as a basis for the following measures, particularly for monitoring wetlands, their protection and, if necessary, the implementation of functional compensation measures.

### 6.3.3 Implementation

This measure will need to be deployed prior to construction. The effort required is considered moderate, as little additional fieldwork is anticipated due to the initial wetland condition assessment provided for in the PSMH and to be completed prior to the start of construction. Its implementation could take about six to nine months.

### 6.3.4 Risks in case of non-implementation

Without this measure, it would be much more difficult to identify wetlands that are most sensitive to the Project and to understand their role in water circulation and storage. The Project could then alter the natural balance of some watersheds without the effects being well anticipated. However, when this balance is disturbed, the consequences are often uncertain. They can also be very important in certain sectors, for example in UEH 1, 2 and 3. This is not just a groundwater issue: It could also have an impact on local biodiversity. Changes in water, wetlands or streams can affect natural habitats, change the living conditions of certain species and cause, for example, effects on fish of interest in streams. Conversely, well characterizing wetlands before the project begins also provides a solid and well-documented baseline. This protects not only the communities, but also the Project proponent, since it becomes easier to distinguish the changes that are actually attributable to the Project from those that are related to other causes. Without this better knowledge, it would become more difficult to protect the right environments, plan for effective monitoring or plan for appropriate measures. In the long term, this could increase the risk of flooding, erosion, loss of groundwater recharge, degradation of natural environments and loss of biodiversity, with potential impacts on ecosystems and communities.

Therefore, despite the planned mitigation measures, residual risks could prove to be moderate to significant for communities and ecosystems since the effects of the Project on wetlands and forests and their hydrological functions will not have been assessed to properly anticipate the consequences of their loss or alteration on watersheds.

## 6.4 Enhance the PSMH based on the results of measure 3 and extend its duration to 25 years after the completion of the bypass construction—M4

### 6.4.1 Finding and objective

This measure aims to enhance the PSMH based on the results of measure 3 and to extend its duration to 25 years after the completion of construction of the bypass. Following the implementation of measure 3, and building on the analyzes already carried out as part of the EIS and the PSMH, i.e. the initial status assessment, this measure should identify and prioritize wetlands that need to be monitored, conservation measures or, where destruction is already envisaged, functional compensation. The proposed enhancement will have to transparently and comprehensively target the sectors and wetlands targeted, based on their vulnerability to the Project and their relative importance, all functions combined.

The measure should then specify the criteria that justify additional monitoring and the methods to be applied. The selected parameters should reflect the evolution of the vitality and water supply of wetlands, their connections with hydrographic networks and groundwater, and their contribution to hydrological functions of interest. For each of these parameters, distinct and representative thresholds should be established, beyond the standardized threshold of 15% currently used in the PSMH. As with the PSPEPES, these thresholds may vary depending on the vulnerability of wetlands assessed under measure 3. The PSMH should also specify the actions to be taken when one of these thresholds is reached, whether they be preventive protection measures, restoration

measures or, where relevant, anticipated functional compensation. Control sites, where no significant impact is expected, will need to be integrated into the monitoring in order to link the observed effects to the Project.

Finally, as with the PSPEPES, the PSMH should cover a sufficiently long period to be representative of the hydrological processes involved and the life cycle of wetlands. A duration of 25 years is considered desirable to document the impacts associated with balancing the hydrosystem on which these environments depend. This duration also makes it possible to maintain a methodological linkage consistent with the PSPEPES.

#### 6.4.2 Expected outcomes

This measure aims to provide the PSMH with a clear and responsive monitoring and response framework, in order to quickly mitigate indirect impacts of the Project on wetlands and to be able to best ensure their hydrological functions within watersheds.

This measure is important because it would allow for better monitoring of wetlands that are most sensitive to the effects of the Project. It would help to better identify signs of degradation, respond more quickly, and protect hydrological functions that are useful in mitigating the impacts of the Project on ecosystems and communities. It would also make the PSMH more efficient, by ensuring that the right environments are monitored with the right service schedules, over a period long enough to observe changes that could prove critical for maintaining hydrological functions of interest within watersheds.

#### 6.4.3 Implementation

This additional measure must be implemented before construction begins. The enhanced PSMH should specify the roles and responsibilities, as well as the communication and decision chains to be applied in the event of exceeding the threshold or observed degradation. As in the current plan, field work will be required to establish the initial status of wetlands selected for monitoring.

Given the work already done, the effort required is considered moderate. The measure could be completed within a maximum of about six months.

#### 6.4.4 Risks in case of non-implementation

Without this measure, the PSMH may remain too general, too short and poorly adapted to the most sensitive wetlands. It would then be more difficult to identify signs of degradation in time, to understand the evolution of environments and to intervene at the right time. Without well-selected indicators, appropriate thresholds and clear prioritization of the environments to be monitored, certain changes could go unnoticed for several years. However, in the case of wetlands, effects may be slow to emerge; a 25-year monitoring timeframe is therefore a minimum to properly measure their evolution. Without this long-term vision, the project could lead to a gradual loss of important functions, such as water storage, flow regulation, groundwater recharge or maintenance of the ecological status of the environment, without being recognized in time. In the long term, this could increase risks to ecosystems and communities, including flooding, erosion, degradation of natural environments and water availability.

Consequently, despite the planned mitigation measures, residual risks could prove to be moderate to significant for communities and ecosystems since the effects of the Project on wetlands and their hydrological functions will not have been properly anticipated, monitored, diagnosed and mitigated to limit the consequences of their loss or alteration on watersheds.

## 6.5 Provide protection for vulnerable wetlands and wetlands of conservation interest before the work begins – M5

### 6.5.1 Finding and objective

The results of measure 3 will identify wetlands that are vulnerable to the effects of the Project on their water supply. In particular, they will need to target environments that are exposed to groundwater drawdown or surface drainage modification, as well as those whose hydrological functions are considered essential for reducing risk to communities. On this basis, and in order to reduce the uncertainty surrounding the indirect and direct impacts of the Project, the Project proponent could be required to plan, prior to construction, in addition to the mitigation measures already identified in the PSMH, the targeted protection of certain wetlands.

This measure aims to integrate, from design and before the start of work, drainage works and adjustments to maintain the water conditions of vulnerable wetlands and wetlands of conservation interest that could be indirectly affected by the Project. On the basis of the information from measure 3, the project proponent may limit the subsequent use of restoration or functional compensation. For example, in excavation areas, the establishment of head ditches could help maintain a high level of surface water and preserve hydrogeological connection with the environment. In the valley, maintaining direct and diffuse water transfers on either side of the backfilled track could also support the water supply of wetlands and best reproduce their connectivity.

### 6.5.2 Expected outcomes

By implementing this complementary measure and linking it to measures 3 and 4, as well as measure 7 where required, the Project proponent will be able to optimize the targeting and effectiveness of its interventions aimed at conserving and maintaining hydrological functions of affected wetlands.

This would protect the wetlands that are most sensitive to the Project from the outset, before they are affected. By intervening early, the Project proponent could better preserve their hydrological functions, reduce the need for restoration or compensation later, and improve the effectiveness of other planned measures. It would thus contribute to better protection of natural environments and more preventive risk management for communities.

### 6.5.3 Implementation

The definition of wetland protection interventions must be completed before the start of Project construction or, failing that, before the finalization and commissioning of permanent drainage works along the bypass. The effort required is considered moderate, insofar as the deployment of these interventions will take place at the time of construction. The targeting of the environments to be protected as well as the definition of protection interventions in the Project design should be possible in about six months.

Finally, it should be emphasized that measures 5 and 7, if the latter were to be deployed, will need to be closely aligned to ensure the consistency of the planned interventions along the Project right-of-way. Any intervention, including functional compensatory measures, must be designed in such a way as not to jeopardize the preventive protection measures provided for in measure 5.

### 6.5.4 Risks in case of non-implementation

Without this measure, vulnerable wetlands could be affected without prior protection, while it is often much more difficult to correct once impacts are observed. The Project may thus sustainably modify their water supply and lead to the loss of important functions, such as water storage, flow

regulation or groundwater recharge. It may also make remedial interventions more complex, less effective and more costly. At the watershed level, this lack of protection could increase risks to ecosystems and communities, including flooding, erosion and water availability.

Consequently, despite the planned mitigation measures, residual risks could prove to be moderate to significant for communities and ecosystems since the effects of the Project on wetlands and their hydrological functions will not have been properly anticipated in order to include in the Project design protection measures for vulnerable wetlands and wetlands of interest for the conservation of their hydrological functions.

## 6.6 Numerical modelling to assess Project impacts on hydrological balance components and the associated risks to communities – M6

### 6.6.1 Finding and objective

This complementary measure promotes numerical modelling to predict changes in the hydrological regime of watersheds crossed by the bypass. The modelling will need to integrate, on the one hand, anticipated or projected wetland losses and, on the other hand, the effects of groundwater drainage and capture during the construction and operation phase. This is a measure for evaluating the hazard, intended to quantify the expected evolution of certain hydrological balance components (runoff, recharge, peak flows, low flow conditions). It should therefore be implemented as a matter of priority in watersheds where high hydrological and vulnerable wetlands could be affected by the Project, as well as in areas with civil security issues or history. These two conditions, resulting from the outcomes of measure 3 and the preliminary analysis of the territorial context, will make it possible to adjust the scope of the work required. Depending on the case, this assessment may require further studies, including hydrogeomorphological studies and, if necessary, hydraulic studies, in order to assess the evolution of sedimentary transport, erosion, aggradation or flood risk.

The first step of this measure is to establish the initial state of drainage and the main components of the hydrological balance of the catchment areas concerned. Part of this work has already been carried out as part of the sizing of drainage infrastructures. However, these analyses were mainly focused on the planned works and did not cover all the catchment areas concerned. Further work will therefore have to consider the Project in its final state by integrating, on the one hand, the anticipated effect of the loss or alteration of wetland areas with hydrological functions of conservation interest, and, on the other hand, the transfers of groundwater to the surface network or, in some cases, to nearby watersheds.

In light of the outcomes of measure 3, the Project proponent may also need to evaluate additional scenarios, including direct or progressive losses of wetlands and a decrease in their regulatory functions. This approach will have several benefits: It will make it possible to define the thresholds for loss of hydrological functions considered acceptable in terms of hazard and risk for communities, while supporting the sizing and location of any protection infrastructure provided for in measure 5 or functional compensatory infrastructure provided for in measure 7.

### 6.6.2 Expected outcomes

The expected outcomes of this measure are important, as they will quantify the impacts of the Project and the risks to communities. They will also contribute to the scripting and sizing of the

functional compensation structures associated with measure 7. In addition, it could lead to adjustments to the PSCES and the PSEPPC, in particular through the definition of reference values and expected thresholds for quantitative and qualitative monitoring of surface waters. It is therefore a central decision support tool to reduce uncertainties and guide mitigation actions.

### 6.6.3 Implementation

This measure will need to be implemented prior to construction. The efforts required are considered moderate to significant, particularly because land acquisitions may be necessary, for example, for flow surveys in low and high water periods. Its implementation could take about six to twelve months.

### 6.6.4 Risks in case of non-implementation

In the absence of this measure, the effects of the Project on stream water flows and levels, and the risk of erosion or flooding, may remain poorly studied prior to the start of the Project. The Project proponent could then underestimate the combined effects of drainage, groundwater abstraction and loss of hydrological functions of wetlands. Without this overview, it would be more difficult to identify the watersheds most at risk, to properly target sensitive sectors and to design appropriate measures at the outset of the Project. Certain protective or compensatory structures could then be improperly sized, poorly located or less effective than expected. In the long term, this could increase risks to communities and ecosystems, including flooding, erosion, sediment transport, habitat degradation and infrastructure damage.

Conversely, this measure would provide significant added value by providing a better understanding of the hydrological functioning of watersheds to assess, at an appropriate scale, the effects of the Project and the resulting risks to ecosystems and communities. It is true that modelling takes time and can lead to significant costs, which explains why one of the scenarios for implementing complementary measures presented in Section 8 considers moving directly to compensatory measures, without carrying out this step. Despite this, modelling remains very useful, as it can show that some compensation measures may not be necessary, thereby avoiding unnecessary costs later on. It may also reveal, on the contrary, that the measures considered at the outset are insufficient or ill suited. This would allow for better predictions of floods, flood risks, the most impacted areas and the areas with the most significant potential issues. Without such a study, it would be much more difficult to accurately identify the most problematic sectors and adapt the project accordingly. It could also lead to an overvaluation of infrastructure and higher costs.

Consequently, despite the planned mitigation measures, residual risks could prove to be moderate to significant for communities and ecosystems since the Project's effects on hydrological and hydrogeological processes and the hydrological functions of wetlands, as well as the risks arising from these effects, will not have been assessed.

This measure would therefore provide the Project proponent with a more solid basis for making good decisions from the design stage and better demonstrating that risks have been seriously assessed. Conversely, this measure would provide significant added value by providing a better understanding of the hydrological functioning of watersheds prior to construction. It would better quantify the effects of the Project, reduce uncertainties, support decisions that are better suited to the site and design more effective protection or compensation structures. It would also provide the Project proponent with a more solid basis for demonstrating that risks have been properly assessed and taken into account from the design stage.

## 6.7 Provide functional compensation for wetlands of interest for lost or altered hydrological functions at Project design – M7

### 6.7.1 Finding and objective

This measure provides for the implementation of functional compensation. It aims to locate and scale the infrastructure needed to compensate for the loss of hydrological functions associated with the Project, in particular in terms of regulating runoff flows, groundwater recharge and sediment transport. It consists in designing infrastructure in the Project that will take into account the anticipated net losses of functions, so as to reproduce, as much as possible, the flow conditions that could result.

This measure will have to build on the outcomes of previous work, in particular that of measure 6 where required. It is based on the finding that financial compensation for lost wetlands alone is not enough to restore lost or impaired hydrological functions within watersheds, nor to reduce uncertainty about the associated risks to communities. Depending on the outcomes of measure 3 and the assessment, by catchment area, of the losses and alterations of hydrological functions deemed acceptable, measure 7 may benefit from scenarios allowing to specify the sizing and location of the planned infrastructures. This approach promotes preventive, targeted and efficient action by integrating the objectives of natural runoff recovery and risk reduction into the Project design.

### 6.7.2 Expected outcomes

Measure 5 will need to be closely linked to this measure (measure 7) to ensure that the planned functional compensation infrastructure does not impede preventive protection actions for vulnerable wetlands of conservation interest.

If a need for functional compensation is confirmed, this measure will generate significant benefits for communities, as it will contribute concretely to their safety and to the maintenance of natural and built assets by supporting the stabilization of hydrological processes.

If a need for functional compensation is confirmed, this measure could bring significant benefits to communities. It would allow for the integration of structures or facilities that could replace, in part, the lost hydrological functions of wetlands from the design stage of the Project. This would help better protect sensitive sectors, reduce certain risks to communities and avoid compensation based solely on financial approaches that do not actually work in the field.

### 6.7.3 Implementation

This measure will need to be implemented prior to the commencement of construction or, failing that, prior to the finalization and commissioning of the permanent drainage works along the bypass. Consistent with measure 6, its implementation may require an update of the PSCES and the PSEEPPC. The efforts required to implement this measure are considered moderate, since at first sight, the implementation of the measure does not involve fieldwork. Its implementation could take about six months.

### 6.7.4 Risks in case of non-implementation

In the absence of this measure, losses in hydrological functions of wetlands and forests may not be effectively compensated for in affected watersheds. Financial compensation alone would not replace important functions in the field, such as flow regulation, groundwater recharge or sediment transport control. Risks to communities and ecosystems could therefore remain present or even

increase over time. Conversely, when functional compensation measures are put in place, the sums provided can be invested directly in useful developments on the ground, rather than paid into a compensation fund whose benefits could materialize elsewhere and not meet the needs of the affected watershed. In this context, it is less an additional expense than a better use of available resources, for the benefit of the local ecosystem and the communities that depend on it. In summary, this measure provides for functional offsets in the Project design that will have the objectives of limiting the negative effects of the project on water flows within watersheds in order to reduce the risks to communities and ecosystems that would result.

Therefore, despite the planned mitigation measures, residual risks could be moderate to significant for communities and ecosystems if the required functional offsets within watersheds are not integrated into the Project design.

## 6.8 Develop a forest monitoring plan – M8

### 6.8.1 Finding and objective

There are currently no plans to carry out a forest monitoring plan. Like wetlands, these environments contribute to the regulation of hydrological processes at the watershed level. Their loss or alteration can influence several components of the hydrological balance, including runoff and evapotranspiration. Direct losses are already anticipated in the Project route. However, the assessment remains deficient in terms of the vulnerability of forest environments, particularly in relation to drainage and groundwater drawdown. This creates uncertainty about the extent of indirect losses likely to be associated with the project.

In this context, UDA suggests that the Project proponent develop a monitoring plan for the forest environments identified in the CIMA+ assessment area of the EIS. This plan should document the change or loss of forest species at the watershed level and, where necessary, provide for compensation measures when such losses reach a level deemed significant in terms of the hydrological balance components. In particular, the necessary information could be supplied by a specific scenario carried out under measure 6.

### 6.8.2 Expected outcomes

UDA believes that the outcomes of this measure on the communities would remain moderate considering the efforts needed to implement it and the expected relative impact on existing hydrological dynamics. Indeed, it appears at first sight that efforts will have to be focused primarily on maintaining wetland functions before that of forest environments. However, the results of measure 6 may be used to confirm or disconfirm the relevance of implementing this measure.

### 6.8.3 Implementation

If this measure is adopted, it must be finalized before the work begins. Its implementation could take place over a period of six to twelve months and require a moderate to significant effort, in particular due to the establishment of a complete initial state of the monitored areas and the completion of the necessary field work.

### 6.8.4 Risks in case of non-implementation

In the absence of this measure, losses or degradation of forest environments could go unnoticed, especially if they appear slowly after work has begun. It would then become more difficult to know if these changes are related to the Project, drainage, groundwater drawdown, or other causes. This uncertainty would limit the ability to properly document the evolution of environments, provide timely response, and provide, if necessary, appropriate protection or compensation measures.

While wetlands remain a priority, forest areas also play an important role in the hydrological balance of watersheds. Their degradation can exacerbate some effects on runoff, infiltration, soil stability and habitat quality.

Therefore, despite the planned mitigation measures, residual risks could be moderate for communities and ecosystems if alterations and losses of forest environments are not adequately monitored and compensated for within watersheds.

## **6.9 Inspect buildings included in the construction's areas of influence of the construction where soils prone to settlement will be dewatered – M9**

### **6.9.1 Finding and objective**

As part of the Project construction work, some excavation and dewatering operations are planned. Although the risk of land subsidence associated with these interventions is considered low, slight uncertainty remains regarding the vulnerability of buildings located in the areas of influence of the work. In addition, along the Chaudière River in the excavated area near MP 27+000, there are cohesive silty and clay soils, likely to present a risk of settlement. In this context, and given the industrial nature of the sector, UDA suggests that the Project proponent carry out an inspection of the initial condition of the buildings concerned.

### **6.9.2 Expected outcomes**

The expected outcomes for communities are considered moderate, given the low risk level and the limited number of buildings involved. However, they could be higher if the nature of the activities or materials found at the impacted sites increased the risk, particularly in an industrial context.

The proposed measure clarifies and complements the provisions already contained in the PGEC, in particular measures CPRC-BV-06 and CPRC-BV-07. It could also lead to an adjustment of the vibration monitoring and building inspection plan.

### **6.9.3 Implementation**

This work will need to be completed prior to excavation and construction, and will require onsite visits. The efforts required are considered moderate and the intervention should be possible over a period of one to two months.

### **6.9.4 Risks in case of non-implementation**

Without this measure, damage to buildings may not be properly identified and documented prior to the start of the work. This would make it more difficult to determine whether cracks or other degradation are caused by the Project, induced settling, or pre-existing conditions. This could complicate complaint management, delay corrective action and increase uncertainty for affected owners. In areas where soils prone to settlement are present, particularly in industrial contexts, this could also increase the risk of disputes and reduce confidence in the Project.

Therefore, despite the planned mitigation measures, residual risks could be low to moderate for communities since some buildings located in sensitive areas could suffer damage without their initial condition having been documented to ensure detection and management.

Conversely, implementing this measure would make it possible to establish a clear and well-documented initial state, better protect residents as the Project proponent, and facilitate the prompt handling of situations that might arise during the work.

## 6.10 Summary of measures

Table 6-1 below summarizes the proposed complementary measures to reduce the uncertainties and residual risks associated with the effects of the Project on groundwater and dependent environments. For each of the measures, it specifies the type of effect intended, whether direct or indirect, the recommended implementation phase, the level of effort required, whether or not field work is required, the estimated duration of implementation and the main expected outcomes. The purpose of this table is to provide an overview of the proposed measures and to facilitate their comparison in terms of their scope, implementation requirements and expected contribution to reducing risks to communities and ecosystems.

**Table 6-1 Summary of proposed additional measures**

Measure 1 (M1) – Provide conditions for deployment of implementing response measures in the event of a drinking water shortage					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Direct effect	Prior to construction phase	Low	No	2 weeks	Ensure drinking water supply in less than 24 hours
Measure 2 (M2) – Extend water monitoring for a minimum duration of 25 years following the completion of the bypass construction					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Direct effect	In the operating phase or at the latest before the end of the term of the PSPEPES	Low	No	1 month	Reduce risks to groundwater users related to climatic uncertainties, the impact of the Project on groundwater recharge and groundwater quality
Measure 3 (M3) - Improve the characterization of wetlands in terms of how they relate to groundwater and surface water					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate	Yes	6-9 months	Prioritization of wetlands and decision support tool for the implementation of other mitigation measures
Measure 4 (M4) – Enhance the PSMH based on the results of measure 3 and extend its duration to 25 years after the completion of the bypass construction					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate	No (initial state)	6 months	Ensure targeted monitoring of vulnerable wetlands and wetlands of interest
Measure 5 (M5) – Provide protection for vulnerable wetlands and wetlands of conservation interest before the work begins					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate	Yes	6 months	Protective measures to mitigate the negative effects of the Project on wetlands and their hydrological functions
Measure 6 (M6) - Numerical modelling to assess Project impacts on hydrological balance components and the associated risks to communities					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate to High	Yes	9-15 months	Confirm the capacity of the river system to support changes to the project's

					water balance and quantify the risk to communities
Measure 7 (M7) - Provide functional compensation for wetlands of interest for lost or altered hydrological functions at Project design					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate	Yes	6 months	Deploy preventive infrastructure to reduce risks to communities
Measure 8 (M8) - Develop a forest monitoring plan					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate to High	Yes	6-12 months	Adequately compensate for the modification or loss of forest species within watersheds
Measure 9 (M9) - Inspect buildings included in the construction's areas of influence where soils prone to settlement will be dewatered					
Type of effect on groundwater	Implementation phase	Effort	Fieldwork	Duration	Outcomes
Indirect effect	Prior to construction phase	Moderate	Yes	1-2 months (continuous)	Reduce uncertainty as to the initial condition of buildings that could be impacted by soil compactions induced by groundwater drawdown

## 6.11 Lay summary of complementary measures

This section summarizes the key complementary measures proposed to better protect water, natural environments and communities. These measures are aimed primarily at better preventing problems, improving monitoring and follow-up mechanisms over time and responding more effectively to impacts.

### M1 - Provide for prompt response in the event of a drinking water shortage

This measure is to ensure that people affected by a loss of drinking or domestic water can receive assistance quickly, even if the exact cause of the problem is not yet confirmed. It would prevent residents from being left without water for several days and increase confidence in the Project.

### M2 - Extend water monitoring to 25 years

This measure aims to monitor changes in groundwater much longer after the work. As some effects may appear slowly, prolonged monitoring would better detect changes, reduce uncertainties and protect private well users more sustainably.

### M3 - Better characterize wetlands and how they relate to water

This would help better understand which wetlands are most vulnerable and what functions they perform in watersheds. It would better target the environments to be protected, monitored or compensated for, and improve the assessment of risks to the environment and communities.

### M4 - Enhance wetland monitoring and extend it to 25 years

This measure aims to make wetland monitoring more accurate, targeted and adapted to the most sensitive environments. It would allow for better detection of degradation, earlier response and monitoring of the Project effects over a period long enough to observe late changes.

**M5 – Protect the most vulnerable wetlands in advance**

This measure consists in providing, before the work, concrete means to protect certain wetlands deemed sensitive or important for the conservation of their ecological functions, including the regulation and filtration of water. By acting preventatively, it would be possible to limit damage before it occurs and reduce the need for restoration or compensation afterwards.

**M6 – Use modelling to better predict the Project’s effects on water**

This measure would allow for a more accurate estimate of the Project’s effects on stream water flows and levels, sediment transport, or to assess erosion and flooding risks. It would help to better understand the sectors most sensitive to the risks involved and to design more effective protection or compensatory measures.

**M7 – Provide functional compensation for lost or altered wetlands**

This measure is intended to concretely compensate for certain lost or altered hydrological functions due to the Project, such as water storage, surface water flow regulation, groundwater recharge or water filtration. It would allow for more direct action in the affected catchment areas rather than relying solely on financial compensation.

**M8 – Develop a forest monitoring plan**

This measure would be used to monitor changes in forest environments that could be indirectly affected by the Project, in particular due to the drainage of the railway track which will result in a groundwater drawdown. It would better document losses or degradation and provide, where necessary, forest compensation measures, including reforestation within the affected watershed.

**M9 – Inspect buildings in areas at risk of settlement**

The purpose of this measure is to verify the condition of buildings in areas where soil could move or collapse due to changes in water levels in the soil. It would better identify sensitive areas, limit damage to property and better protect affected communities.



## 7 SCENARIOS FOR IMPLEMENTING COMPLEMENTARY MEASURES

Scenarios for implementing complementary measures must meet two requirements. On the one hand, they must support informed decision-making, based on a rigorous and representative assessment of the risks to ecosystems, territories and communities. On the other hand, they must optimize the timetable for implementing complementary measures in order to maximize their efficiency, complementarity and the reduction of residual uncertainties and risks related to the Project.

Implementation must also take into account operational constraints. This includes the temporal sequence of measures, the complementarity of intermediate and final deliverables, the seasonality of some field work. In addition, there are issues related to communication arrangements, as well as the clear division of roles and responsibilities among the various stakeholders, which are essential for consistent and effective implementation.

In this context, three implementation scenarios are proposed as decision-support tools. Each scenario aims to reduce uncertainties by providing a better understanding of the risks and natural functions involved, while promoting consistent alignment and greater complementarity between the proposed measures.

Whatever the scenario chosen, certain parameters remain essential. Measures 1 and 2 will therefore have to be implemented separately. As for measure 9, it may be the subject of an independent evaluation, in order to confirm its relevance, the timing and possible conditions of its implementation.

The three proposed scenarios, A, B and C, all reduce the residual risks attributable to the Project, although there will always be some uncertainty, the significance of which will depend on the implementation scenario selected. If none of these scenarios are implemented, several risks may remain present or become more difficult to manage. Some residents may have problems with drinking or domestic water supply, sometimes after the end of the initial monitoring operations. Progressive effects on groundwater, wetlands, forests and watersheds could also go unnoticed for several years, delaying response. In the long term, this could increase the risk of flooding, erosion, sediment transport, habitat degradation, loss of biodiversity, damage to certain buildings or infrastructure, as well as loss of important natural functions such as water storage, groundwater recharge and flow regulation. It could also maintain a lot of uncertainty about the actual effects of the project, complicate the analysis of causes, result in additional costs, and reduce community confidence in the Project's ability to properly manage its effects over time.

The three proposed scenarios cover the same risks and all aim to reduce them. However, they will allow for a different response to the objectives pursued by the proposed complementary measures. The difference between them is mainly in the progression of measures, their implementation order and the time required to achieve them. The option of selecting no scenario should not be considered, as it would leave significant residual risks in place. The objective of this section is to guide the operations to be carried out by choosing the scenario best suited to the situation, the challenges encountered and the available leeway in the sequencing of measures.

### 7.1 Conservative scenario (A), focused on risk control

#### 7.1.1 Conservative scenario logic (A)

The conservative scenario is based on a rigorous risk management approach. It is based on a structured methodical assessment of the hazards and vulnerabilities of territories and communities exposed to the indirect effects of the Project. It is intended to ensure that risks to communities are adequately assessed prior to the start of the Project's construction.

This scenario favours sequential implementation of the measures and allows more time for their implementation. This approach allows for greater flexibility, especially when the actual duration of certain steps remains uncertain. It provides for several measures to be conditional on the results of the previous steps. Figure 7-1 shows the flowchart associated with the scenario, while Figure 7-2 illustrates its timeline, including the period and estimated duration of implementation of each measure.

Figure 7-1 Typical flowchart of the conservative scenario (A), focused on risk control

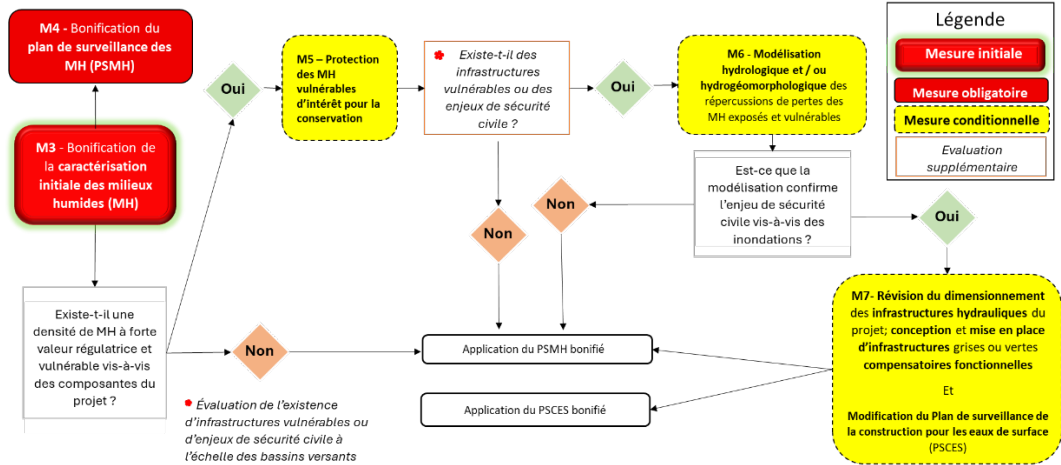
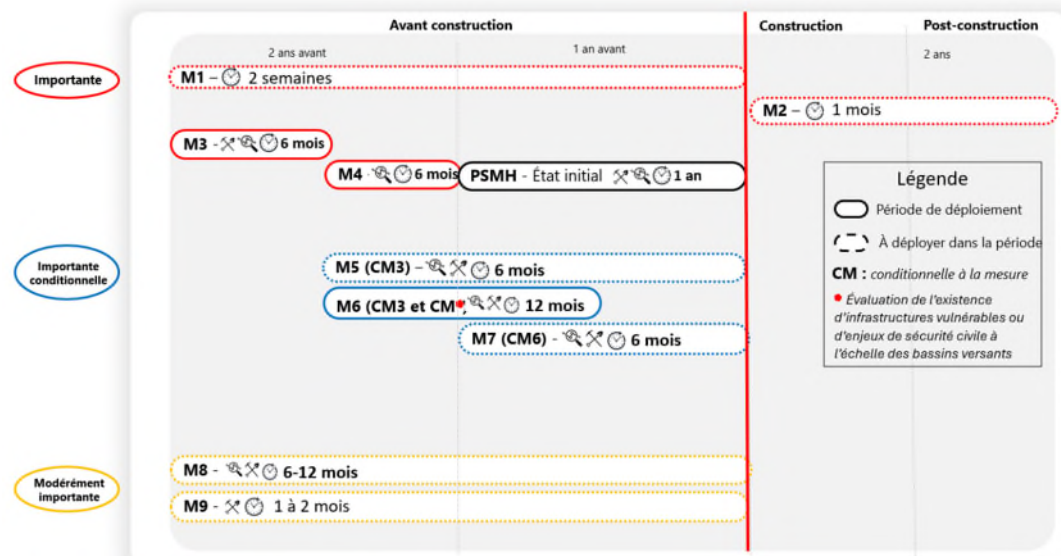


Figure 7-2 Timing of complementary measures in the conservative scenario (A), focused on risk control



### 7.1.2 Decision-making pathway

In this scenario, measure 3 is the starting point for the reasoning and decision chain that may or may not lead to the implementation of conditional measures (5 to 7). Its results should confirm, at the watershed level, the presence of wetlands of high hydrological value and wetlands vulnerable to Project components.

- ▷ If measure 3 confirms the presence of wetlands with high hydrological value and vulnerability, the implementation of measure 5 may be recommended in order to integrate, from the design stage, appropriate mitigation measures;
- ▷ If this condition is not met, certain conditional measures foreseen in the following steps may not be deployed, their relevance will depend on the outcomes achieved at this step;
- ▷ In all cases, measure 4, which aims to improve the PSMH, will have to be deployed following measure 3 and lead to the establishment of the initial state, an essential step provided for in the PSMH.

In parallel with measures 4 and 5, the project proponent will have to carry out an in-depth assessment of the presence of vulnerable infrastructure and civil security issues in watersheds where measure 3 will have highlighted wetlands with high hydrological value and vulnerable wetlands. A history of loss events, such as flooding, erosion or land movements, may serve as relevant indicators to characterize the issues and level of risk associated with these territories.

In the absence of significant territorial history or issues, conditional measures 6 and 7 may not be retained, even if vulnerable wetlands or wetlands with high hydrological value are present. On the other hand, if these two conditions are met, measure 6 will have to be implemented in the watersheds concerned in order to confirm or eliminate the risks to communities, particularly in terms of civil security.

Where certain conditional measures are not required, the establishment of the initial wetland state under the PSMH could be done, at least in part, in parallel with measure 4. It can also be reduced by relying on the data acquired in the framework of measure 3 and previous characterizations.

This scenario is based on a sequential progression of conditional measures, where each step relies directly on the results of the previous one. It makes it possible to better adapt the scale and location of interventions, in particular with regard to the functional compensation structures associated with measure 7, based on a finer understanding of flow dynamics. This helps to limit the potential impacts and risks associated with the Project.

This approach promotes gradual and informed decision-making on the implementation of subsequent conditional measures. In this sense, this scenario is described as conservative, as it offers more flexibility than the other scenarios for the implementation of complementary measures and uses a sequenced approach to implementation. It also reduces the number of measures that need to be implemented when the environments are not of significant conservation interest and the risk is considered non-existent or acceptable.

### 7.1.3 Estimated duration

The effective duration for this scenario is estimated to be two years before the start of work, which remains a conservative assumption if all complementary measures are to be implemented. However, this estimate remains dependent on the season in which the work begins and on field constraints, which reinforces the conservative nature of this scenario by offering room for adaptation in the event of unforeseen or delays.

## 7.2 Optimized scenario (B), focused on risk control

### 7.2.1 Optimized scenario logic (B)

As with Scenario A, optimized Scenario B aims to adequately assess risks before work begins. However, it is distinguished by the simultaneous implementation of several measures and the relaxation of certain preconditions for their implementation. This scenario is based on a close linkage between the measures, their sequencing and the continuous sharing of intermediate results between the consultants of the different studies.

This approach optimizes efforts and should reduce the time required to implement additional measures before construction. However, it has a tighter timeline, which limits the ability to adjust interventions based on intermediate outcomes achieved during the process.

Figure 7-3 presents the flowchart associated with this scenario, while

Figure 7-4 illustrates the timeline, including the period and estimated duration of implementation of each of the measures.

Figure 7-3 Typical flowchart of the optimized scenario (B), focused on risk control

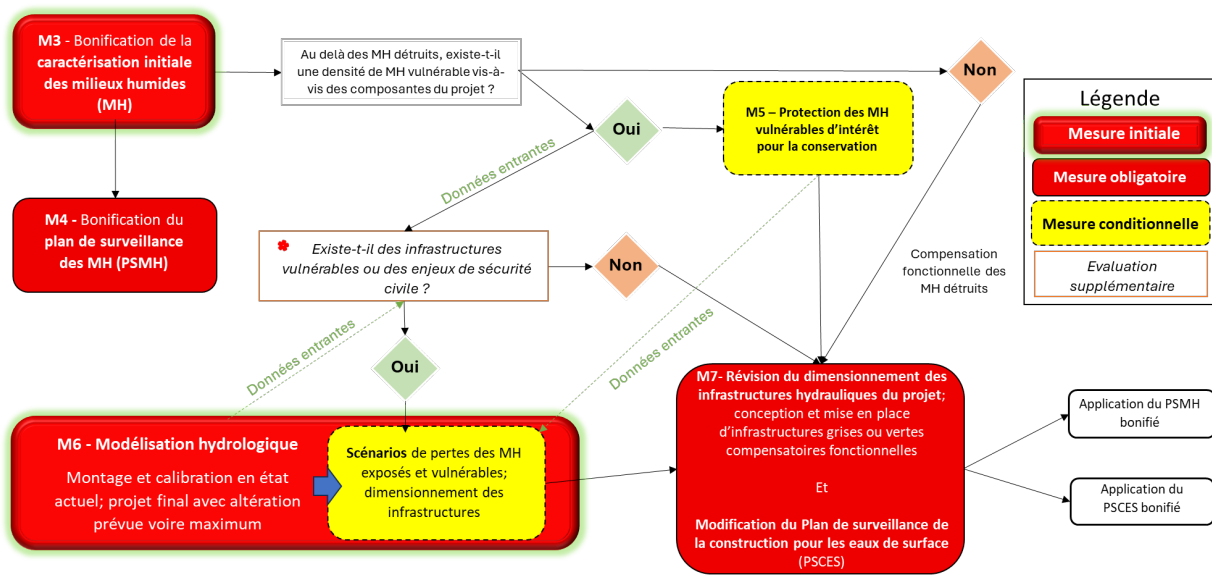
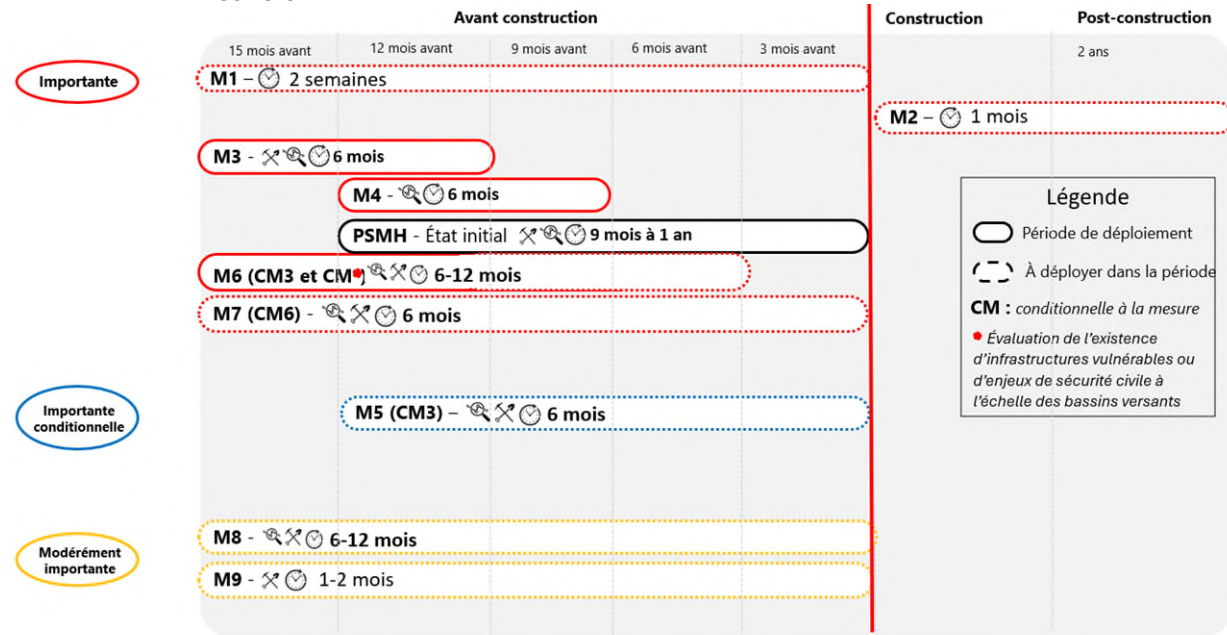


Figure 7-4 Timeline for complementary measures of optimized scenario (B), focused on risk control



### 7.2.2 Decision-making pathway

In the optimized scenario, measures M3, M6 and M7 are implemented from the outset. However, the implementation of measure M5 remains conditional on the results of measure M3, in particular the confirmation of the presence of vulnerable wetlands with significant hydrological value to regulate peak flows for surface water and groundwater recharge. This measure is thus the only conditional measure in this scenario. This scenario is based on strong coordination between interventions. Methodologies and data exchange between measure M3 and the assessment of the initial state of the PSMH will need to be aligned to limit field efforts. A grouping of some field campaigns between studies will also be possible. This scenario is also based on the valorization of existing data and geomatic analyzes to reduce delays, which makes it possible to consider a joint performance of measure M3 measure and the initial state of the PSMH over a shorter period (allowing 9 to 12 months). Measure M4, as well as the PSMH update, should then be performed from the measure M3 outcomes.

As regards measure M6, it will be implemented in parallel with the characterization of the hydrological functions of wetlands of measure M3. It will be implemented in two stages. Initially, this measure consists in developing a hydrological model representative of the current state of the environments and watersheds. It must also include a complementary reference scenario corresponding to the final project considered, including the direct loss of wetlands as well as the

transfer of groundwater flows from excavation areas. In a second step, and depending on the results of measure M3 and the identification of significant wetlands, a third scenario dealing with the loss of hydrological functions and the associated risk assessment could be carried out. This two-step approach optimizes implementation times. Thus, if the results of the preliminary studies do not justify a third modelling scenario, the study could be finalized early. As for scenario A, the Project proponent will then have to specify the issues found in the territories concerned and define an acceptable level of risk. This concept will establish the acceptable rate of loss of wetlands of interest not to be exceeded under a complementary scenario, if applicable.

Measure M7 can be considered from the outset to evaluate functional compensation options for wetlands already recognized as of interest for the conservation of hydrological functions as part of the initial characterization of CIMA+/WSP. These compensations could also be integrated into the initial numerical modelling scenario of measure M6. Subsequently, the results of the modelling scenarios, combined with the assessment of risk and acceptability, will allow the development and adjustment of more precise functional compensation (M7) scenarios, including the integration of infrastructure adapted to the watershed scale.

This scenario is therefore based on continuous iterations between measures M3, M6 and M7. These dynamics make it possible to gradually adjust the analyzes and the solutions proposed, in order to ensure that the compensation measures are well sized, consistent with the identified issues and effective at the territorial level.

### 7.2.3 Estimated duration

The goal of achieving this in 12 months appears ambitious. An intermediate period between Scenario A and this objective seems more likely, in the scale of 15 to 24 months. In this optimized scenario (B), simultaneous implementation of all measures from the outset is likely to result in higher costs than in Scenario A.

## 7.3 Optimized scenario (C), focused on maintaining hydrological functions of wetlands

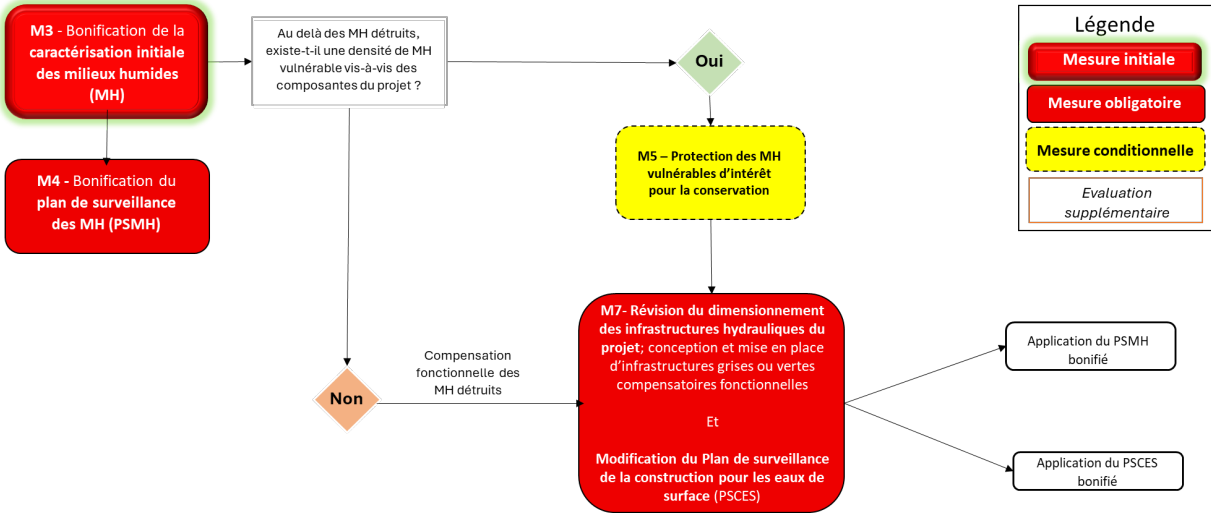
### 7.3.1 Optimized scenario logic (C)

In this optimized scenario (C), which focuses on maintaining wetland hydrological functions, a systematic approach to protection and functional compensation of wetlands that are lost or considered vulnerable in terms of their hydrological and filtration functions is recommended. Unlike other scenarios, it provides for systematic functional compensation of wetlands that will be destroyed by the project. In addition, it relies on the PSMH developed in measure M4 to guide interventions to compensate for wetland alterations and losses that will be observed and attributable to the Project, without specifying at the outset the sizing or location.

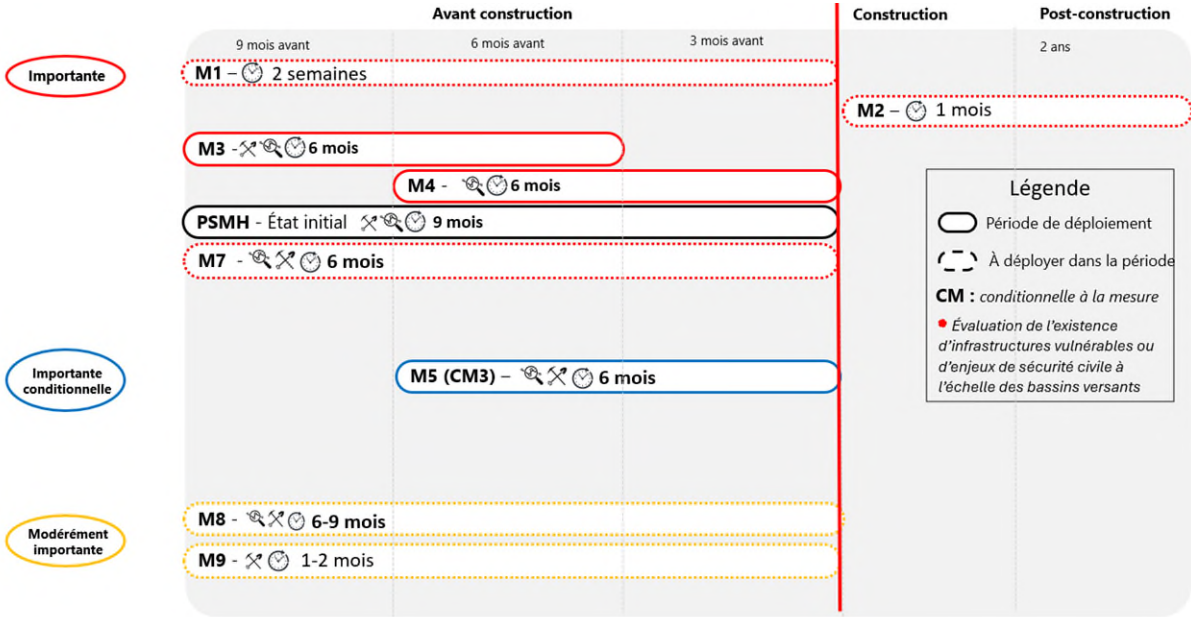
This approach is based on the outcomes of measure M3 in order to integrate into the PSMH the implementation of functional compensatory measures in the event of reaching thresholds associated with the loss of function evaluated since the initial state. It accelerates the deployment of interventions before construction. On the other hand, it entails a risk of inaccuracy in the targeting of measures and offers less certainty as to their real effects on the hydrological balance and on the dynamics of watersheds.

Figure 7-5 presents the flowchart associated with this scenario, while Figure 7-6 illustrates the timeline, including the period and estimated duration of implementation of each of the measures.

**Figure 7-5 Typical flowchart of the optimized scenario (C), focused on maintaining wetland functions**



**Figure 7-6 Timeline for complementary measures of the optimized scenario (C), which focuses on maintaining hydrological functions of wetlands**



**7.3.2 Decision-making pathway**

The decision-making pathway for this scenario is simpler than the previous scenarios. This scenario (C) excludes measure M6 from the outset and, therefore, does not condition the implementation of measure M7 to numerical modelling analyzes. As with scenario B, the measures must be

implemented in parallel. This approach requires rigorous methodological linkage, data sharing, the realization of a single coordinated field campaign, the valorization of existing characterizations and an increased use of geomatic analyzes.

As in the previous scenario (B), measure M5 remains the only conditional measure. Its implementation will depend on the results of measure M3, which will confirm the vulnerability and relative importance of exposed wetlands.

As in scenario B, measure M7 is considered from the outset to compensate for functional losses in wetlands that are already expected to be destroyed. Measure M4 will then have to incorporate the required adjustments. It will also need to define the conditions and compensation arrangements for wetlands that may suffer degradation or loss of function over the course of the Project. In principle, this compensation should be applied systematically when the wetland concerned is considered to be of conservation interest, in particular because of its role in flow processes. However, this importance remains relative in the absence of in-depth analysis and cannot be fully confirmed or quantified in terms of risk regulation for communities.

In this model, measure M7 could be redeployed whenever the application conditions described in the PSMH require it. Thus, reaching a threshold may, for example, trigger a review or the addition of infrastructure. As a result, there is a high level of uncertainty in this scenario. This uncertainty concerns both the management of risk for communities, the scale of the effort required, the efficiency of the infrastructure (sizing and location in watersheds) and the associated costs. Furthermore, in the absence of numerical modelling, the risk of inadequately designing functional compensatory infrastructures, particularly with regard to their sizing and location within watersheds, remains real. Such a situation could compromise their sustainability and efficiency, and further deregulate hydrological processes at the watershed level.

### 7.3.3 Estimated duration

Of the three scenarios proposed, this is the shortest. Its theoretical duration could be reduced to about nine months. However, this shorter time depends on the implementation of measures M3 and M4 and the systematic application of functional wetland compensatory measures at the watershed level, which could result in significant additional costs during the operation phase of the bypass.

## 7.4 Lay summary of scenarios

Three deployment scenarios for the nine complementary measures, identified by UDA, have been established and all aim to reduce the risks arising from the effects of the Project on groundwater and dependent environments in order to better protect communities and ecosystems from the risks involved. The difference between them is mainly due to the level of conservatism, the time required to carry out the additional measures and the level of knowledge sought before deciding on the measures to be put in place.

### Scenario A – Conservative scenario, focused on risk control

This scenario is the most comprehensive and conservative. It consists in taking the time to better understand the effects of the Project before implementing all the measures. This further reduces uncertainties and better targets the most useful actions to protect environments and communities. It begins with an enhanced characterization of wetlands, which is used to determine whether additional measures are really needed. If this step confirms the presence of vulnerable wetlands that are important for the conservation of their restored ecological functions, protection measures can be provided from the design stage, while the wetland monitoring plan must be improved in all cases. If no ecosystem and community protection issues are considered important in the watersheds concerned, numerical modelling and functional compensation may not be necessary;

if risks are confirmed, they are then implemented to better manage impacts. This scenario therefore moves step by step, adapting the interventions according to the results obtained, which makes it possible to better target efforts, limit unnecessary measures and reduce the risks of poor design. This is the most cautious and flexible approach, but also the longest, with an estimated duration of about 24 months before the start of the work.

### **Scenario B – Optimized scenario, focused on risk control**

This scenario seeks a balance between conservatism and efficiency. It keeps the steps considered the most important to properly manage the risks, but it allows for faster implementation by carrying out certain steps concurrently. Protection of vulnerable wetlands remains the only conditional measure, as it depends on the outcomes of enhanced wetland characterization to confirm which wetlands are most sensitive and most important for conservation. In addition, numerical modelling is done in two stages: First to represent the current state and the final project, and then, if necessary, to more accurately assess the effect of anticipated losses and alterations in wetland hydrological functions and the associated risks. This scenario therefore makes it possible to gradually adjust the proposed solutions thanks to the efficient communication between consultants of the data and results obtained from the characterization, modelling and design of wetland protection and compensation measures to be applied within watersheds, this makes it a structured and optimized approach, while reducing delays compared to scenario A. its maximum duration is estimated at approximately 15 months.

### **Scenario C – Optimized scenario, focused on maintaining hydrological functions of wetlands**

This scenario is the simplest and fastest, as it does not include numerical modelling before moving to functional compensation for wetlands that will be destroyed in the Project's right-of-way. As with the previous scenario, the measures are implemented concurrently, which requires meticulous coordination, a well-planned field campaign and rigorous data sharing. Protection of vulnerable wetlands remains the only conditional measure, as it depends on the results of enhanced wetland characterization. This scenario, however, involves a higher level of uncertainty, notably due to the lack of risk assessment for communities through hydrological modelling and the absence of useful data for the design of functional compensation structures and their positioning within watersheds that could compromise their effectiveness. This scenario is faster, but also less cautious than the other two in terms of overall risk control. Its maximum duration is estimated at approximately 9 months.

In summary, scenario A is the safest, but also the longest (24 months), scenario B seeks the best compromise between conservatism and speed (15 months), and scenario C allows for faster action (9 months), but with a higher level of uncertainty regarding the achievement of the objectives of the complementary measures identified by UDA.



## 8 CONCLUSION AND RECOMMENDATIONS

### 8.1 Conclusion

UDA’s analysis shows that the Project’s effects on groundwater and their dependent environments are plausible, interrelated and, for many of them, still imperfectly accounted for in the technical and environmental documents filed with the Canadian Transportation Agency (CTA). The temporary or permanent drawdown of the groundwater table, caused by the construction of the railway track and its drainage during the operation phase, is the main effect of the Project on groundwater. This effect can lead, directly or cascading, to impacts on the availability and quality of groundwater for private users. It can also modify the exchanges between groundwater and surface water, as well as their flow dynamics and quality. It can also affect wetlands and forests, their hydrological functions, and soil stability and saturation. These impacts can lead to risks for communities. These include the loss of access to quality water for users, the loss of use and enjoyment of the territory, as well as civil security issues.

The examination of the draft studies, the EIS, and the management, monitoring and tracking plans shows that several effects of the Project were well recognized by the Project proponent. However, their quantification, integration and consideration in the Project design as well as in the proposed mitigation measures or compensation measures remain incomplete in several respects. In particular, the indirect, cumulative and delayed effects of the Project at the watershed level remain insufficiently documented. This limitation concerns in particular the interactions between the drainage of the railway track, the drawdown of the water table, the loss or alteration of wetlands and forests, the modification of surface water flow regimes, the evolution of aquifer recharge, as well as the risks that may result for communities and ecosystems.

UDA’s analysis of the Drinking Water Well and Groundwater Monitoring Plan (PSPEPES) shows that this plan can reassure users regarding maintained access to drinking water despite the permanent and irreversible effects of the Project on groundwater. The plan appears robust. However, its application period, limited to two years after construction, may be insufficient to cover the long-term effects of the Project on the recharge of the water table, in combination with those expected from climate change. In addition, the absence of an emergency protocol in the event of a drinking water shortage to ensure the rapid supply of drinking and domestic water is a major deficiency.

Conversely, UDA’s analysis of the Wetland Monitoring Plan (PSMH) shows that it remains incomplete, unrobust and marred by several methodological deficiencies. In its current form, therefore, it does not adequately maintain the ecological functions of wetlands, including their hydrological functions, at the watershed level. Moreover, its duration of application, limited to 10 years, appears insufficient in view of the timeframe horizon on which the long-term effects of the project are likely to manifest themselves on wetlands.

UDA’s analysis of construction and post-construction management plans also shows that several plans on file are primarily based on reactive logic. This approach has a significant limitation, particularly for surface waters, wetlands and forests. Indeed, the anticipated impacts related to their loss or alteration at the watershed level should be assessed prior to the construction of the Project. In addition, the risks that may result for communities should also be analyzed beforehand, in particular the risk of flooding for sectors located downstream of watercourses, including the city of Lac-Mégantic.

It is necessary to take these impacts and risks into account in order to integrate, as soon as the Project is built, measures for the protection and functional compensation of wetlands and forests, adapted to the needs that will be deemed priority.

Therefore, UDA’s analysis reveals uncertainties about the effects of the Project on groundwater and dependent environments. It also identifies gaps in the monitoring and tracking plans and in the

mitigation measures or compensation measures intended to reduce impacts and risks to ecosystems and communities. Despite these findings, we do not see any potential residual groundwater environmental impact at this stage that is irreversible, impossible to mitigate and likely to compromise the feasibility of the Project.

However, UDA believes that, in its current form, the technical file identifies several major issues, but does not satisfactorily demonstrate that all significant effects of the Project on groundwater and dependent environments will be adequately prevented, monitored, mitigated or compensated for. Consequently, any authorization for the Project should, according to UDA, be accompanied by explicit additional conditions in order to reduce critical uncertainties, strengthen prevention and response mechanisms, and ensure that mitigation measures and compensation measures are proportionate to the anticipated impacts.

Following its analysis of the documents filed with the CTA, UDA has identified nine complementary measures to be implemented to limit the effects and risks for communities, some of which are conditional. For the most part, these measures should be implemented prior to Project construction to reduce uncertainties and residual effects and risks to groundwater and dependent environments from the Project. Complementary measures are therefore the subject of recommendations.

## 8.2 Recommendations

Based on the overall analysis in this document, UDA makes the following recommendations:

- ▷ Provide explicit conditions for the implementation of emergency response measures in the event of loss of access to drinking water or deterioration of its quality.

The PSPEPES should be enhanced in order to explicitly provide for immediate actions to be taken when a user loses access to drinking water or when the quality of the water becomes unsuitable for use, including in the interval between two monitoring campaigns. This recommendation aims to avoid significant impacts on users occurring without a rapid and proportionate response.

- ▷ Extend monitoring of at-risk drinking water wells and groundwater, surface water, wetlands and forests for a minimum of 25 years following completion of construction.

The duration currently foreseen in several plans appears insufficient in view of the potential temporality of the Project's effects. An extension of monitoring is considered necessary to take into account delayed, cumulative or evolutionary effects, particularly in the context of climate change and gradual readjustment of hydrological and hydrogeological systems.

- ▷ Improve the characterization of wetlands in terms of their hydrological functions and how they relate to groundwater and surface water.

This characterization should make it possible to identify the environments most vulnerable to the Project, those that play an important role in hydrological regulation of watersheds, as well as those that are of priority interest for conservation. It should also improve the establishment of baseline status and better target the environments to be monitored.

- ▷ Improve the PSMH based on the results of this characterization and extend its effective period.

The PSMH should be based on a clear prioritization of monitored environments, include control sites, provide response levels adapted to the functions monitored and allow the monitoring of alterations beyond the initially selected strip when the vulnerability of the environments warrants it. Its duration should also be aligned with that recommended for other long-term environmental monitoring.

- ▷ Provide, prior to the start of work, measures to protect vulnerable wetlands and areas of conservation interest.

Where certain wetlands or forests contribute significantly to hydrological regulation or risk reduction to communities, protective measures should be incorporated into the design and phasing of the work. This recommendation aims to reduce functional losses before they materialize.

- ▷ Carry out numerical modelling to assess the impacts of the Project on the components of the hydrological balance at the watershed scale.

This modelling should integrate groundwater inputs from excavations, losses and alterations of wetlands and forests, and assess possible effects on flows, water levels, erosion, flooding, and risks to communities. It should make it possible to assess whether functional compensatory measures are to be expected to reduce anticipated impacts and risks. The analysis will support, if required, the selection, sizing and positioning of functional compensatory structures.

- ▷ Provide for functional compensation for wetlands whose hydrological functions will be lost or altered.

UDA recommends that compensation should not be based solely on financial or surface logic, but should aim at maintaining or restoring equivalent hydrological functions, ideally at the scale of the affected watersheds. The Quebec framework for wetland and water conservation highlights the importance of the ecological and hydrological functions of wetlands in environmental analysis.

- ▷ Develop a monitoring plan for forest environments exposed to the hydrogeological effects of the Project.

This plan should monitor the integrity of forest environments that may be affected by environmental fragmentation, loss of hydraulic connectivity or groundwater depletion. It is expected to complement the PSCF, which currently remains focused on compensating deforested areas. The timeframe should align with that of the PSMH.

- ▷ Pre-inspect the buildings and infrastructure located in areas at risk of soil settlement.

This recommendation is particularly aimed at areas where cohesive or sensitive soils are found and where deep excavations and groundwater drawdown are anticipated. It should be accompanied, if necessary, by specific monitoring of the buildings exposed during and after the work.

As for the scenarios for the implementation of the identified complementary measures, the analysis shows that a conservative scenario or at least an optimized scenario with a strong focus on risk control appears to be the most consistent with the residual uncertainty level that remains. The most robust scenarios are those that allow action to be taken before impacts materialize, to better document hydrological functions of affected environments, to extend monitoring time and to provide clear intervention and adaptation mechanisms. Conversely, an approach that is too limited to minimal monitoring or financial compensation alone does not seem sufficient to meet all the anticipated effects. Therefore, the estimated duration for the deployment of these measures is in the window 9 to 24 months before the start of the work, depending on the feasibility of carrying out certain measures in parallel.

Finally, it is important to mention other general recommendations:

- ▷ Requiring the filing and assessment of missing plans, including the Environmental Protection Plan and the Environmental Response Plan, before work begins.

These documents are necessary to adequately assess the management of accidental contamination risks and the proponent's response capacity during construction and operation. Their absence is currently a significant gap in the overall assessment of the case.

- ▷ Subjecting the Project authorization to conditions for conducting adaptive reviews of the monitoring and tracking plans.

In the event of unanticipated effects that are more extensive or longer-lasting than expected, the proponent should be required to adjust the monitoring networks, response thresholds, mitigation measures and, if necessary, functional compensation measures. This approach is particularly important in a context where some hydrological functions and cumulative effects remain partially uncertain.

- ▷ Prioritizing the most conservative deployment scenario or, failing that, an optimized scenario with a strong focus on risk control.

In view of the residual uncertainties and the potentially irreversible nature of some effects, UDA recommends that the CTA prioritize an implementation scenario that focuses primarily on complementary knowledge acquisition, prevention, protection of the most vulnerable environments and long-term monitoring, rather than a minimal scenario based primarily on reactive impact management.

Overall, the ultimate objective of these recommendations is to ensure that the effects of the Project are sufficiently known, monitored, anticipated and addressed to reduce risks to communities and ecosystems, improve the proportionality of the proposed mitigation measures and compensation measures, and support conservative regulatory decision-making based on an adequate level of information.

It should be noted that upon CTA's request, UDA obtained comments from CPRC and TC on the content of this report. However, these comments do not change in any way our findings and recommendations, which remain unchanged. They are based on the available information and data at the time of our analysis of the Project documents filed with the CTA. Our recommendations are set out as nine complementary measures, out of which three are conditional. We consider that these measures are relevant to reduce uncertainties related to the Project's environmental effects that were identified following the analysis of the Project's documents. Our recommendations are consistent with a proactive assessment and management approach for risks to communities and ecosystems that could arise from these effects. Finally, we acknowledge that since the filing of the Project documents with the CTA, further work has been conducted. Therefore, the data and outcomes obtained from this work could be used for implementing the complementary measures proposed as part of our assessment of the Project documents submitted by the CTA.

June 8, 2026



DÉVELOPPER, DANS LE RESPECT DES MILIEUX

# Appendix A

## Statement of work (SOW)

**Statement of Work (SOW)**

Work Order No: 744840

**Provision of expert technical advice to the Canadian Transportation Agency  
regarding hydrogeological aspects of the proposed Lac-Mégantic Rail Bypass**

For the Canadian Transportation Agency (Agency)

Date: **2026-01-22**

## 1. Title

The Canadian Transportation Agency (Agency) requires a hydrogeologist (Contractor) to provide expert technical advice regarding the proposed location of the Lac-Mégantic Rail Bypass.

## 2. Background

On July 6, 2013, a freight train made up of 72 tank cars carrying crude oil derailed in downtown Lac-Mégantic, leaving 47 people dead. In 2018, the Prime Minister of Canada and the Premier of Quebec announced project funding for a 12.5 km rail bypass in order to avoid freight rail going through Lac-Mégantic’s downtown core.

At Transport Canada’s request, on September 19, 2025, [CPKC filed with the Agency an application](#) to construct the rail bypass, pursuant to section 98 of the *Canada Transportation Act*. The purpose of the Project, as articulated by the Government of Canada, is “promoting the collective wellbeing of the Lac-Mégantic community”<sup>4</sup> and “to help the community of Lac-Mégantic move forward and mitigate the traumatic effects associated with the accident.”<sup>5</sup>

CPKC’s application includes extensive technical studies, as well as [environmental mitigation measures](#) proposed by CPKC and Transport Canada (TC).

An important element of the application is the assessment of the hydrogeology of the area and the potential hydrogeological impacts of the project. The application highlights the fact that there is no detailed hydrogeological model of the region, and therefore that there is a wide range of uncertainty regarding the potential impacts (“insignificant to significant”) of the project on potable water wells, wetlands, surface water, and forest/agricultural lands. There are also some other considerations, such as the fact that the Quebec government<sup>6</sup> has specifically prohibited mineral exploration or mining in the area that could harm the underground aquifers, that are not mentioned in the application.

The Agency is an [independent regulator and quasi-judicial tribunal](#) with a mandate to ensure the transportation system runs efficiently in the interests of all Canadians. This includes reviewing applications and approving the construction of railway lines such as the

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<sup>4</sup> Government of Canada (Transport Canada), April 2022, *Lac-Mégantic Rail Bypass*, “Newsletter Issue no 1 – April 2022” (online: <https://tc.canada.ca/en/rail-transportation/lac-megantic-rail-bypass/newsletter/issue-no-1-april-2022>).

<sup>5</sup> Government of Canada (Transport Canada), June 2023, *Lac-Mégantic Rail Bypass*, “Decision of Minister and Statement of Reasons” (online: <https://tc.canada.ca/en/rail-transportation/lac-megantic-rail-bypass/decision-minister-statement-reasons>).

<sup>6</sup> Arrêté numéro AM 2006-040 du ministre des Ressources naturelles et de la Faune en date du 19 octobre 2006.

proposed rail bypass. The Agency has launched a public [consultation process](#) on the project, which will end on January 30, 2026.

### 3. Purpose, Scope and Requirements

The Agency is seeking hydrogeological expertise to review the evidence on file and to provide an analysis of that evidence and technical advice.

The Contractor **must**:

1. Review the Agency's records, including:
  - CPKC's Environmental Effects Evaluation (EEE)
  - TC's environmental management plans (EMPs)
  - Hydrogeological studies commissioned by CPKC or TC
  - Technical opinion letters on hydrology issues (e.g. NRCan letter)
  - Any other relevant documentation
2. Assess groundwater and hydrogeological risks, taking into consideration uncertainties revealed by field data since 2021. Specifically, opine on whether the remaining uncertainty regarding the hydrogeology of the region is such that there is a reasonable risk that a significant part of the groundwater will be lost or contaminated.
3. Analyze the potential irreversibility, immitigability and materiality of residual water-related environmental impacts based on CPKC's application, and taking proposed mitigation measures and EMPs into account.
4. Evaluate the robustness and performance effectiveness of the proposed mitigation measures, and the relevant monitoring plans, including
  - The Groundwater and Potable Well Water Monitoring Plan (GPWWMP)
  - The Wetland Monitoring Plan (WetMP)Specifically, opine on whether the measures identified in these two monitoring plans would be sufficient to avoid and mitigate the impacts of a significant loss or contamination of groundwater during construction and over the long term.

Advise to what extent further studies could reduce the uncertainty regarding the hydrogeology of the region, and specify what these further studies would entail in terms of field work, analysis and timelines.

In keeping with the confidentiality of the Agency's decision-making process, the contractor will be required to keep its work under the contract confidential. The Agency intends to publish the final report submitted by the Contractor as stipulated in Section 5 below and the Contractor would be notified beforehand.

#### 4. Tasks

The Contractor **must** perform the following tasks:

- **Task 1:** Attend a preliminary discussion with Agency staff regarding the application for authorization of the Lac-Mégantic Rail Bypass Project, the purpose and scope of the contract, and the reference documentation.
- **Task 2:** Submit a workplan including timelines and deliverables necessary to complete the following Tasks.
- **Task 3:** Review the Agency’s records, prepare assessments, and prepare the briefing noted in Task 4 and the presentation noted in Task 5.
- **Task 4:** Present a verbal briefing to the Agency to share initial observations and findings in response to the requirements outlined in Section 3 above.
- **Task 5:** Submit a draft report and make a presentation to the Agency on final findings and advice in response to the requirements outlined in Section 3 above.
- **Task 6:** Finalize and submit report, taking into consideration comments provided by the Agency during the presentation provided as part of Task 4.

For these tasks, all meetings will take place virtually.

The Contractor **must** deliver all items within the timelines in Section 5.

#### 5. Contract Deliverables, Duration and Milestones

The contract period extends to **September 30, 2026**.

Deliverables must be submitted using an approved receipt form to:  
**Luc Chamberland, Project Authority**

Task No.	Deliverables	Frequency	Delivery Date*
1	Preliminary discussion with Agency staff	Once	Within one week following

Task No.	Deliverables	Frequency	Delivery Date*
			the contract award date
2	Workplan	Once	2 weeks following contract award date
4	Verbal briefing with Agency to share initial observations and findings	Once	4 weeks following the contract award date
5	Draft report with presentation to Agency	Once	8 weeks following the contract award date
6	Final report	Once	10 weeks following contract award date

\*Reasonable extensions to the delivery dates could be granted with prior approval from the Project Authority

### Formatting Requirements:

Draft and final reports: MS Word and PDF, in English *or* French.

Briefing materials (virtual meetings): PowerPoint or PDF.

### 6. Project Authority

All questions must be directed to Contracting Authority. If clarity is required, the Contracting Authority will reach out to the Project Authority.

### 7. Accessibility Criteria

The *Accessible Canada Act* is intended to enhance the full and equal participation of all persons, especially persons with disabilities, in society. This is to be achieved through the

progressive realization, under federal jurisdiction, of a Canada without barriers, particularly by the identification, removal and prevention of barriers.

In accordance with the Treasury Board Contracting Policy and the *Accessible Canada Act*, federal departments and agencies must consider accessibility criteria and features when procuring goods or services.

**All electronic non-web documents (e.g., PDF, Microsoft Word and PowerPoint) must be in an accessible format. Accessible templates will be provided by the Project Authority.**

## **8. Acceptance**

The Project Authority must acknowledge the acceptance of deliverables under separate correspondence. If the Consultant has not received a notification to the contrary within ten (10) working days, the deliverables will be considered to have been accepted.

## **9. Government Furnished Equipment (GFE)**

No GFE will be provided to the Consultant.

## **10. Project Cost and Method of Payment**

The Agency estimates that the level of effort required to complete the work under this Contract is approximately forty (40) working days. If, at any point during the performance of the work, the Contractor determines that the estimated level of effort is insufficient to complete the requirements of the Contract, the Contractor must notify the Contracting Authority in writing as soon as possible.

This tasking will be performed as a Limit of Expenditure Contract with monthly invoicing based on the level of effort.

## **11. Security Requirements**

There are no security requirements associated with this contract as the Consultant is not expected to access any confidential information.

## **12. Location of Work**

The work is to be performed at the Consultant Owned Site.

### 13. Travel

There is no travel associated with this contract.

### 14. Key Reference Documents

The following is the list of reference documents will be provided to the Consultant by the Project Authority as part of this contract. These documents will be provided in electronic format and are not confidential.

#### Relevant Project and Hydrogeology Related Reports

- 1. Englobe 2024.** Investigation hydrogéologique Voie de contournement ferroviaire du Lac-Mégantic, Lac-Mégantic (Québec).
- 2. LNA 2025 - Laforest Nova Aqua inc. 2025.** Plan de surveillance des puits d'eau potable et des eaux souterraines (PSPEPES).
- 3. CIMA+ 2025.** Plan de suivi des milieux humides.
- 4. NRCan, July 24, 2025.** Voie de contournement ferroviaire de Lac-Mégantic, Québec – Avis d'expert en hydrogéologie Commission géologique du Canada (CGC), Ressources naturelles Canada.
- 5. CPKC – Technical Note, August 8, 2025.** Megantic Bypass Project: CPKC Technical Comments on Natural Resources Canada and CIMA+ Opinion Letters about Potential Additional Studies on Groundwater and Connected Surface Waters.
- 6. Project Application Submitted on September 19, 2025.**

**This SOW and its contents have been:**

**Prepared By:**

X

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Tanmay Praharaj  
Senior Manager

**Reviewed By:**

X

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Mariah Sunohara  
Contracting Authority

**Approved By:**

X

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Luc Chamberland  
Director



DÉVELOPPER, DANS LE RESPECT DES MILIEUX

# Appendix B

## Qualifications of UDA Team Members

# RESUME



**CINTIA RACINE**  
**CPI, MSc (6039473)**  
**PROJECT DIRECTOR IN HYDROGEOLOGY**

## EDUCATION

2015-ongoing PhD – Soils and Environment, Université Laval  
2003-2005 Master's degree – Hydrogeology, INRS – Eau Terre Environnement  
1998-2002 Bachelor of Geological Engineering, Université Laval

## SUMMARY OF EXPERIENCE

Ms. Racine has 23 years of experience in the field of hydrogeology. She has participated in numerous characterization and hydrogeological modelling projects related to the environmental, agricultural and municipal fields (drinking water supply and groundwater vulnerability analysis), etc. Over the years, Ms. Racine has developed expertise in physical and numerical modelling of flows in porous media with variable saturation as well as in real-time data assimilation.

Here are some examples of tasks performed by Ms. Racine:

- ▷ Hydrogeological studies to meet various needs:
  - Application for a certificate of authorization;
  - Water withdrawal permit application (Bauval Inc. and Graymont (QC) Inc. quarries in Quebec);
  - Impact assessment;
  - Assessment of groundwater resources and their vulnerability;
  - Modelling groundwater flow and mass transport, etc.;
- ▷ Determination, by numerical modelling, of groundwater withdrawal protection areas in more than 30 cities and municipalities, involving various catchment contexts:
  - Granular, fractured rock or mixed aquifers;
  - Confined, semi-confined or unconfined aquifers;
  - Wells, infiltration gallery, drain, etc.;
- ▷ Mass transport modelling:
  - Relevant experience: Modelling of regional and local aquifers in the Bagotville sector and simulation of mass transport;
- ▷ Project management for groundwater research and drinking water supply;
- ▷ Management and planning for the research project on the development of a guide for the design and operation of subriver water intakes (PESF) in Quebec for drinking water supply;
- ▷ Physical modelling of the PESF concept in a laboratory setting – capture/backwash;
- ▷ Monitoring of full-size systems design and operation work (PESF);
- ▷ Study of Canada-United States and interprovincial transboundary aquifers;
- ▷ Study on the types of drinking water supply in Canada and uses;
- ▷ Modelling and assimilation of data for the development of a predictive model of underground irrigation in cranberry cultivation in Quebec;
- ▷ Study of alternatives to control groundwater plumes contaminated by dense and light immiscible liquids in

Ville-Mercier.

## **CAREER PATH**

Since 2025 Groupe Conseil UDA Inc., Director of Hydrogeology Projects  
2022 to 2025 Akifer Group Inc., a subsidiary of UDA Consulting Group Inc., Senior Project Manager for hydrogeology projects  
2019 to 2022 Akifer Group Inc., Senior Project Manager in Hydrogeology  
2008-2015 INRS - Eau Terre et Environnement, Research Professional  
2006-2007 Geological Survey of Canada, Research Professional

## **PROFESSIONAL ASSOCIATIONS**

Quebec Order of Engineers



# Maxime Dubé

Biologist, MSc

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## Position at UDA:

Director and biologist  
Ecology and environmental  
compliance approvals

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## At UDA since: 2014

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## Education:

### 2012

Université Laval -  
Master in Environmental  
Biogeosciences

### 2010

Université du Québec à  
Trois-Rivières - Bachelor of  
Biological and Ecological  
Sciences

### 2007

Cégep de Sorel-Tracy - DEC  
in Environment, Occupational  
Health and Safety

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## Association:

Association des biologistes du  
Québec No. 3116

## PROFESSIONAL PROFILE

Maxime Dubé is a biologist specializing in plant ecology, particularly in the characterization of the natural environment, whose fields of expertise include the identification of environmental issues, the delineation of wetlands, surveys of plants of conservation interest and wildlife surveys. He also has high proficiency in the provincial and federal regulatory framework for the environment.

For the past twelve years at UDA, he has participated in various projects related to the conservation of floristic species of conservation interest, identification of environmental issues and application of laws and regulations in various levels of government.

Since joining UDA in 2014, Mr. Dubé has been involved in site investigation activities prior to various projects and participated in more than 50 applications for ministerial authorizations. He has participated in numerous environmental characterization studies, including the description of terrestrial, wetland and aquatic environments.

As a versatile biologist who can proactively contribute to any type of environmental project or study involving the characterization of the natural environment or the assessment of vegetation, wetlands or wildlife, he is recognized for his flexible and dynamic approach, as well as for his extensive multidisciplinary knowledge.

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## AREAS OF EXPERTISE

- ▷ Plant ecology
- ▷ Strategic support in project planning
- ▷ Management of multidisciplinary projects
- ▷ Team management
- ▷ Knowledge of federal and provincial regulations
- ▷ Development of compensation projects



## PROFESSIONAL EXPERIENCE

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### **SINCE 2014: UDA CONSULTING GROUP INC. — BIOLOGIST AND DIRECTOR**

- ▷ Strategically supporting clients through the environmental assessment and authorization process
- ▷ Participating in coordination and planning meetings with the client team and regulatory authorities
- ▷ Specialist in plant ecology (at-risk species, vegetation, wetlands)
- ▷ Participating in major project inventory programs
- ▷ Drafting ecological studies and professional opinions
- ▷ Coordinating activities and review deliverables

### **Since 2025: Métaux Osisko inc. – Reference studies for a mining development project in Gaspésie**

Copper mine development project in Gaspésie. UDA was mandated to conduct a baseline study covering various valued components, including ichthyofauna, wetlands and vegetation, in order to acquire the base knowledge necessary to complete the Environmental Impact Assessment (EIA) of the Project. The baseline study was to meet the requirements of the federal *Impact Assessment Act* (IAA, 2018) and the *Environment Quality Act* (EQA, chapter Q-2).

### **2025: Hydro-Québec – Reconstruction of the Quyon-Wyman line in the Outaouais region – Environmental assessment**

Reconstruction of the centenary line 1376 located between the Quyon and Wyman substations (10 km) in the Outaouais region to increase HQ's power grid reliability. UDA had the mandate to carry out floristic and wildlife surveys to give an overview of the elements of ecological interest found there and assess the potential impacts of the project on the environment.

### **2025: City of Drummondville – Preliminary characterization study**

Conducting a preliminary ecological characterization to identify and delineate wetlands and water environments on a city property as part of an industrial development project.

### **Since 2024: Énergir s.e.c – Installation of a gas pipe by directional drilling (Vachon bridge) – Applications for ministerial authorizations**

The project aimed to relocate a section of gas pipeline currently attached to the Vachon bridge (Highway 13) connecting Laval to Boisbriand. The new section of the pipeline is constructed north of the Vachon bridge by directional drilling over approximately 1.5 km under the Mille-Îles River. The mandate included the preparation and filing of applications for authorization to the provincial government and the application to Fisheries and Oceans Canada (DFO) for a license under the *Fisheries Act*. The mandate also involved seeking a compensation project for fish habitat losses and approving this project with DFO. The firm participated in Indigenous consultations. Finally, the services rendered included the proposal of mitigation measures for the construction period.

### **2024 – Ongoing: Kruger Energy – Les Jardins Wind Project - Impact Study (EQA)**

As part of a wind project in the Napierville region, Kruger Energy commissioned UDA to carry out the environmental impact assessment (EIA) of the wind project area.

### **2024: City of Sorel-Tracy – Surveys of species of conservation interest on the territory**

Assessment of the potential presence of species of conservation interest and floristic and wildlife surveys in priority survey areas for the City of Sorel-Tracy, which account for 1,532 ha.

### **Since 2023: Clearlight Energy – Canton MacNider Wind Project - impact Assessment (LQE)**

Construction and operation of a new wind farm located in Saint-Damase and Saint-Noël, in the RCM of La Matapédia. UDA was mandated to prepare all documentation related to the impact assessment process, participate in BAPE sessions and liaise with landowners by signing option contracts.

**Since 2023: Dépôt Rive-Nord – Ecological studies for the expansion of the LET in Saint-Thomas**

Conduct ecological characterization studies on study areas totalling 224 ha in the municipalities of Sainte-Geneviève-de-Berthier and Saint-Thomas, in the Lanaudière region. The objective of this study was to identify the environmental considerations present in the study areas. The firm is also involved in environmental studies to support the Environmental Impact Assessment (EIA) at the selected site in St. Thomas.

**2023-2024: Quebec Ministry of Transport and Sustainable Mobility (MTMD) – Several bridge rehabilitation projects in the Laurentides and Lanaudière regions**

As part of a framework agreement with the MTMD, UDA has been mandated to support the MTMD in various bridge and road rehabilitation projects. The firm provided support for the application of the regulatory framework, the characterization of wetlands and water, the delineation of the coastal boundary and the drafting of technical reports.

**2023: City of Laval – Biological characterization – Natural environment restoration project**

The City of Laval mandated GREBE Inc., a subsidiary of UDA, to carry out a biological characterization to support the submission of a funding application for a restoration project under its regional wetland and water plan.

**2023: City of Québec – Ecological characterization study of a former snow disposal site - Industrial project in Québec City**

To obtain ministerial authorizations to redevelop a former snow disposal site (hereinafter “the site”) into a centre for the management of surplus excavation materials and the treatment of contaminated soil, UDA has been commissioned by its subsidiary Akifer to carry out an ecological characterization study of the partially developed site.

**2022-2023: Intragaz – Environmental services - Industrial project in Pointe-du-Lac**

Application for ministerial authorization for a project to modify Intragaz’s facilities at the Pointe-du-Lac station, Quebec. UDA participated in the ministerial authorization application, coordinated the implementation of certain sectoral studies (groundwater and surface water) and carried out the ecological characterization study of the site.

**2020-2021: City of Montreal – Ecological vegetation audit - Mount Royal heritage site**

Ecological vegetation audit of the Mount Royal Heritage Site to update and refine certain knowledge to guide the development requirements, future interventions and management of these sites. This mandate targeted 16 sites totalling nearly 265 ha of area. Ecological characterization of these woodlots required 404 survey stations. This mandate was carried out in partnership with GREBE Inc, a subsidiary of UDA.

**Since 2020: Montreal Pipe Line Ltd. – Various applications for authorization to the MELCCFP for maintenance work in wetlands, waterfalls and/or riparian areas**

Pipeline Infrastructure Maintenance and Optimization Program (pipelines) of Pipeline Montréal Ltd. UDA has been mandated to carry out several dozen applications requiring detailed ecological characterizations for maintenance sites in water and wetlands. Several applications for permits under the *Species at Risk Act* (SC 2002, c 29).

**2019-2023: Infrastructure Canada – Environmental monitoring at Lapierre Island for habitat loss compensation project**

Monitoring of compensatory wildlife developments carried out on Lapierre Island for the construction work of the new Samuel-De Champlain bridge in partnership with Tetra Tech. UDA had the mandate to carry out the herpetofauna monitoring for three years.

**2018-2019: Énergir - Natural gas service - Industrial-Port area in Saguenay – EIS**

Construction of a 13.8 km gas pipeline in Saguenay (borough of La Baie) to supply natural gas to the ZIP. UDA has been mandated by the proponent to carry out the environmental impact study.

### **2017–2018: Énergir - Extension of the network in Bellechasse (Chaudière-Appalaches)**

Project to extend the natural gas network in Chaudière-Appalaches (Saint-Henri, Saint-Anselme, Sainte-Claire, Saint-Lambert-de-Lauzon, and Lévis) for ± 71 km. UDA was mandated to obtain permits and authorizations from federal (TC, DFO), provincial (MELCC, MFFP, CPTAQ) and regional authorities, and also to carry out environmental monitoring of the work.

### **2016: Canadian National (CN) - Ecological characterization of natural environments in Saint-Hyacinthe**

Project to install new culverts in the railway right-of-way due to the extension of a boulevard, resulting in the diversion of a watercourse and the destruction of part of a wooded area. UDA had the mandate to carry out a biophysical characterization of the natural environments to be impacted.

### **2015-2021: TQM / TC Energy Pipeline – Various applications for authorization to the MELCCFP for maintenance work in wetlands, waterways and/or riparian environments**

Completion of several dozen applications for authorization with the MELCC requiring ecological characterizations, assessment of environmental issues, survey planning, floristic survey and delineation of wetlands in the field, the identification and location of floristic species of conservation interest as well as drafting ecological characterization studies

### **2014–2017: TC Energy - Energy East Pipeline Project**

Pipeline project (4,600 km) between western and eastern Canada, including 650 km in Quebec to transport 1.1 million barrels of crude oil per day. UDA was mandated to carry out ecological characterization in addition to obtaining permits and authorizations from several governmental and municipal authorities.

## **2013 to 2014: SAVARIA CONSULTANTS – BIOLOGIST, NATURAL ENVIRONMENT PROJECT MANAGER**

### **Various mandates within the company:**

- ▷ MRC Pierre-de-Saurel : Environmental monitoring during work in watercourses
- ▷ XM Naturae: Ecological characterization of the Saint-Timothée marsh in Beauharnois-Salaberry Park
- ▷ Private real estate company: Several floristic surveys in Laval for residential projects
- ▷ Riparian owner (individual) in Saint-Michel-des-Saints : Restoration of fish habitat (environmental advisor and monitoring of restoration work)
- ▷ Transport Serge Beauregard Inc. : Installation of culverts in a watercourse in Saint-Jacques-le-Mineur (biophysical characterization of the aquatic environment)

## **2012 to 2013: RIO TINTO, IRON AND TITANIUM INC. – ENVIRONMENTAL ADVISOR**

### **Various mandates within the company for many projects**

- ▷ Relocate a colony of *Carex folliculata* (species of special status) for ministerial authorization
- ▷ Apply for ministerial authorization to the MELCCFP
- ▷ Enforcement of environmental laws and regulations
- ▷ Coordinate air sampling campaigns
- ▷ Technical procedures related to environmental protection
- ▷ Application of environmental management systems
- ▷ Supervision of decontamination of sites
- ▷ Environmental monitoring in the factory and on construction sites

## **2009 to 2010: ST. LAWRENCE VALLEY NATURAL HISTORY SOCIETY ECOMUSEUM — BIOLOGIST**

### **Map turtle population study – Lac des Deux-Montagnes**

The project consisted of carrying out a herpetological survey in order to identify the critical habitats used by the map turtle. Locating nesting sites, tracking the relocation of individuals in subsequent years, and compiling data were part of the tasks.

**2006 to 2008: RIO TINTO, IRON AND TITANIUM INC. – ENVIRONMENTAL TECHNICIAN**

**Various mandates within the company**

- ▷ Collection, compilation and analysis of various environmental data (dust, surface water quality, etc.)
- ▷ Conduct sampling (soil, air and water) according to recognized MELCCFP protocols
- ▷ Assessment of the effects of the company's activities and equipment on the surrounding environment
- ▷ Coordination of residual hazardous materials management
- ▷ Residents' meeting (management and follow-up of environmental complaints)
- ▷ Supervision of decontamination operations
- ▷ Employee awareness of various issues

# RESUME



**JÉRÉMIE ROQUES**

**SENIOR PROJECT MANAGER IN HYDROGEOLOGY**

**MSc HYDROGEOLOGY**

## EDUCATION

- 2013 Master's degree "Hydrogeology, Soil and Environment" with honors – Université d'Avignon et des Pays de Vaucluse (France):
- 2010 License "Land and water" with honors – University of Avignon and pays de Vaucluse (France):
- 2009 Technological University Degree "Biological Engineering" option: "Environment" – Université de Perpignan, via Domitia (France)
- 2007 Bachelor of Science, specialized in Life and Earth Sciences with honors - Lycée Docteur Lacroix, Narbonne (France)

## SUMMARY OF EXPERIENCE

Mr. Roques has nearly 15 years of professional experience in hydrogeology, hydrology and, more broadly, integrated watershed water management. His experience, both transversal and integrated, acquired internationally in diverse physical, socio-economic and environmental contexts covers various fields ranging from regulatory application to spatial analysis, geographic information management and the co-construction of solutions with territorial stakeholders in order to meet the hydroclimatic and development challenges they face. In addition, he has participated in several study and research projects involving hydrology, hydraulic and hydrogeological modelling with the aim of facilitating the characterization and sustainable management of water resources at the territorial level. In Quebec, Mr. Roques participated in the deployment of numerous projects associated with vulnerability analyses of drinking water sources, the development of community resilience to climate change hazards or the development of standardized protocols and procedures for characterizing and monitoring hydroclimatic hazards.

Building on his experience and knowledge acquired through the many projects that he has fully managed or coordinated, Mr. Roques has all the skills and competencies necessary to carry out multidisciplinary and impactful projects and achieve objectives within budgets and deadlines.

Mr. Roques' duties include technical and financial planning, as well as the realization of projects supporting municipalities, RCMs or other private or community stakeholders, in identifying solutions for a better knowledge and a better quantitative and qualitative management of their water resources. With these same

stakeholders, he works to identify the best strategies and actions to implement to secure their drinking water supply in accordance with the legal and regulatory context.

Here are some examples of projects supervised and/or carried out by Mr. Roques:

- ▷ Hydrogeological studies in support of the development of a drainage master plan for the Town of Mount Royal to prevent flooding episodes on its territory (2025);
- ▷ Support and deployment of an ESSIDES protocol and assessment of the regulatory applicability of the exploitation of a new drinking water source by the Town of Baie-Saint-Paul (2025);
- ▷ Hydrogeological advice on the potential impacts of the installation of new activities in the drinking water catchment protection areas of the municipality of Fossambault-sur-le-lac (2025);
- ▷ Aquifer management for the municipalities of Sainte-Luce and Champlain (2025);
- ▷ Technical advice for the Town of Thetford Mines to ensure compliance of its three used snow deposits with the ministerial authorizations issued (2025);
- ▷ Vulnerability analysis of drinking water sources for the cities of Saint-André-d'Argenteuil and Sainte-Luce and for the Municipality of Les Éboulements, including the review of protection areas and the assessment of groundwater vulnerability using the DRASTIC method (2024 to 2025);
- ▷ Characterization of wells in the context of applications for renewal of withdrawal permits or to bring into compliance facilities in place under the EQA and the REAFIE (Durham-Sud, Association of private owners - 2024-2025);
- ▷ Hydrogeological studies, with numerical modelling, for Carrières Régères Inc., a division of BauVal Inc., in support of a water withdrawal application under the EQA and REAFIE as part of the expansion of the Salaberry-de-Valleyfield Bedford quarry (2024-2025);
- ▷ Hydrogeological study in support of drinking water research for the municipality of Saint-Pascal-de-Kamouraska (2024);
- ▷ Hydrogeological studies for a housing project at Cumberland Mills and for the construction of a snow disposal site and a municipal garage in the municipality of Saint-Ambroise to assess feasibility, impacts on the aquifer and other withdrawals (2024);
- ▷ Geostatistical modelling of floods on the Chaudière River watershed as part of the development of methods for assessing the costs and benefits of different flood adaptation strategies in a climate change context (Ouranos - 2021);
- ▷ Development of protocols for the acquisition and management of information on flood hazards in collaboration with Université Laval, the Quebec Ministry of Public Safety and coordination of the deployment and collection of information during flooding throughout Quebec (2018-2024);
- ▷ Conceptual and geomatic modelling for the impact assessment of the installation of an oil project on the territory of Quebec (2017);
- ▷ Deployment and monitoring of an in situ measurement network (level, bathymetry, flow) and field observers; spatial and temporal hydraulic modelling (1D/2D) of floods in the Tana Delta (Kenya - 2013-2015);
- ▷ Research project to characterize interactions between surface and underground reservoirs in volcanic insular environment and cyclonic context by hydrological modelling (Réunion Island - France - 2012);
- ▷ Local coordination of consultancy activities (geophysics, pumping, hydrological modelling, etc.) For the humanitarian project drained risk reduction (ECHO-EU) on the Okok watershed as part of the characterization of the regional hydrosystem (Uganda - 2010-2011);
- ▷ Sampling and analysis of a network of instrumented observation wells for hydrogeochemical modelling of a basement aquifer (Groundwater Quality Monitoring project - Uganda - 2009);
- ▷ Acquisition of knowledge, interpretations and geological mapping of a sedimentary and metamorphic anticlinal area; surveying and production of supports (2007);
- ▷ End-of-operation impact study of an environmentally classified wastewater evaporation basin (2006).

## CAREER PATH

- Since 2025 Groupe Conseil UDA Inc., Senior Project Manager in Hydrogeology
- 2021 - 2025 Regroupement des Organismes de Bassins Versants du Québec (ROBVQ), Coordinator of Member and External Services
- 2016 - 2021 Regroupement des Organismes de Bassins Versants du Québec (ROBVQ), Project Manager for flood, drinking water and geomatics projects
- 2013 - 2015 Institut de Recherche pour le Développement (IRD) / Kenya Wetlands Biodiversity Research Group, Project Manager for water and flood projects
- 2011 - 2012 Action Against Hunger, Field Study Coordinator (Uganda - Karamoja)

# RESUME



**Jenifer Gadomski**

**MSc in Agronomy and MIS**

**PROJECT MANAGER FOR INTERMEDIATE PROJECTS IN  
HYDROGEOLOGY AND ENVIRONMENT**

## ACADEMIC TRAINING

2012 Bachelor of Science in Industrial Engineering in Agronomy, Ath, Belgium

2014 Master of Science in Industrial Engineering in Agronomy, Ath, Belgium

2017 Specialized Master's in Computer Science and Telecommunications Engineering, INSA, Lyon, France

2021-2023 Doctoral candidate in Soil and Environment, Université Laval, Quebec

## SUMMARY OF EXPERIENCE

Ms. Gadomski has more than 10 years of university education in hydrogeology and the environment. As a project manager, she participated in the modelling for vulnerability analyses of sources intended for drinking water supplies in Quebec. She runs drinking water source protection plans for more than 100 municipalities across Quebec. For two years, she has been part of the UDA Consulting Group team.

Here are some examples of cases overseen by Ms. Gadomski:

- ▷ Project management for drinking water source protection plans (over 100 projects);
- ▷ Application for funding to MELCCFP;
- ▷ Numerical modelling to define drinking water source protection areas (Batiscan, Saint-Hubert-de-Rivière-du-Loup, Métabetchouane-Lac-à-la-Croix, Desbiens, Saint-Ambroise and Normandin);
- ▷ Vulnerability analysis of sources for drinking water supply, modelling technical report;
- ▷ Hydrogeological expertise in the context of bacterial contamination of a water catchment for the Coopérative de l'aqueduc de l'Alverne (Pointe-à-la-Croix);
- ▷ Compilation of field data;
- ▷ Visit of groundwater withdrawal facilities;
- ▷ Water quality analysis at the Université Laval laboratory;
- ▷ Laboratory assistant in soil science;
- ▷ Analysis and expertise in isotopic geochemistry at Université Laval;
- ▷ Lecturer, creation of courses and various information material;
- ▷ Speaker at several scientific events (INRS, APCQ and Université Laval);
- ▷ Web application and scientific database programmer (INRS and Université Laval);
- ▷ Responsible for projects in biotechnology and genomic analysis, laboratory analysis;
- ▷ Project manager and funding request for humanitarian projects;
- ▷ Groundwater quality monitoring;

▷ Phase 1 environmental assessment studies.

## **CAREER PATH**

Since 2025 Groupe Conseil UDA Inc., Project manager for intermediate projects in hydrogeology and environment

2023-2025 Groupe Akifer Inc., Project manager for hydrogeology and environment projects

2020 - 2021 Self-employed worker for Groupe Akifer Inc.

2018-2022 Lecturer and assistant at Université Laval, Quebec

2017 Research professional at Université Laval, Quebec

2015 Project manager for invasive species control, Évian, France

2014 Biotechnology project assistant, Centre de foresterie des Laurentides

2010 Project manager in beekeeping, Benin - Humanitarian trip