

Appendix 'C'



Memorandum

245 Consumers Road, Suite 400
Toronto, Ontario M2J 1R3
Canada
T +1.416.499.9000
www.jacobs.com

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| Subject | Risk Management Memorandum | Project Name | Mud Creek Rehabilitation Project: Phase One, Canadian National Railway Crossing |
| Prepared for | City of London | Project No. | 701235CH |
| Prepared by | Jacobs | | |
| Date | July 23, 2020 | | |

The Canadian National Railway crossing that is part of the Mud Creek Rehabilitation Project in the City of London, like any other construction of underground-related projects, has risks associated with the planning, design, procurement and construction of tunnel works. Identification of potential hazards and "...management of risk to ensure their reduction to a level 'as low as reasonably practicable' (ALARP) ..." as stated in A Code of Practice for Risk Management of Tunnel Works (2012, The International Tunnelling Insurance Group) is an integral part of the Project.

The objective of risk management is to decrease the probability and impact of risk events. Risk management is a continuous and iterative process throughout the life of the project. Risk management includes four main activities: risk identification, risk and impact analysis, risk response development, and ongoing monitoring and control of risk during the project execution.

Jacobs prepared a Risk Register for the CNR crossing and conducted a preliminary risk evaluation to identify the major risks that could impact the project from a tunnelling perspective. The risks are categorized into Procurement, Design & Planning, Stakeholder, Environmental, Construction, Operability & Maintainability. Since the risk is the product of probability times impact, the qualitative evaluation of the probability and impact allows quantitative classification of risks. Once the risks were evaluated Jacobs identified measures to eliminate or mitigate those risks that could not be eliminated or transfer the risks to the contractor in the cases where the contractor is more suitable to price the risk. The evaluation and measures to mitigate the risks are included in the Risk Register attached to this Technical Memorandum (TM). A colour code is assigned to each risk based on the rating; green is assigned to negligible risks, orange is assigned to tolerable risk and red is assigned to very significant and intolerable risks (refer to Risk Framework attached).

The intent of this document is to provide the City of London with an understanding of the potential risks, how they have been mitigated, and what the residual risks are that the project may encounter, according to the Jacobs evaluation. Since the City determines the acceptable level of risk, we would like the City to review and approve the RR with its mitigation measures or to modify the register including mitigation measures or the Risk Framework if they are not in agreement with our assessment.

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Mud Creek Rehabilitation Project
Risk Management Memorandum

The Risk Register prepared for this project includes several identified risks which, without some form of mitigation measures, may have substantial impacts on the project and stakeholders. From those risks, three scored higher as follows:

- Ground around shafts can't support heavy equipment for construction.
- Boulders size/concentration stops the Micro Tunnel Boring Machine (MTBM), and
- Minimal overburden cover along tunnel alignment may cause soil movement near toe of CN berm and potentially cause MTBM to move uncontrollably

After mitigation, the risks that are considered to have the greatest potential impact on the project are Minimal overburden cover along tunnel and Boulders size/concentration stops the Micro Tunnel Boring Machine (MTBM). The low bearing capacity around shafts is being transferred to the contractor who is the party in control of the equipment. The mitigation of the low overburden carried a moderate likelihood before the approval from the CNR of the mitigation measures; however, it is noted that the design was approved as included in the contract drawings.

In the case of boulder size/concentration stopping the MTBM the risk still remains, and the work required to remove the obstruction in artesian conditions could have a high impact on the total project cost as the contractor will make claims to recoup losses that have been incurred from their removal. The mitigation action to reduce the likelihood of this type of risk from occurring would be a prequalification process to document the experience of contractors and disqualify inexperienced bidders that do not know how to resolve these types of situations. Prequalification was done and the mitigation measure of indicating in the contract documents that the contractor will encounter an obstruction that may need to be removed from the inside will increase the contract cost because the potential contractors will add this cost in their bid. Also, the contract documents require the contractors to provide an air-lock or similar means that will allow the contractor to access the back of the MTBM cutting head under pressurized conditions. If the conditions of boulder size/concentration that stops the MTBM is not encountered, the City would pay even if the obstruction is not found as the contractor will price the risk.

Camilo Quintero, P.Eng.
Principal Tunnel Engineer

