Technology and Innovation
4700 Daybreak Parkway
South Jordan, Utah
84095
USA
T +1(801) 204 2350
F +1(801) 204 2890

Internal memo

From	Doug Oliver, Principal Advisor – Hydrogeology (T&I) Zak Brown, Senior Advisor – Hydrogeology (T&I) Craig Stevens, Principal Advisor – Hydrogeology (T&I)
To	Rod Williams (IOC), Callie Andrews (IOC)
CC	Mike Muggridge (IOC)
Reference	14738
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Subject	**Technical Memorandum** **Groundwater Model Predicted Dewatering Rates** **IOC Wabush 3 Project**

Summary

Project Purpose

Rio Tinto Iron Ore Company of Canada (IOC) plans to develop Wabush 3; a new mine pit that would be located south of Luce pit. Rio Tinto Technology and Innovation (TI) conducted a groundwater modeling study to evaluate potential impacts to Dumbell Lake , documented in *Groundwater Modeling Predictive Results for IOC Wabush 3 Project Technical Memorandum* (Rio Tinto TI, 2014), but did not quantify potential groundwater extraction rates resulting from dewatering ahead of mining (only passive flows to the pit were quantified).

The Town of Labrador City is concerned that the higher flows necessary to dewater the Wabush 3 pit ahead of mining may impact the surrounding lakes. At IOC's request, TI has conducted an evaluation to answer the following focussing question:

> ***What are potential dewatering rates for the Wabush 3 Pit over the life of mine and do they impact the surrounding lakes?***

To answer this question, TI conducted additional groundwater modeling of Wabush 3 LOM that builds upon previous modeling (Rio Tinto TI, 2014) to simulate dewatering ahead of mining and quantify the necessary extraction rates and their potential impacts on the surrounding lakes.

Key Findings

The key findings from this work include:

1) Necessary dewatering rates, defined as extraction rates that keep groundwater levels more than one bench below the pit surface elevations, are as expected, somewhat higher than those predicted for passive seepage to the pit. The predicted dewatering

rates range from 300 to 900 US gpm over the LOM, peaking in approximately 2035 (assuming dewatering begins coincident with mining). This is approximately 100 to 400 US gpm more than was predicted using passive seepage to the pit.

2) Impacts to the Dumbell Lake and Beverley lakes are expected to be minimal, unless these lakes are connected directly to the pit via high hydraulic conductivity pathways that have not been identified.

Methodology, Detailed Findings, and Recommendations

Introduction and Purpose

Rio Tinto Iron Ore Company of Canada (IOC) plans to develop Wabush 3; a new mine pit that would be located south of Luce pit. The Wabush 3 pit and associated waste rock dumps and overburden stockpile are located within the catchments of a number of lakes including Dumbell Lake, the nominated back-up water supply for the Town of Labrador City, Leg Lake, and White Lake/Luce pit. The overburden stockpile is also close to the catchment of Beverley Lake, the current municipal water supply for the Town of Labrador City. The Wabush 3 life of mine (LOM) is planned to extend until 2063 when the pit reaches its maximum depth at an elevation of about 430 meters above mean sea level (m amsl).

IOC is currently in the process of obtaining environmental permits for the Wabush 3 expansion project, which include an Environmental Impact Statement (EIS). As part of the EIS, possible impacts must be identified and mitigation of potential impacts must be proposed. As part of this evaluation, a hydrology study of the area was conducted that is documented in *Wabush 3 Hydrology Technical Report* (Golder Associates, 2014). Additionally, Rio Tinto Technology and Innovation (TI) conducted a groundwater modeling study to evaluate potential impacts to Dumbell Lake, documented in *Groundwater Modeling Predictive Results for IOC Wabush 3 Project Technical Memorandum* (Rio Tinto TI, 2014). This modelling simulated the Wabush 3 pit with seepage face cells (passive flow to the pit), which results in a lower dewatering rate than would be needed to maintain groundwater levels at least one bench below the pit bottom. Actual dewatering will be through the use of extraction wells in and around the pit and will result in higher dewatering rates.

The Town of Labrador City is concerned that the extraction rates necessary to dewater the Wabush 3 pit ahead of mining may impact Dumbell and Beverley lakes. At IOC's request, TI has conducted an evaluation to answer the following focussing question:

> ***What are potential dewatering rates for the Wabush 3 Pit over the life of mine and do they impact the surrounding lakes?***

To answer this question, TI conducted additional groundwater modeling of Wabush 3 LOM that builds upon previous modeling (Rio Tinto TI, 2014) to simulate dewatering ahead of mining through the use of dewatering wells (simulated with drains; described in more detail in the methodology section) and quantify the necessary extraction rates and their potential impacts on the surrounding lakes.

Detailed Findings

Dewatering rates for the Wabush 3 pit are predicted to range from approximately 300 to 900 US gpm over the LOM, based upon the current conceptual model of groundwater flow in the area and assuming constant extraction rates (see Figure 1). These rates are 100 to 400 US gpm greater than predicted seepage rates to the pit for the baseline (Run 1) (Rio Tinto TI, 2014), due to increased drawdown necessary to maintain water levels at least one bench below the pit bottom needed to achieve a dry pit ahead of mining (see Figure 1). Actual peak extraction rates may need to be higher, given extraction well downtime due to maintenance and/or reliability issues not accounted for in the model. For simplicity and comparison to previous simulations, the timing of the start of dewatering has been assumed to be coincident with the start of mining for this predictive run. However, it would be advantageous to begin dewatering well in advance of mining. This would likely decrease peak rates and give some buffer for well downtime.

This simulation does not represent an optimized dewatering strategy; it is a generalized prediction of the expected flows over the LOM. Additional hydrogeologic characterization and observation data, including long term water levels and their response to pumping, will be necessary before these predictions can be refined to specify the number of wells, individual flow rates, and locations. The presence of high hydraulic conductivity zones (such as those encountered at Luce pit) that connect to nearby lakes could increase required dewatering rates substantially (Rio Tinto, 2014).

Based on this and other simulations, dewatering of the Wabush 3 pit is not predicted to significantly impact the surrounding lakes. For Dumbell Lake, a decrease in groundwater discharge to the lake of approximately 2 US gpm (from 13 to 11 gpm, an insignificant amount of recharge when compared to surface water flows) was predicted, which is the same as was predicted using the seepage face for Wabush 3. Dewatering of the Wabush 3 pit is not predicted to have any significant or measurable impacts on Beverley Lake in terms of changes in groundwater flux to the lake.

The hydrogeology of the Wabush 3 area and the hydraulic conductivity between the pit and the surrounding lakes is still somewhat uncertain. While the calibrated model did not predict significant impacts to the surrounding lakes, as noted in previous simulations (Rio Tinto TI, 2014 and 2015) the magnitude of impacts to surrounding lakes are highly dependent on the presence or high hydraulic conductivity features connecting the pit area to the lakes, and the effective hydraulic conductivity and geometry of these features.

Methodology

The groundwater flow model used for these predictions is described in *Groundwater Modeling Predictive Results for IOC Wabush 3 Project* (Rio Tinto TI, 2014). For the dewatering predictions discussed in this memorandum, 20 drain cells representing dewatering wells were dispersed throughout the Wabush 3 pit area. The prescribed water level in these drain cells (representing drawdown in a pumping well) was then adjusted through time in an iterative fashion until simulated water levels remained approximately one bench below the ground surface of the pit. The flows from these cells were then summed to determine the total necessary dewatering rate.

To determine impacts to surrounding lakes, the flow budgets for the general head boundary cells simulating the lakes were examined over the LOM.

Recommendations

Based on TI's analysis and results presented herein, IOC should:

1) Continue to characterize the hydrogeology of the area between Wabush 3 and Dumbell, Leg, and Beverley Lakes and collect data to establish baseline conditions prior to construction and operation of Wabush 3.

2) Collect surface water stream gaging data on tributaries to Dumbell, Leg, and Beverley Lakes to establish baseline conditions prior to construction and operation of Wabush 3.

3) Revise the hydrogeological conceptual site model with data collected during the hydrogeological characterization effort as described above.

4) Revise and recalibrate the IOC South Area numerical groundwater model to incorporate the hydrogeological data collected and reflect any changes to hydrogeological conceptual site model. Perform predictive simulations with the recalibrated model.

References

Golder Associates, 2014. *Rio Tinto – IOC Wabush 3 Hydrology Technical Report*. April 2014.

Rio Tinto Technology & Innovation (TI), 2014. *Groundwater Modeling Predictive Results for IOC Wabush 3 Project, Technical Memorandum* from Zak Brown, Doug Oliver and Craig Stevens (Rio Tinto TI) to Rod Williams and Callie Andrews (IOC), 6 April 2014.

Rio Tinto Technology & Innovation (TI), 2015. *Evaluation of Potential Impacts to Beverley Lake, Technical Memorandum* from, Doug Oliver, Zak Brown and Craig Stevens (Rio Tinto TI) to Rod Williams and Callie Andrews (IOC), 21 January 2015.

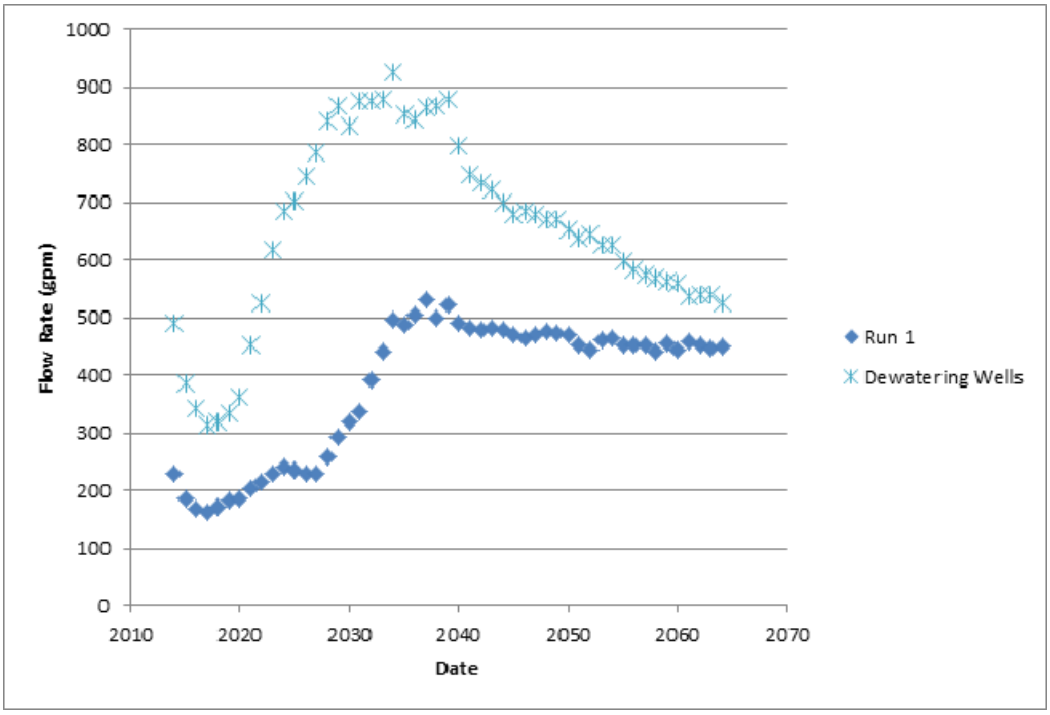

Figure 1. Predicted Dewatering Flow Rates and Passive Seepage (Run 1) to Wabush 3 Pit over LOM