
To: Richard Sithole, P.Eng.
Colliers Project Leaders
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From: Erica Bonhomme, P.Geo.
Project Manager
Date: February 24, 2021

Reference: Review of Golder Associates Ltd. Unnamed Lake Water Balance Assessment DRAFT Report

Nunami Stantec Limited (Nunami Stantec) was retained by Colliers Project Leaders (Colliers) to complete a third-party review of the draft report produced by Golder Associates (Golder) titled *Water Balance Assessment on Unnamed Lake – Modelling Report*.

The scope of this third-party review included:

- meeting with Golder's technical lead to discuss report background, methods, supporting data, and assumptions that were included in the report
- reviewing the report's assumptions and limitations
- identifying data gaps and risks
- discussing results of the review with Golder's technical lead
- producing a short memo report addressed to Colliers Project Leaders summarizing the results of the review (i.e., this memo)

Please note that our review did not include a technical review of input data and model development/calibration/validation. Such a review would require access to input data and calculations (which are not provided in the report), as well as access to the model.

Findings of our review are summarized in three parts below.

1. Based on the verbal and email correspondence between Golder and Stantec, we believe Golder is making a few changes to the report. These are:
 - Monthly Unnamed Lake outflows and Apex River flows in Table 12 will be updated. Current monthly distribution of flow does not match data available from the Water Survey of Canada Station 10UH002 (Apex River at Apex) where monthly averaged flow in June is approximately twice the monthly averaged flow in July.
 - Similar to Table 12 (above), Tables 22 and 23 will be updated. Also, Tables 22 and 23 will include Apex River flows and effects (similar to Table 12).
 - The report will state that the GoldSim model was run continuously, including the winter period. Current presentation formatting of the report does not explicitly provide this confirmation.
 - Section 3.9 of the report mentions that Transducer 1 (not Transducer 2) was used for validation. The updated report will mention that Transducer 2 was used.

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- Lake Geraldine Overflow in Figure 1 will be corrected so that it does not go to Apex River.
2. In addition to the abovementioned updates that Golder is planning to make, we recommend the following changes. This includes information that a reviewer (e.g., the third-party reviewer or regulators) would need to be able to confirm the big-picture approach of the report.
- Section 3.1, the catchment area for Unnamed Lake should be provided.
 - Section 4.2, the stage-discharge equation should be provided.
 - We understand that Tables 4 to 5 and Tables 14 to 17 provide information in the format that the client requested. However, these tables (i.e., showing the portion of open water season precipitation that becomes available as runoff after evapotranspiration) do not show the water balance picture of the watershed, mainly because they do not show the runoff due to snowmelt. To conduct an approximate water balance verification, the report should also present average monthly and annual precipitation, evapotranspiration, sublimation, and runoff values for the Lake Geraldine and Unnamed Lake watersheds for the existing and climate change conditions, and show that at the annual time scale, the water balance of “precipitation minus evapotranspiration minus sublimation equals to runoff” holds for both watersheds.
 - There is a reservoir deficit value for all exceedance probabilities in Table 6 (no water consumption scenario). These results suggest that even with no water consumption from Lake Geraldine, the lake is not full before the freeze-up even during wettest years. This would be correct if Lake Geraldine had zero natural outflow prior to the freeze-up even during the wettest years (i.e., a substantially negative water balance). Otherwise, either the term “deficit” needs to be redefined, or the model calibration requires improvement.
 - In Tables 9 and 10, please add a column to show the lake level reductions (i.e., difference between lake levels before and after pumping) in metres. This would be a useful environmental effects indicator.
 - Table 12 is critically important for environmental effects assessment. Showing the results averaged over all consumption scenarios decreases the meaning and usefulness of this table. The results could be used for effects assessment if different tables were presented for each consumption scenario. Also, the results would be more useful for effects assessment if instead of mean and max values, mean value and 10th/90th percentile exceedance values were presented. This comment applies to Tables 22 and 23, too.
 - The report explains that the model resets the water level every 10 years to avoid artificially introducing non-stationary conditions with those generated. The report should confirm that this process does not introduce bias. This can be confirmed by comparing water levels at the end of each 10-year period with the initial water level. For example, if the water level at the end of the 10-year

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period is consistently below the initial water level, resetting the model every 10 years would add a positive bias.

3. Additional analyses should be completed (possibly after this report) as part of the decision-making process for the viable long-term solution to supplementing drinking water supply to the City of Iqaluit. These are:

- The existing report only evaluates two water consumption scenarios. Nunami Stantec recommends evaluating more water consumption scenarios. Water consumption scenarios with higher winter demand as well as increasing the maximum consumption scenario should be considered.
- The sensitivity of the model to uncertainty in the catchment area of Unnamed Lake should be analyzed. Any assumption based on topographic information should be field verified.
- Modelling five, partially connected reservoirs of Unnamed Lake has high, inevitable uncertainty due to the complicated interaction between the reservoirs. A conservative and reliable alternative would be to rely on the central basin only (or possibly the combination of central and south basins).
- The current model is based on four weeks of pumping prior to freeze-up. Sensitivity analysis for different timing and duration scenarios (e.g., winter supplementation and/or shorter or longer than four weeks supplementation) may provide more cost-effective results with less environmental effects.
- It is not clear how sensitive the model is to the presumed Unnamed Lake outflow rating curve. If such a sensitivity is significant, the Unnamed Lake model should be validated with lake level and outflow data collected for this purpose. This information is also required to understand the annual variability of lake levels as well as the contribution of outflow from Unnamed Lake to the Apex River. Validation of this relationship is required to assessing the overall efficacy of this project.
- The environmental effects assessment of pumping from Unnamed Lake to Lake Geraldine will require more water balance scenarios to be run (e.g., different pump rates, different timing/duration etc.). This includes consideration of Fisheries and Oceans Canada (DFO) guidelines for the Unnamed Lake outflow and Apex River. The DFO guidelines limit withdrawal volumes to keep the reduction of instantaneous flow to 10% and no withdrawals when flows are less than 30% of mean annual discharge. If these guidelines are not met, further environmental effects assessment will be required. Conclusive statements regarding use of Unnamed Lake water to supplement Lake Geraldine is subject to completion of such environmental effects assessment.
- A limnological baseline program of Unnamed Lake should be conducted to characterize existing conditions as well as any potential variability in water quality parameters with depth.
- The existing Lake Geraldine water balance model, referenced in the report, should be used to determine the optimal storage capacity of the Lake Geraldine reservoir. The existing storage capacity provides operational limitations with regards to supplementation from another source.

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- Additional water source options for Lake Geraldine supplementation may be available and should be fully evaluated prior to making a final decision.

We trust that the information provided in this letter address Colliers' needs given the information available at the time of developing this memo. If you have any questions, please contact the undersigned at the phone number or email below.

Sincerely,

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