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Richard Dwyer

Manager of Licensing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, Nunavut
X0B 1J0

March 2nd, 2020

Re: Review of Hydrodynamic Model for Water Licence No: 2AM-BRP1831; Amendment Application by Sabina Gold & Silver Corp.; Back River Project.

Dear Richard Dwyer, the KIA has completed its review of Sabina Gold & Silver Corp.'s Back River amendment application for Water Licence No. 2AM-BRP1831.

The modification package for the Back River Project has been reviewed by our geotechnical engineering, aquatic environment, fisheries, and wildlife consultants.

Our fisheries consultant found that there's very little interaction with fish/fish habitat at the 400 m2 section of rock placement along a shoreline for barge docking and water withdrawals for road and camp construction. The rock placement has been reasonably assessed as not significant, based on the extremely small area relative to the size of Bathurst inlet and the negligible negative effect on fish. They see no problem with the assessment and there are mitigations in place.

Our geotechnical engineering, aquatic environment and wildlife consultants had reviewed Sabina's responses to KIA's Information Requests (IRs) that were provided on November 30, 2020. Our consultants were satisfied with the responses provided.

The hydrodynamic model has now been reviewed by our aquatic environment consultant and their comments and recommendations are as follows:

Thank you

John Roesch

John Roesch, P.Eng.

Senior Hope Bay Project Officer
Kitikmeot Inuit Association, Department of Lands and Environment

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Hydrodynamic Model Technical Comments

KIA–TC–01: Divergence from FEIS predicted impacts to Goose Lake.

Source:	Kitikmeot Inuit Association
TC Number:	KIA-TC-01
Request to:	Sabina Gold & Silver Corp.
Reviewer:	Hutchinson Environmental Sciences Ltd
Subject:	Divergence from FEIS predicted impacts to Goose Lake
Reference:	Sabina. 2020. Back River Project: Modification Package Version 2. Prepared by Sabina Gold & Silver Corp. Sabina. 2015. Back River Project: Final Environmental Impact Statement Supporting Volume 6: Freshwater Environment. Prepared by Sabina Gold & Silver Corp. Golder (Golder Associates Ltd.). 2021. Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake. Prepared for Sabina Gold & Silver Corp. February 2021. Ref No. 20147072-074-TM-Rev0.
Issue/Concern:	In the Modification Package Version 2 under Section 2.3.3 Sabina writes, *"Water management and discharge will also continue to occur in the same manner as outlined in the FEIS, and discharge to the environment will only occur during Closure and in compliance with pre-established discharge criteria as previously assessed and permitted." In Section 3.1.6 Sabina states, "In alignment with original Project design, discharge to the environment will only occur on Project Closure. At that time, discharge will be provisional on attainment of the Site-Specific Water Quality Objectives and established Water Licence criteria. No changes to these requirements are being proposed as a part of this modification. As a result, residual effects to Freshwater Water or Sediment Quality remain as predicted in the FEIS. These effects are anticipated to be negligible in nature and the significance rankings of the overall residual effect aspects remain unchanged from those predicted in the FEIS."* These statements indicate that the modifications to the Back River project will not change the impacts to the receiving environment; anticipated effects of the proposed changes to the project will continue to be negligible in nature and in line with the magnitude of effects assessed in the FEIS. In Section 4.5.4.3.3 of the FEIS Volume 6, Sabina writes, *"For the Closure phase, results indicate that predicted arsenic concentrations remain below the CCME guideline in the main basin of the lake. However, small, localized areas in the western and southern parts of the lake are predicted to have arsenic concentrations above the CCME guideline but at or below the site*

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	specific WQO for Goose Lake (0.01 mg/L) … Predicted arsenic concentrations at the known Lake Trout Spawning Habitat area and the Fish Overwintering Habitat area are predicted to remain below the CCME guideline for the protection of freshwater aquatic life (0.005 mg/L)." *"For the 'worst-case' year, predicted arsenic concentrations are greater than the CCME guideline throughout [Goose Lake] during all seasons and at all depths. However, predicted concentrations remain below the WQO (0.01 mg/L) for the main basin of the lake."* *"Overall, Goose Lake is predicted to have arsenic concentrations close to or below the CCME guideline for the protection of freshwater aquatic life (0.005 mg/L) for the long-term (Figure 4.5-1)."* The predicted effects of surface contact water discharged to the freshwater environment outlined in the FEIS included consideration of all areas of Goose Lake and found arsenic concentrations were to remain below the Site-Specific Water Quality Objective (SSWQO) during discharge and that concentrations would remain below the CCME guideline for the long-term. These predictions were used to predict a low magnitude effect on Goose Lake water quality with no residual effects. Similar predictions were made for the other significant parameter of concern, copper: In Section 4.5.4.3.8 Copper of the FEIS, Sabina writes, *"Copper concentrations were predicted to be greater than the CCME water quality guideline for copper in soft waters (0.002 mg/L) in the Llama OF and Goose IF SE tributaries during the Closure and early Post-Closure phases (Tables 4.5-7, 4.5-8, and 4.5-10). However, as copper is naturally abundant in Goose Lake and its tributaries, a site-specific WQO was developed of 0.0042 mg/L.* *No predicted copper concentrations were greater than the site-specific water quality objective of 0.0042 mg/L. Although some predicted copper concentrations in Goose Lake tributaries were greater than the generic CCME water quality guideline (0.002 mg/L), the predicted copper concentrations were expected to be within the natural variation in the receiving environment. Therefore, the magnitude of the residual effects from copper on water quality was concluded to be low. The duration of the residual effects of copper, based on the quantitative modelling results, was short term, because the long-term median concentrations of copper in the Post-Closure Phase were close to baseline concentrations and less than the site-specific water quality objective and the generic CCME water quality guideline."* Section 5.1 of the Hydrodynamic and Water Quality Modelling of Goose Lake highlights that the *"Time periods when maximum monthly*

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	concentrations for water quality constituents are predicted to be above chronic water quality benchmarks (Table 1) at the outlet of Goose Lake are: • *The modelled operational, closure, and post-closure periods: aluminum and copper* • *The modelled closure and the post-closure periods: nitrate, nitrite, arsenic, chromium, and iron."* As depicted in Figures 1 of Attachment 1 of the Hydrodynamic and Water Quality Modelling of Goose Lake technical memorandum, concentrations of nitrite, aluminum, arsenic, copper and iron do not recede below their respective guidelines or objectives during the 25 years of mine life modeled. This suggests that despite the entirety of Goose Lake being considered as part of the mixing zone, these parameters remained elevated and could potentially impact aquatic biota further downstream. In the FEIS, increases to receiving environment concentrations of arsenic, aluminum, copper, and other parameters of concern were considered low in magnitude, medium term in duration and reversible. The updated hydrodynamic model suggests that concentrations of these parameters of concern will be higher than previously anticipated and lasting longer in duration. This represents a significant divergence from the FEIS conclusions.
Recommendation:	We recommend Sabina propose and implement mitigations for impacts to water quality such that the significance evaluations presented in the FEIS are maintained. We highlight predicted residual elevated concentrations of nitrate, nitrite, aluminum, arsenic, copper and iron in the freshwater environment presented in the hydrodynamic modelling for Goose Lake as a significant concern, and recommend mitigations focus on that list of parameters at minimum.

KIA–TC–02 Change in discharge period to include two years of the operational period.

Source:	Kitikmeot Inuit Association
TC Number:	KIA-TC-02
Request to:	Sabina Gold & Silver Corp.
Reviewer:	Hutchinson Environmental Sciences Ltd
Subject:	Change in discharge period to include two years of the operational period
Reference:	Sabina. 2020. Back River Project: Modification Package Version 2. Prepared by Sabina Gold & Silver Corp. Golder (Golder Associates Ltd.). 2021. Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake. Prepared for

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	Sabina Gold & Silver Corp. February 2021. Ref No. 20147072-074-TM-Rev0.
Issue/Concern:	In the Modification Package Version 2 under Section 2.3.3 Sabina writes, *"Water management and discharge will also continue to occur in the same manner as outlined in the FEIS, and discharge to the environment will only occur during Closure and in compliance with pre-established discharge criteria as previously assessed and permitted"*. In Section 1.0 of the Hydrodynamic and Water Quality Modelling of Goose Lake, Sabina states, "The Project is a proposed open pit and underground gold mine with an estimated 28-year life from mobilization to post-closure. Water associated with mine-affected discharges to the receiving environment (Goose Lake) are not planned to occur until Year 11 of the operational period." The change in discharge timelines should be clearly communicated.
Recommendation:	Please clarify within the application that discharges to the environment are now planned during the operation project phase representing a departure from FEIS predictions. We further request a discussion of any potential implications this change may have on interactions with the receiving environment.

KIA–TC–03: Water quality predictions and defining the mixing zone.

Source:	Kitikmeot Inuit Association
TC Number:	KIA-TC-03
Request to:	Sabina Gold & Silver Corp.
Reviewer:	Hutchinson Environmental Sciences Ltd
Subject:	Water quality predictions and defining the mixing zone
Reference:	Golder (Golder Associates Ltd.). 2021. Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake. Prepared for Sabina Gold & Silver Corp. February 2021. Ref No. 20147072-074-TM-Rev0. Section 1.2 Objectives, Section 4.0 Model Uncertainties and Limitations and Attachment 1 Sabina, 2020. Back River project Water Management Plan. Prepared by Sabina Gold & Silver Corp.
Issue/Concern:	In the Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake Section 1.2 Sabina indicates that, *"The main objective of this study was to predict water quality constituent concentrations at the outlet of Goose Lake and identify constituents of potential concern."*

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	In Section 6.1.5 of the Back River Project Water Management Plan Sabina states, *"This updated Hydrodynamic model will be utilized to verify the Water and Load Balance model, determine treatment options required to meet CCME guidelines, and to establish potential associated regulated mixing zones within the receiving environment."* At the IR stage, KIA requested the updated hydrodynamic model predict water quality at the edge of a regulated mixing zone to assist reviewers in understanding the extent water quality will exceed applicable water quality objectives guidelines within Goose Lake. By modeling a single point (the outlet), the extent of impacts within Goose Lake cannot be assessed. Furthermore, Goose Lake is fish bearing and water quality within it should be maintained at or below CCME WQOs or SSWQOs as applicable for the protection of aquatic life in that waterbody beyond a 100 m mixing zone. As part of Sabina's water management objectives as outline in Section 7.2 of the Back River Project Water Management Plan, they are committed to*, "Collecting and treating contact water as required to meet SSWQOs in the receiving environment."* Therefore, as part of this commitment to meeting SSWQOs in the receiving environment a discussion surrounding treatment options should be provided. In section 4.0 Model Uncertainties and Limitations Sabina states*, "The water balance model is based on average climate conditions (SRK 2020) as such no climate variations are included in the hydrodynamic model, (i.e., wet or dry years)."* Water quantity plays an important role in determining the concentration of water quality parameters in the receiving environment. Completing a sensitivity analysis by altering precipitation scenarios (i.e., wet vs dry year scenarios) will help the reviewer evaluate the size of the mixing zone and the extant of mine impact on the receiving environment. In Section 6.1 of the Back River project Water Management Plan Sabina states, *"The Water and Load Balance model for the Project was developed using the GoldSim© software package (version 12.1.3) (GoldSim Technology Group 2019). The model was run on a daily time step and runs from Year -2 to Year 47. This run length was chosen as it allows the model to run until steady state conditions are reached in pits and downstream receptors."* In Section 2.2 of the Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake Sabina states, *"Two modelling periods were used in the Goose Lake Model… Forecast Periods: Project mining Year 11 to 25 (SRK 2020, Appendix A). This period includes the final two years of operation, eight years of closure, and five years of post-closure (as discharge quality is expected to improve after closure). This specific*

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	timeframe was used in the modelling as this is the period that site contact water will be discharged to Goose Lake. The model forecast simulation was initialized in fall of Year 10 of operations prior to lake freeze-up to accommodate a warm-up period." The figures contained in attachment 1 of the hydrodynamic model depict concentrations of nitrate, nitrite, aluminum, arsenic, copper and iron all exceed either their CWQGs or SSWQOs. Concentrations of nitrite, aluminum, arsenic, copper and iron do not recede below their respective guidelines or objectives during the 25 years of mine life modeled. This suggests that despite the entirety of Goose Lake being used as the mixing zone these parameters remained elevated and could potentially impact aquatic biota further downstream. The point in time at which these parameter concentrations return to background concentrations or below CWQGs or SSWQOs remains unknown suggesting the time frame of modeling should be extended to understand when concentrations of these key parameters no longer pose a threat to aquatic biota. As noted by Sabina earlier 47 years of modeling were required to reach steady-state conditions.
Recommendation:	1. As several parameters of concern do not meet CWGQs or SSWQOs at the outlet of Goose Lake, Sabina is again requested to define the extent of the mixing zone(s) for each inflow into Goose Lake under a) increased and decreased precipitation scenarios (i.e., wet vs dry year scenarios), b) increased warming conditions (i.e., a thickening of the active layer), c) under ice to determine the effect of cryo-concentration on water quality within Goose Lake. Note the under-ice scenario should assume 100% solute exclusion. 2. Provide a discussion on treatment options to be utilized to meet CCME guidelines or SSWQOs as applicable at the edge of a defined mixing zone. Note that the regulated mixing zone should be 100 m from where surface contact water flowing from the site enters the receiving environment. 3. Extend the timeframe of the modelling to include the point at which parameters of concern (nitrate, nitrite, aluminum, arsenic, copper and iron) return to concentrations below their respective CWQGs or SSWQOs.

KIA–TC–04: Model warm up period.

Source:	Kitikmeot Inuit Association
TC Number:	KIA-TC-04
Request to:	Sabina Gold & Silver Corp.
Reviewer:	Hutchinson Environmental Sciences Ltd
Subject:	Model warm up period
Reference:	Golder (Golder Associates Ltd.). 2021. Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake. Prepared for

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	Sabina Gold & Silver Corp. February 2021. Ref No. 20147072-074-TM-Rev0. Section 2.2 modelling periods and Section 2.4.5 Water Quality Inputs.
Issue/Concern:	In Section 2.2 Sabina states, *"In both modelling periods, a warm-up period was included to provide sufficient time for the model to reach dynamic equilibrium before simulation results were used for comparison against measured data or for future predictions." Further in the report in Section 2.4.5 Sabina states, "Initial conditions on the first day of forecast period (September 15, Year 10; before lake freeze-up) within Goose Lake were defined using the median value reported in Golder 2019 (Appendix 2D, Table 2D-16). Temperature and chemistry were assumed constant throughout the domain for initialization purposes."* A proportionately larger flush of arsenic is anticipated at the beginning of the discharge period. If the beginning of the modelling period is artificially held constant and/or is not provided for review or compared against measured or for future predictions large fluxes in parameters of concern, which may be acutely toxic to biota, could be missed.
Recommendation:	Please clarify what is considered a "warm up period", the "domain", and why parameters of concern were artificially held constant throughout the domain and indicate how large fluxes in parameters of concern due to discharge initiation will be modeled and where this data can be found for review.

KIA–TC–05: Water quality inputs into the hydrodynamic model.

Source:	Kitikmeot Inuit Association
TC Number:	KIA-TC-05
Request to:	Sabina Gold & Silver Corp.
Reviewer:	Hutchinson Environmental Sciences Ltd
Subject:	Water quality inputs into the hydrodynamic model
Reference:	Golder (Golder Associates Ltd.). 2021. Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake. Prepared for Sabina Gold & Silver Corp. February 2021. Ref No. 20147072-074-TM-Rev0. Section 2.4.5 Water Quality Inputs. Table 5: Average Input TDS Concentration of Inflows – Calibration Period.
Issue/Concern:	Sabina indicates that, "Water quality data required for the Goose Lake Model included chemistry and temperature data for inflows to the lake: • *For the calibration period: TDS and water temperature…* • *During the calibration period TDS concentrations of inflows from local watersheds (natural tributaries of Goose Lake basin) were represented by the median TDS concentrations (values reported as "calculated TDS", calculated from major ions as per APHA 2012) reported in the Aquatic Baseline Synthesis Report (Golder 2019),*

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	except for PN-04 where average monthly concentrations were used (given the variability)" The concentration of several metals (arsenic and copper) is of particular interest for the hydrodynamic model of Goose Lake. Therefore, it would be prudent to include these metals as part of the calibration period to ensure predicted concentrations of these metals are consistent with measured concentrations. Clarification is also required what is meant by median TDS concentrations. Does this refer to the monthly median, annual median, median over the entire monitoring period or another averaging period? A more conservative approach such as using the 75th percentile would be more prudent.
Recommendation:	We recommend that parameters of concern, such as arsenic and copper, be specifically assessed during the calibration period of the hydrodynamic model to provide confidence in the accuracy of predicted metal concentrations within the forecast portion of the model. We also request Sabin apply a more conservative value for TDS concentrations at PN04 during the calibration period for inflows from local watersheds; the 75th percentile or higher of seasonal values is recommended.

KIA–TC–06: Model calibration.

Source:	Kitikmeot Inuit Association
TC Number:	KIA-TC-06
Request to:	Sabina Gold & Silver Corp.
Reviewer:	Hutchinson Environmental Sciences Ltd
Subject:	Model calibration
Reference:	Golder (Golder Associates Ltd.). 2021. Technical memorandum Hydrodynamic and Water Quality Modelling of Goose Lake. Prepared for Sabina Gold & Silver Corp. February 2021. Ref No. 20147072-074-TM-Rev0. Section 2.4.5 Water Quality Inputs and Section 3.0 Model Calibration and Section 3.2 Transport Calibration
Issue/Concern:	In Section 2.4.5 Sabina states, *"During the calibration period TDS concentrations of inflows from local watersheds (natural tributaries of Goose Lake basin) were represented by the median TDS concentrations (values reported as "calculated TDS", calculated from major ions as per APHA 2012) reported in the Aquatic Baseline Synthesis Report (Golder 2019), except for PN-04 where average monthly concentrations were used (given the variability observed in the measured data) (Table 5)."*

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	In Section 3.0 Sabina states, *"The hydrodynamic and transport modules of MIKE3 FM were calibrated to match measured and predicted thermal and transport behaviour in Goose Lake. The Goose Lake Model was calibrated to measured temperature and TDS concentrations (values reported as "measured TDS") in 2012 and 2013 (Golder 2019) by comparing measured and predicted values."* Finally, in Section 3.2 Sabina states, *"Predicted TDS profiles at GLTL are compared with the measured data on Figure 7. During both open-water and ice-cover seasons, the predicted TDS profile follows the measured profile pattern. As discussed in Section 2.5.4, TDS concentrations of inflows to the lake were based on "lab calculated" values, while the in-lake concentrations (used to compare to predicted results) were based on "field measured" values. The difference between the two TDS values could cause a minor difference in the reported values. Thus, calibration was considered adequate if the observed and predicted TDS followed the same pattern, while recognizing that the absolute values would not be expected to match."* TDS inputs should be consistent for all aspects of the model. If measured TDS concentrations are not available for all water quality stations than calculated TDS concentrations should be used consistently for model inputs, model calibration and model forecasting to allow for a more consistent evaluation of model prediction accuracy. In Section 3.0 Sabina states, *"Within the temperature formulation, the minimum temperature was set to 0°C instead of the default value of -2.1°C to prevent freshwater temperatures dropping below 0°C."* Full rationale for this change and its implications to modelling outputs were not provided.
Recommendation:	We recommend Sabina, 1. Use a consistent measurement approach for TDS inputs into the hydrodynamic model. We specifically recommend the use of calculated TDS given measured TDS is not available for all stations throughout the period of record. 2. Provide an explanation of the implications of altering the temperature formula of the hydrodynamic model.