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TECHNICAL MEMORANDUM

To: Linda Jackson, Payette Forest Supervisor, Stibnite Gold Project, 500 N. Mission Street, Building 2, McCall, Idaho 83638; https://www.fs.usda.gov/project/?project=50516

From: Ann Maest, PhD; Buka Environmental

Date: 31 December 2022

Re: Stibnite Gold Project, Idaho: Review of Supplemental Draft Environmental Impact Statement (SDEIS) Issues Related to Geochemistry and Water Quality

Executive Summary

The comments in this memorandum are organized according to the development of water quality predictions in water bodies at the Stibnite Gold Project (SGP) site. My comments address shortcomings in the geochemical testing program, the Development Rock and Adaptive Management Plans, the development and use of source terms, the Site Wide Water Chemistry model, and the comparison of predicted water quality to relevant standards.

Need for a Revised SDEIS: A Revised SDEIS is needed. The highest priority water quality issues that need resolution before a Final SEIS is created are:

- Climate change needs to be quantitatively evaluated in the water balance and Site Wide Water Chemistry (SWWC) models that are used to predict future water quality resulting from the project.
- An evaluation of the legality of allowing the degradation of groundwater and surface water quality in locations that currently do and do not exceed water quality standards is needed; this examination also affects the assumption of no future groundwater use.
- The source terms for the SWWC model are based on criteria that will not identify or distinguish materials that will degrade water quality; these same criteria are proposed to, but should not, be used in mine management plans.
- Bench-scale testing of the proposed mine water treatment methods is needed; the current evaluation only uses a desk study with outdated references.

These issues are discussed further in the Executive Summary and the main body of this technical memorandum.

General comment: The SDEIS contains multiple discrepancies between references listed in the document and those available on the USDA Forest Service website. The implication from these discrepancies is that the SDEIS was not adequately reviewed before it was released to the public, and, even more concerning, the SDEIS may not have used the most up-to-date data and information in its preparation. The Forest Service should review and correct the documents and make them available for public review in a revised SDEIS.

Geochemical Testing Results and Management Plans: The selection of samples for geochemical testing did not consider hydrothermal alteration, which can substantially affect contaminant leaching and acid generation potential. Failing to use geochemical test units within each lithology means that the testing results are most likely not representative of the range of leachate chemistries that will develop at the mine. In addition, the volumes of each subgroup within a lithology with different leaching characteristics is not known and cannot be applied to the block model and the SWWC model to more accurately estimate site water quality.

The methods used to estimate neutralization potential (NP) will likely overestimate NP in the long term. Overestimating NP will make it appear as if fewer samples and waste types are potentially acid generating (PAG). If more mined material is PAG, additional mitigation measures will be needed to prevent the formation of acid drainage from new mining activity.

Much uncertainty exists about whether the newly mined materials will produce acid and therefore leach higher contaminant concentrations over the long term. Although the kinetic tests were conducted for more than 100 weeks in many cases, rocks in the deposits could take even longer to form acidic drainage. The depletion rates of NP and acid production potential are similar, which makes it difficult to predict which will "win out" in the long run. Because the wastes will exist at the site in perpetuity, long-term leachate production is important, and conservative estimates should be used to design effective mitigation measures.

Management plans for the wastes are poorly developed or completely undeveloped and will need more supporting information and detail. According to the Development Rock Management Plan (DRMP), active segregation of PAG/metal leaching material is not required, presumably because this material will be placed in the pit as backfill or in the Tailings Storage Facility (TSF) Buttress. Such an assumption relies on the performance of engineered measures to limit the transport of mine-influenced leachate from the pits and the TSF Buttress to downgradient water bodies. Cutoff values for rock with low ARD/ML potential (which could be used for facility construction materials) are defined in the DRMP as ≤500 mg/kg total arsenic and NPR values >1.5. However, a substantial number of HCT samples with NPR values >1.5 had elevated arsenic release rates, and samples with total arsenic values <500 mg/kg leached arsenic in excess of the federal drinking water standard of 0.01 mg/L. The adaptive management plan(s) (AMP) are not developed and will be needed. These and other management plans should be made available for public review in a revised SDEIS.

Source Terms: Source terms were created using leaching rates and concentrations from long- and short-term leach tests, respectively. They are expressed as rates (in mg/kg/week) and are one of the most important inputs to the SWWC model for predicting water quality. The "first flush" of contaminants is released during the early weeks of humidity cell testing, but rates from those times were not used to develop source terms. Instead, lower average "steady-state" rates from later times in testing were used. The first flush of contaminants from mined materials will occur when weathered wastes and ore are flooded (e.g., in flooded pits) and when weathered wastes and ore are wetted from storm events or snowmelt, especially after a previous dry period. Such conditions will exist at the SGP site in waste and ore stockpiles, backfilled pits, pit walls, and in the TSF Buttress/Embankment. Because the first-flush rates have been ignored, the source terms for development rock and ore will underestimate the release of contaminants from mine facilities during operations and closure/post-closure.

Source terms were developed using the designations of PAG vs. non-PAG and waste vs. ore for a given deposit and lithology. However, these distinctions do not result in a meaningful difference in source term values for arsenic and antimony, which are two of the mine-related contaminants of highest concern (that is, source term values are very similar for PAG vs. non-PAG and for waste vs. ore). Source terms for the SWWC model need to be thoroughly reexamined in a revised SDEIS.

Site Wide Water Chemistry Model: The Site Wide Water Chemistry (SWWC) model relies on inputs from the geochemical characterization program, source terms, the water balance model, and water treatment plant (WTP) effluent quality to predict water quality resulting from development of the SGP. The model predicts average annual and average monthly concentrations for site water quality and uses average precipitation, runoff, and infiltration without considering climate change. The extensive use of averages will underestimate potential maximum concentrations that will require treatment or management.

The SWWC does not evaluate the effects of ammonia or selenium. Ammonia will result from blasting of the open pits, and selenium can be leached from mined materials. The effluent discharge permit (IPDES) for release of treated water to Meadow Creek should require monitoring and permit limits for both of these mine-related contaminants. The mine wtaer treatment evaluation does not consider the removal of ammonia or selenium.

The SWWC model includes individual conceptual models for the pits and the TSF but does not include an overall conceptual model for the entire site. The SWWC model also does not consider the stream sediment (surface water-stream sediment) or food-chain (sediment-macroinvertebrates/periphyton-fish) pathways, and no monitoring of these environmental media (sediment, macroinvertebrate, periphyton contaminant content) is proposed.

Although the movement of contaminants from the TSF and the pits is considered in the water balance model, the future use of groundwater for drinking water has been excluded from consideration in the SDEIS, based on a 20-year-old ATSDR report. The ATSDR report eliminated the consideration of groundwater as a pathway for the mine site that existed at that time but said nothing about the potential for future groundwater use based on current knowledge or the current proposed project. Further, ATSDR was completing an assessment of the site to fulfill its congressional mandate for preparing a public health assessment within one year of US EPA proposing *a site to the National Priority List (Superfund)*. In contrast, the SGP is a new proposed mine subject to applicable groundwater quality standards. The potential for groundwater use as a drinking water supply in the future cannot be discounted and applicable groundwater quality standards must be met.

The SDEIS also implies that it would be acceptable to further degrade groundwater quality because groundwater in certain locations currently exceeds drinking water standards for antimony and arsenic. The legality of further degrading groundwater quality needs to be evaluated in a revised SDEIS. The Forest Service must demonstrate that the proposed mine plan is in compliance all applicable state and federal laws.

The SWWC and the underlying water balance model do not consider climate change. Executive Order 14008 requires the Chair of the Council on Environmental Quality and the Director of the Office of Management and Budget to ensure that Federal permitting decisions consider the effects of greenhouse gas emissions and climate change. Greenhouse gas emissions from the project are quantitatively estimated in the SDEIS, but climate change has not been considered in any meaningful way in the water balance model or in facility sizing. Because the mine life is proposed to be 20 years (including construction, operation, closure, and reclamation), TSF seepage is predicted to last for 40 years, and post-closure and active management of the site will be needed in perpetuity, it is unacceptable that climate change has not been incorporated into the predictions for the proposed project. Climate change must be incorporated into all water balance estimates and the SWWC model in a revised SDEIS.

The mine water treatment approaches proposed have not been evaluated using laboratory bench studies, and the desk study performed used outdated references whose conclusions have been contradicted by more recent studies. These many shortcomings indicate that the SWWC model and associated studies need to be thoroughly reevaluated in a revised SDEIS. The need for perpetual capture and treatment of mine-influenced water should also be evaluated in a Revised SDEIS.

Comparison to Relevant Water Quality Standards: The surface water quality standards that could become part of an IPDES discharge permit need to consider the use of an aquatic life guideline for antimony in case the groundwater standard for antimony is not considered relevant. A chronic aquatic life guideline for antimony should be considered. The selenium standard used to compare to predicted surface water concentrations in the SWWC model may not reflect the most updated approach used by US EPA that includes monitoring of not only water but also aquatic biota. Existing groundwater under the TSF Buttress/Embankment does not exceed arsenic or antimony standards, but predicted groundwater arsenic and antimony concentrations are higher than background values and Idaho groundwater standards. The legality of permitting a project that predicts it will exceed water quality standards in groundwater that currently does not exceed standards must be evaluated. The Forest Service must ensure that the proposed mine plan complies with all applicable state and federal laws. The use of groundwater at the site as a drinking water resource in the future should require that the project cannot worsen groundwater quality. Idaho's arsenic groundwater standard of 0.05 mg/L does not reflect the current federal drinking water standard of 0.01 mg/L. The current federal drinking water standard for arsenic should be used to compare against predicted groundwater concentrations resulting from the project.

1. Introduction

The comments contained in this technical memorandum address geochemical and water quality issues related to the proposed Stibnite Gold Project (SGP) in central Idaho. My comments are submitted on behalf of Earthworks, a Washington DC-based nonprofit organization. The comments are in response to the SGP Draft Supplemental Environmental Impact Statement released by the Forest Service on October 28, 2022 (USDA Forest Service, 2022a; SDEIS) and related reports available on the USDA SGP EIS website[1] under Project Documents. My comments on the SDEIS also cite additional information from published articles, environmental standards and criteria, and other technical information. All sources cited in my SDEIS comments are listed in the references section of this memorandum.

I submitted extensive technical comments on SGP's Draft Environmental Impact Statement (DEIS; USDA Forest Service, 2020) in October 2020 (Maest, 2020). Some of my comments were addressed in the SDEIS and others were not. A table containing my major comments on the DEIS and whether and how they have been addressed is presented in Appendix A. The most important remaining geochemistry and water quality concerns in response to the SDEIS are summarized in the Executive Summary of this memorandum.

The memorandum is organized according to the development of water quality predictions in water bodies at the SGP site. The chemical inputs to water quality predictions start with the results from geochemical characterization testing. Certain of these results, after modifications to account for differences between laboratory and field conditions, are used to develop the chemical source terms for each input feeding into the Site Wide Water Chemistry (SWWC) model. In conjunction with inputs from the water balance model (precipitation, infiltration, runoff, seepage volumes from mine facilities) and predicted water treatment plant effluent, water quality predictions in site water bodies are developed in the SWWC model. The predictions are then compared to relevant water quality standards in receiving water bodies. A schematic showing how water quality predictions are developed and used is presented as Figure 1.

My memorandum focuses on shortcomings in the steps outlined in Figure 1 that will lead to underestimating the concentrations and effects of mine-related contaminants in site water bodies during operation, closure, and post closure. Because each step builds on information from all previous steps, shortcomings also affect all subsequent steps.

The final sections of the memorandum include a summary of my qualifications (Section 7), a listing of references cited (Section 8), and a summary of my major previous SEIS comments and whether they have been addressed in the SDEIS (Appendix A).

[1] https://www.fs.usda.gov/project/?project=50516

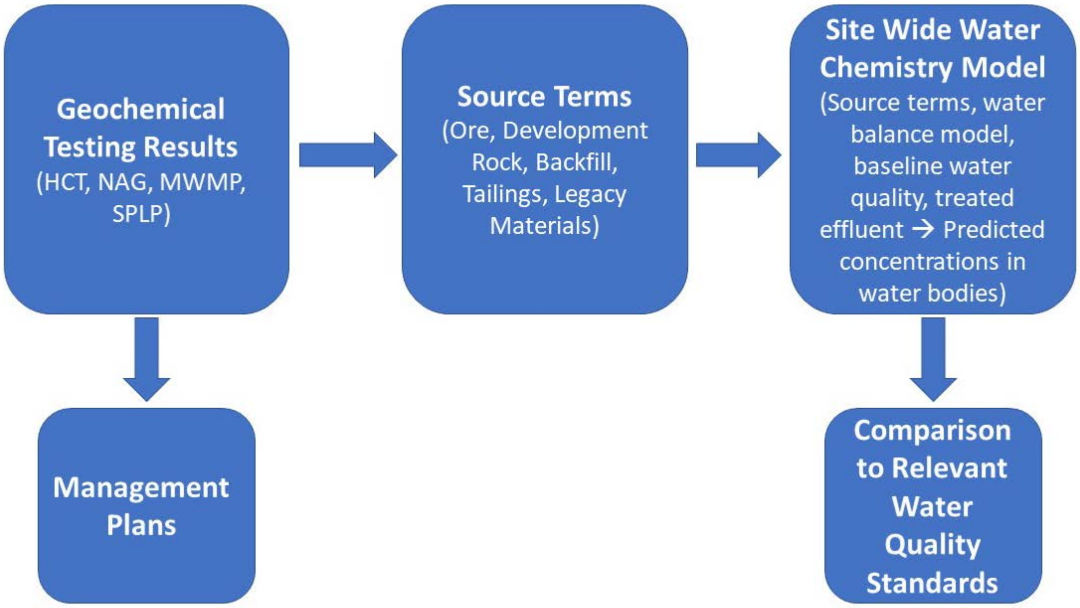


Figure 1. Inputs to, development of, and use of geochemical testing results and water quality predictions.

2. General Comment on SDEIS Version Control and Review

The SDEIS contains multiple discrepancies between references listed in the document and those available on the USDA Forest Service website. Six examples are listed in Table 1. In addition to not citing or using the most recent version of the report or plan in the SDEIS, in one case the reference was not listed in the SDEIS, and in another case the reference listed in the SDEIS has a more recent date but the version available on the website is titled “Comprehensive” and has an earlier date (see Table 1).

The implication from these discrepancies is that the SDEIS was not adequately reviewed before it was released to the public, and, even more concerning, the SDEIS may not have used the most up-to-date data and information in its preparation. All versions listed in the right column in Table 1 have dates before the release of the SDEIS and presumably could have been used. Note that these are only the discrepancies found for some of the geochemistry and water quality/ water resources reports; other discrepancies could be common throughout the SDEIS. These discrepancies make review of the SDEIS by the public more challenging. A much more careful review of a Revised SDEIS and the Final SEIS is needed.

Where discrepancies exist between reports listed as references in the SDEIS and those available on the USDA Forest Service website (see Table 1), the references used in this memorandum are listed in Section 8. References Cited.

Table 1. Discrepancies between geochemistry and water quality references cited in the SDEIS and those available on the USDA Forest Service website.

As listed in SDEIS, Section 7.1 References	Available from USDA Forest Service website, Project Documents[1]
Brown and Caldwell. 2021b. Stibnite Gold Project Water Management Plan. Prepared for Perpetua Resources Idaho, Inc. October 2021.	Brown and Caldwell. 2021. Stibnite Gold Project Water Management Plan. Prepared for Perpetua Resources Idaho, Inc. *December*. 638 pgs. (more recent)
Brown and Caldwell. 2021c. Stibnite Gold Project. Environmental Monitoring and Management Program. Prepared for Perpetua Resources Idaho, Inc. May 2021.	Brown and Caldwell. 2021. Stibnite Gold Project Environmental Monitoring and Management Program. Prepared for Perpetua Resources Idaho, Inc. *September*. 64 pgs. (more recent)
Brown and Caldwell. 2021d. Stibnite Gold Project. Development Rock Management Plan. Prepared for Perpetua Resources Idaho, Inc. October 2021.	Brown and Caldwell, *2022*. Final Development Rock Management Plan. Prepared for Perpetua Resources Idaho, Inc. *May*. 143 pgs. (more recent)
Not listed in SDEIS	Brown and Caldwell. 2021. Stibnite Gold Project Water Resources Monitoring Plan. Prepared for Perpetua Resources Idaho, Inc. November. 50 pgs.
SRK Consulting (SRK). 2018b. Stibnite Gold Project Proposed Action Site-Wide Water Chemistry (SWWC) Modeling Report. Prepared for Midas Gold Idaho, Inc. December 2018.	SRK Consulting (SRK). *2021*. Stibnite Gold Project ModPRO2 Site-Wide Water Chemistry (SWWC) Modeling Report. Prepared for Perpetua Resources Idaho, Inc. *October*. 558 pgs. (more recent)
SRK Consulting (SRK). 2021a. Stibnite Gold Project Baseline Geochemical Characterization Report – Phase 1 and Phase 2. Prepared for Perpetua Resources Idaho, Inc. December 2021. (not available on USDA website)	SRK Consulting (SRK). *2021*. Stibnite Gold Project Comprehensive Baseline Geochemical Characterization Report. Prepared for Perpetua Resources Idaho, Inc. *November*. 3514 pgs. (not as recent but may be a more comprehensive report)

1 https://www.fs.usda.gov/project/?project=50516
Italics in the column to the right highlight the discrepancies in dates.

Summary: The most recent geochemistry and water quality reports by Perpetua's consultants are not used in the SDEIS. The discrepancies and errors in the references used in the SDEIS imply that the SDEIS was not adequately reviewed before it was released to the public, and, even more concerning, the SDEIS may not have used the most up-to-date data and information in its preparation.

3. Geochemical Testing Results and Management Plans

The primary document containing the geochemical characterization results is SRK (2021a). The majority of my previous comments on the shortcomings of the geochemical characterization program are still relevant for the SDEIS (Appendix A) and continue to be supported by more recent documents. A summary of previous comments and new comments related to geochemical testing results and their use in management plans follows.

3.1 Geochemical test units were not identified or used to select samples for analysis.

The mineralization and hydrothermal alteration of the Stibnite-Yellow Pine mining district is described in Section 2.3.5 of SRK (2021a). The effects of hydrothermal alteration on mineralogy, and consequently on leachate chemistry, are localized and numerous within each lithology. However, the lithologic units used in the geochemical testing program were not broken down into different testing units that reflect different types of hydrothermal alteration. For example, hydrothermal alteration of low-grade ore and development rock has produced iron carbonates, which are not effective acid neutralizers, and pyrite, which is the primary producer of acid mine drainage (SRK, 2021a, p. 13).

As noted in my previous comments, the importance of identifying and using geochemical test units is widely understood. Two examples follow:

- INAP (2009, Section 4.3.2.1) Sample Selection "Compositional Representation – Sample selection should include all major material types and cover the range of pertinent characteristics for each material type (e.g., pH, carbonate, sulphur, and neutralizing potential content). Personnel tasked with sample selection must be familiar with the geological characteristics of the deposit, including rock types, fracture patterns, weathering, alteration, and mineralization."
- NDEP (2018, p. 6): "A model that assumes geochemical homogeneity among lithologic units, or zones of alteration, mineralization, or weathering rather than documenting the actual range of variation, is unacceptable because it fails to demonstrate that the characterization is representative as required in NAC 445A.396. In the case of geochemical modeling, adequate characterization data are required to illustrate the full range in geochemical characteristics representative of each major lithologic, alteration, and mineralization unit and zone across the site that is identifiable and discrete."

The large variability in acid generation potential, total metal concentrations, and leachate results within the lithologies used for geochemical testing for the SGP is a strong indication that geochemical test units should have been identified. Failing to use geochemical test units within each lithology means that the testing results are most likely not representative of the range of leachate chemistries that will develop at the mine. In addition, the volumes of each subgroup within a lithology with different leaching characteristics is not known and cannot be applied to the block model and the SWWC model to more accurately estimate site water quality.

3.2 The neutralization potential of the samples has been overestimated.

SRK (2021a) used the modified Sobek method to determine the neutralization potential (NP) of the selected samples. This method and the use of total inorganic carbon measurements can overestimate NP because silicates and iron carbonates are included, and they may not contribute "real" NP in the field (SRK, 2021a, Section 3.4.4). However, the modified Sobek method was the most common method used to estimate NP for the Stibnite samples. A site-specific NPR (neutralization potential ratio, using NP divided by the measured acid generating potential) of 1.5

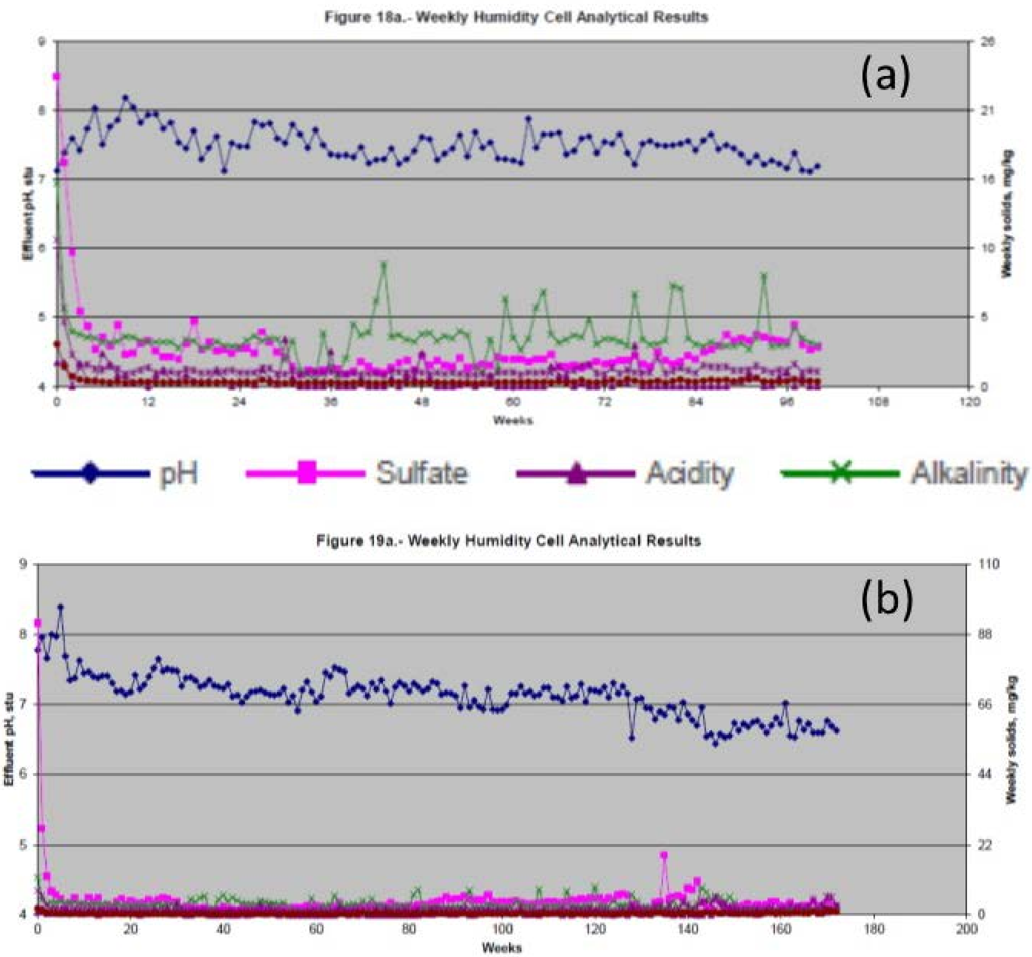
was used as a cutoff to separate potentially acid generating (PAG) and non-PAG samples (SRK, 2021a, Section 3.3), when a more protective value of 2 is more commonly used (INAP, 2009). In addition, a net acid generating (NAG) pH cutoff of 4, rather than 4.5, was also used to separate PAG from non-PAG samples (SRK, 2021a, Section 3.4.5; INAP, 2009). Although justifications are provided in SRK (2021a), these “site-specific” and less environmentally conservative cutoff values to identify PAG samples will most likely be used during mining to determine the leaching characteristics and final placement of the mined materials. Overestimating the neutralization potential (NP) will make it appear as if fewer samples and waste types are potentially acid generating (PAG). If more mined material is PAG, additional mitigation measures will be needed to prevent the formation of acid drainage from new mining activity.

3.3 A high level of uncertainty exists about whether acidic conditions will develop over the longer term for new mining

All SDEIS documents that discuss or summarize the geochemical testing results conclude that acidic conditions will not develop as a result of mining. For example: “Despite this higher potential for acid generation, none of the ore grade HCTs generated acid for the duration of the test and net acid conditions have not developed within the Project area.” (SRK, 2021a, p. xvii). As shown in Figure 2, two of the Yellow Pine ore samples (described as development rock in some tables, including SRK, 2021a, Table 3-17) had HCT pH values dropping into the low 7s (Figure 2a, HCT-18) and into the mid 6s (Figure 2b, HCT-19) near the end of the Phase 2 tests. The Phase 2 geochemical testing program was designed to fill data gaps (lithology gaps) from Phase 1 and to focus more on samples that are more potentially acid generating (SRK, 2021a, p. 48). Sample HCT-19 was run for much longer than HCT-18 (172 vs 100 weeks), and pH values did not drop below 7 until week ~125. As shown for acid-base accounting (ABA) results in SRK (2021a, Appendix A, pdf p. 323), most samples had high NP values and NPR values (“Ratio”) generally higher than 3, indicating non-PAG conditions. Samples with higher NP values, such as those for the SGP, can take longer for acidic conditions to develop (Maest et al., 2005).

HCTs are designed to be accelerated weathering tests, and while the results suggest acidic conditions will not develop for a period of time, they also indicate that the NP would eventually be exhausted. When mined materials, especially mineralized waste rock, are left on the land surface in perpetuity, those longer timeframes are realized.

The comparative rates of NP and sulfur (sulfide and sulfate) depletion were examined for the mill tailings samples, and in general the NP is predicted to outlast the acid potential (SRK, 2021a, Section 4.3.7). For HCT termination testing of ore and development rock samples, SRK (2021a, p. 129) concluded that less than 20% of the original sulfide content was oxidized, and less than 15% of the initial NP was consumed. To the extent that these HCTs are representative of field conditions, the depletion rates for NP and AP for ore and development rock are similar, and a high level of uncertainty exists about whether acidic or neutral-pH leachate would “win out” under long-term field conditions. Corresponding field weathering tests should have been conducted but were not. SRK (2021a, p. 29) concludes that most material mined from the Hangar Flats and Yellow Pine deposits would be unoxidized. It is the unoxidized material that is more likely to contain pyrite and be potentially acid generating over time, as noted for the Yellow Pine and Hangar Flats deposits (SRK, 2021a, p. 52 and 58). Although the ore-grade samples were more PAG than the development rock samples (see, e.g., SRK, 2021a, p. 59 and Tables 3-8 to 3-10), the definition of ore vs. waste will change over time, and samples currently designated as ore could instead by considered waste rock in the future.



Sources: SRK, 2021a, Tables 3-17 and 3-21, Appendix B.3

Figure 2. HCT samples with lower pH values. (a) HCT-18, Phase 2, MGI-12-306 (67.29-69.12m), Yellow Pine Alaskite, initial NAG pH 2.5, 100 weeks. (b) HCT-19, Phase 2, MGI-11-157 (137.6-142.5m), Yellow Pine Quartz Monzonite/Alaskite DR/ore, initial NAG pH 2.42, 172 weeks.

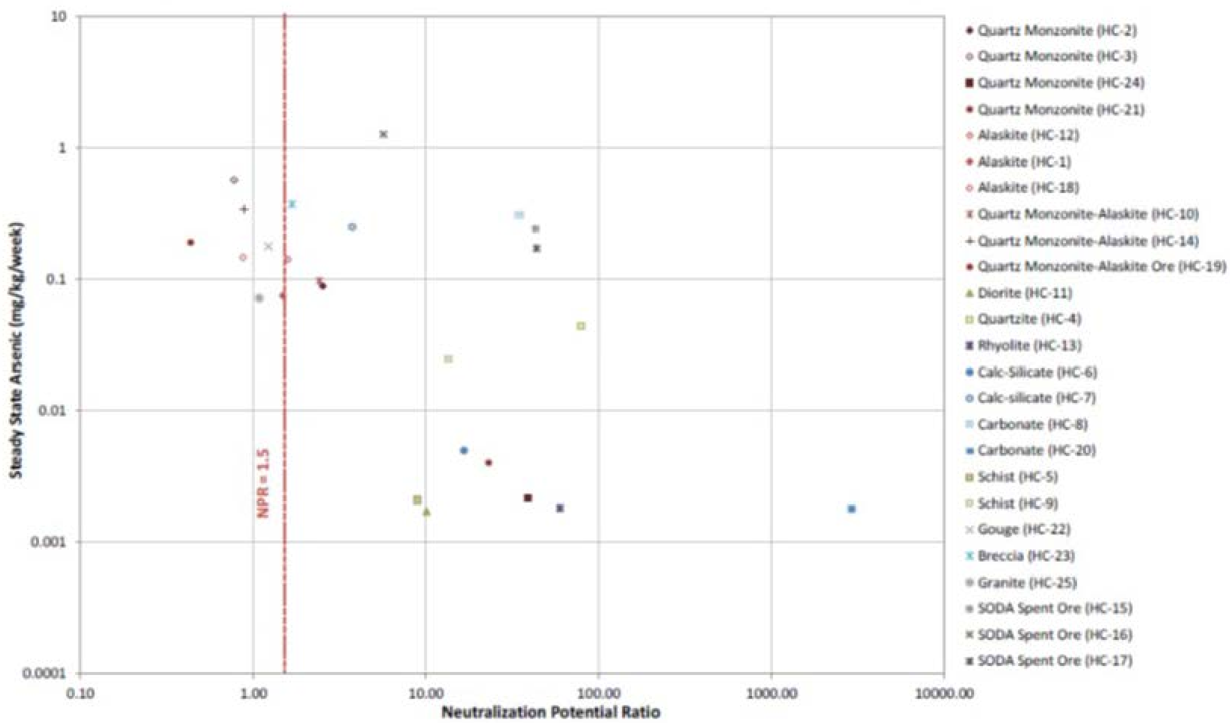
3.5 The Development Rock Management and Adaptive Management Plans are not well developed

A Development Rock Management Plan (DRMP) was not included in the DEIS but was created by Brown and Caldwell for the SDEIS (Brown and Caldwell, 2022). The DRMP must be based on the results of the geochemical testing program and ongoing monitoring and should provide an actionable approach for distinguishing acid generating/metal leaching (ARD/ML) development rock from more benign rock in the field. The DRMP includes a review of site conditions, the mine plan, a geochemistry summary, but only a half-page on segregating ore and development rock (Brown and Caldwell, 2022, p. 6-3). Again, the definition of ore (based on ore grade and the price of metals) will almost certainly change during mining. Therefore, rock designated as ore today could easily be considered waste rock in the future.

According to the plan, active segregation of PAG/ML material is not required, presumably because this material will be placed in the pit backfills or the Tailings Storage Facility (TSF) Buttress. Such an assumption relies on the performance of engineered measures to limit the transport of mine-influenced leachate from the pits and the TSF Buttress to downgradient water bodies. Assumptions about contaminant transport and predictions about the potential effects on water quality are included in the Site Wide Water Chemistry (SWWC) model (see Section 5 of this memorandum).

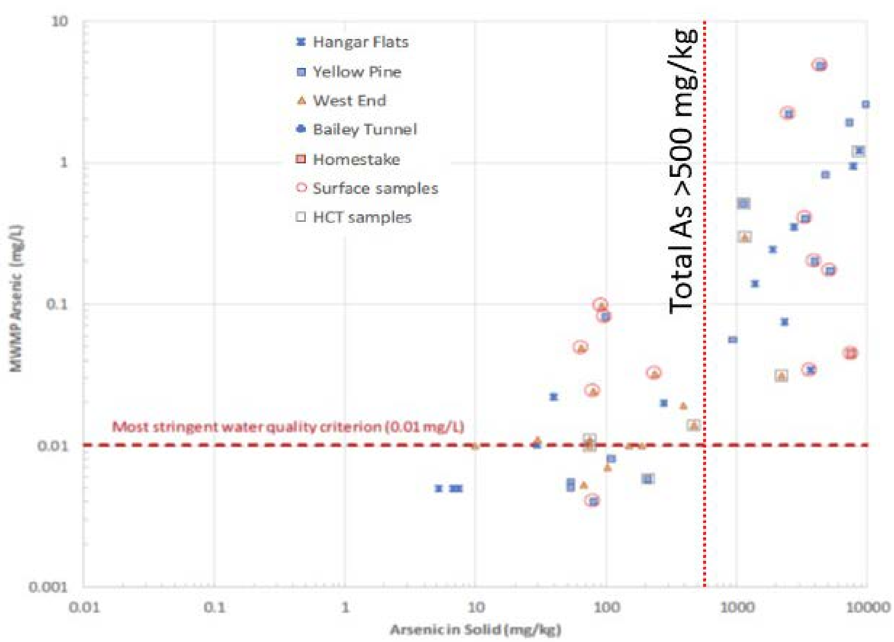
Development rock with low ARD/ML potential is proposed to be used for any construction application, including for constructing haul roads and pads for site facilities, and for use as road surfacing material or concrete aggregate (SDEIS, p. 2-46). Development rock with low ARD/ML potential is defined in the DRMP as material with bulk arsenic concentrations ≤500 mg/kg and NPR values >1.5 (Brown and Caldwell, 2022, Section 6.3). As shown in Figures 3a and b, the proposed cutoff values do not instill confidence that they will reliably identify materials with low vs. higher ARD/ML potential. Figure 3a shows that a substantial number of HCT samples with NPR values >1.5 have elevated steady-state arsenic release rates. As discussed in Maest (2020) and in Section 4 of this memorandum, steady-state release rates underestimate higher concentrations that are released early in the tests and under first flush conditions in the field. Figure 3b shows that a number of samples with total arsenic values <500 mg/kg have short-term releases of arsenic that exceed the federal arsenic drinking water standard of 0.01 mg/L.

Adaptive management plans (AMPs) are not developed as part of the SDEIS documents. The Water Resources Management Plan (Brown and Caldwell, 2021a) contains just 1.5 pages on adaptive management and states: “The specific thresholds and actions will be added to the WRMP when the permits are issued” (Brown and Caldwell, 2021a, p. 5-1). The DRMP has only two pages on adaptive management (Brown and Caldwell, 2022, Section 8). Specific performance measures, impact thresholds, and operational adjustment options are not included in any document. Given the uncertainty of the selected cutoff values used to identify material that can be used as construction fill, the DRMP needs to refer to a related AMP with specific monitoring, thresholds, and actions that will be put in place.



Source: Brown and Caldwell, 2022, Figure 5-6.

Figure 3a. Relationship between the NPR cutoff of 1.5 and steady-state arsenic HCT release rates from development rock and ore. Many samples with NPR values >1.5 leached



Source: SRK, 2021a, Figure 3-43.

Figure 3b. Relationship between total arsenic cutoff of 500 mg/kg and short-term leachate concentrations.

Summary: The selection of samples for geochemical testing did not consider hydrothermal alteration, which can substantially affect contaminant leaching and acid generation potential. Identifying geochemical test units within a given lithology would have solved this problem, but no test units within the lithologies were identified. The acid-base accounting methods used will likely overestimate NP in the long term, and much uncertainty exists about whether the newly mined materials will produce acid and therefore leach higher concentrations of contaminants over the long term. Management plans for the wastes are poorly developed or completely undeveloped and will need more supporting information and detail in a Revised SDEIS.

4. Shortcomings in Source Term Development

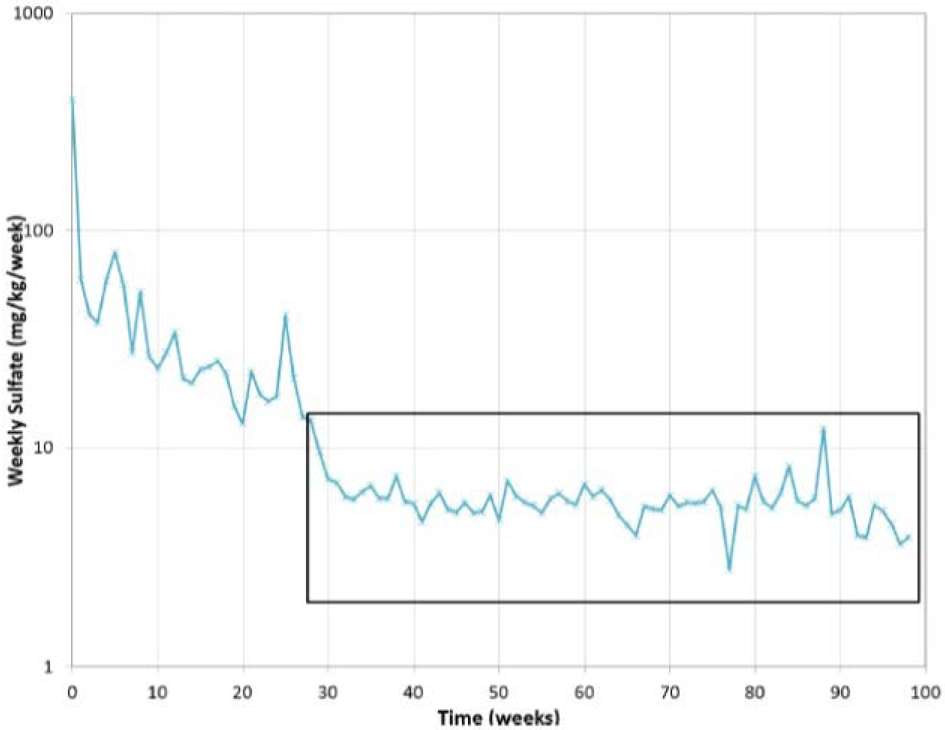
Source terms are created using scaled leaching rates from HCTs, and, in some cases, concentrations from short-term leach tests. The source terms are used as inputs to the SWWC model, in conjunction with meteorologic data, to predict the concentration of mine-related contaminants in groundwater and surface water resources on and off the Stibnite site. The primary shortcomings related to source term development are the exclusion of higher HCT first-flush rates, the lack of appropriate flushing terms for the backfilled pits and the tailings facility, and the lack of meaningful classifications used to develop and distinguish source terms. The development of source terms is primarily discussed in Appendix A and Sections 3, 5, 7, and 8 of SRK (2021b).

4.1 Use of average, steady-state leaching rates underestimates potential maximum concentrations.

Figure 4 presents an example of how steady-state leaching rates for sulfate are derived from HCT data. The original HCT data are in mg/L of sulfate, and the rates are calculated using the amount of material in the test columns (in kg) and the differences in concentrations between each week of testing. Source terms are derived for a particular sample using the average of all the rates inside the box depicted in Figure 4. Ignoring the initial higher release rates will underestimate the "first flush" of contaminants released when the sample is first wetted. The flush is caused by dissolution of soluble salts (usually metal sulfate salts) that form from the weathering of sulfide minerals. In fact, the HCT method underestimates the potential release of metals and sulfate that can occur under field conditions because of the frequent flushing with water (Price, 2009, p. 18-2). The first flush of contaminants from mined materials will occur when weathered wastes and ore are flooded and when weathered wastes and ore are wetted from storm events or snowmelt, especially after a previous dry period. Such conditions will exist at the Stibnite site in waste and ore stockpiles, backfilled pits, pit walls, and in the TSF Buttress/Embankment. Because the first-flush rates have been ignored, the source terms for development rock and ore will underestimate the release of contaminants from these mine facilities during operations and closure/post-closure.

4.2 Source terms do not reflect the flushing of contaminants from the pit walls or backfill that will occur as water levels rise and fall during closure/post-closure

Backfilling of the Hangar Flats, Yellow Pine, and Midnight Area pits will result in certain environmental benefits, as outlined in SRK, 2021b, Section 1.2. However, backfilling will also result in an initial increase in contaminant concentrations when the pits fill with water (for Hangar Flats and Yellow Pine) and when water levels in the pit fluctuate over time. The pits will be filled with development rock/ore, and the pit walls are also representative of development rock and ore (and the distinction between the two materials will change over time as commodity prices fluctuate). Because the source terms for development rock and ore do not take first flush concentrations into account from the HCTs, the predicted initial concentrations in the backfilled pit are likely severely underestimated.



Source: SRK, 2021b, Appendix A, Fig. 2-1.

Figure 4. Graph showing how "steady-state" average release rates are calculated for use in developing source terms. The box represents data used to calculate average release rates.

For most source terms average, steady-state rates were used, as discussed in Section 4.1 of this memorandum. However, for the legacy Spent Ore Disposal Area (SODA) and the Hecla Heap Leach, the averages included the first flush results from early in the humidity cell testing "as accumulated weathering products will flush during rehandling" (SRK, 2021b, Appendix A, Table 2-6). The same approach was used for the tailings source term (including first flush results) "as all water that comes into contact with the tailings will remain in the tailings facility, including the first flush chemistry" (SRK, 2021b, Appendix A, p. 20). This same flushing will result in the backfilled pits as water levels rise during closure and post-closure, as noted by SRK, 2021b:

- "During operations, the pit walls will be exposed to oxygenated conditions and will weather to form secondary minerals, including soluble salts. As the pit walls in Hangar Flats and Yellow Pine pits resaturate, soluble salts and other weathering products will dissolve into the ambient groundwater that flows into the pit as the walls are inundated." (p. 94)

- "Many solutes show initially elevated concentrations during operations, due to a relatively high solid:solution ratio during pit wall runoff events. Further solute flushing occurs during the groundwater rebound from both the initial flushing of backfill material and the proportion of unsaturated backfill." (p. 115, for Yellow Pine pit)
- "Most solute concentrations in the Yellow Pine pit backfill peak during the initial flush at mine year 13 (Figure 7-13). This results from a peak in solute flushing from the backfill and pit wall materials in the 'active zone of groundwater inflow' during this period." (p. 119)

Despite the multiple descriptions of the formation and dissolution of secondary salts on pit walls and pit backfill, average steady-state HCT rates are still used to estimate the release of contaminants. Although the water quality predictions for the Yellow Pine and Hangar Flats pits show higher initial concentrations (see, e.g., SRK, 2021b, Table 7-14 for the backfilled Hangar Flats pit, which will begin to fill in Mine Year 13), the predicted initial concentrations are only moderately higher and sometimes lower than predicted concentrations in subsequent years.

Raising and lowering of water levels in backfilled pits and in the West End pit lake will cause formation and dissolution of secondary minerals on a seasonal or annual cycle (related to storms, drought, snowmelt, etc.), and this is not taken into account in source term development or model predictions. As noted by Price (2009, p. 7-9), "Flooding will result in dissolution of any secondary minerals that have precipitated from process water or from previous weathering…Seasonal variation in drainage inputs may result in: large fluctuations in the height of flooding, annually flushing weathering products from intermittently exposed portions of the mine, changing flow paths and adding new discharge locations down gradient of the excavations….The initial flooding and any subsequent flow may result in significant leaching and discharge of soluble contaminants."

Because the flushing of contaminants from secondary minerals is not considered in the development of source terms or modeling, predicted concentrations in the backfilled pits will be higher than predicted and can adversely affect downgradient water quality.

4.3 The humidity cell results used to develop source terms for waste vs ore or PAG vs non-PAG materials do not correspond to their classifications, and the distinctions appear to be meaningless

Designations of PAG/non-PAG materials and waste vs ore are not meaningful classifications for the severity of leaching from source materials. The source terms were developed using these designations for a given deposit and lithology, but as shown in Table 2 for Yellow Pine deposit's Alaskite ore and waste, these distinctions appear to be meaningless for arsenic and antimony leaching, which are two of the mine-related contaminants of highest concern. Further, HCT results from material classified differently than the source term designations were used in their development – for example, non-PAG samples were used to develop PAG source terms and vice versa. The rationale behind the convoluted use of HCTs for source term development is not explained.

As shown in Table 2, some of the same HCT samples were used for PAG vs. non-PAG waste and even waste vs. ore. For example, HC-14 was used for all categories, regardless of whether the source term is for waste, ore, PAG, or non-PAG. HC-14 is classified as PAG quartz monzonite/alaskite development rock (using the NPR cutoff of 1.5; HC-14's NPR is 0.89; see SRK, 2021b, Appendix A, Table 2-2). In the same table, HC-19 is classified as PAG ore yet is used in development of source terms for PAG and non-PAG waste and PAG ore. HC-1 is classified as PAG development rock and is from the Hangar Flats deposit yet is used for the Yellow Pine non-PAG waste source term.

Table 2. Comparison of sources terms for Yellow Pine Alaskite ore and waste rock.

Waste/Ore	PAG/non-PAG	HCTs used (averages of all listed)	Arsenic source term (mg/kg/wk)	Antimony source term (mg/kg/wk)
Waste	PAG	HC-12, HC-14, HC-19	0.22	0.0079
Waste	Non-PAG	HC-12, HC-1, HC-14, HC-19	0.19	0.0098
Ore	PAG	HC-14, HC-19	0.25	0.0098
Ore	Non-PAG	HC-12, HC-14	0.23	0.0066
Source: SRK, 2021b, Appendix A, Attachment 4.				

Although arsenic source terms for PAG waste are slightly higher than those for non-PAG waste, and ore values are slightly higher than similar waste values, the same is not true for antimony. Non-PAG waste has the same antimony source term as PAG ore (0.0098 mg/kg/wk), and the antimony source term for non-PAG waste (0.0098 mg/kg/wk) is higher than the source term for PAG waste (0.0079 mg/kg/wk).

The lack of significant differences between PAG vs non-PAG and waste vs. ore source terms indicates that the acid generation potential and material type (waste vs. ore) are not meaningful distinctions – yet they were used to develop source terms for the SWWC model.

In addition to a cutoff value of 1.5 NPR to separate PAG and non-PAG rock, the other cutoff value used in the DRMP is 500 mg/kg arsenic (see Section 3.5 of this memorandum). However, as shown in Figure 3.b, samples with total arsenic values <500 mg/kg leached arsenic concentrations both above and below the drinking water standard of 0.01 mg/L.

Summary: Source terms are one of the most important inputs to the SWWC model for predicting water quality, yet their development is convoluted and unsupportable. Source terms for the SWWC model need to be thoroughly reexamined in a Revised SDEIS.

5. Shortcomings in the Site Wide Water Chemistry Model

The Site Wide Water Chemistry (SWWC) model relies on inputs from the geochemical characterization program, source terms, the water balance model, and water treatment plant (WTP) effluent quality to predict water quality resulting from development of the SGP. The primary document for the SWWC model is SRK, 2021b. The shortcomings of the model include the use of averages, omissions of contaminants and contaminant pathways, lack of consideration of climate change, and assumptions about proposed mine water treatment.

5.1 Use of averages underestimates the potential upper range of concentrations in mine-influenced waters

The SWWC model predicts annual average chemistry for the TSF Buttress and Embankment, TSF surface water, and the West End pit lake (SRK, 2021b, Tables 5-5, 6-7, and 8-3, respectively). Surface water quality at nine prediction nodes is now estimated on a monthly rather than an annual time step (SRK, 2021b, p. 4).

Existing groundwater chemistry used averages for the entire period of record for each well (2012-2019; SRK, 2021b, p. 55). Infiltration through the TSF Buttress and Embankment geosynthetic cover during post-closure is estimated at <5% of average annual precipitation, but the annual average precipitation does not take climate change into account. The scaling factors used for HCT rates (to scale from laboratory to field conditions) use the annual average temperature (which does not consider climate change), average release rates (as described in Section 4.1 of this memorandum), and average infiltration from the Site Wide Water Balance Model (Brown and Caldwell, 2021b; which also does not consider climate change) (SRK, 2021b, Sections 5.9 and 8.1). A single sensitivity analysis on temperature (increasing the annual average temperature from 2.8 to 12°C) was examined in the sensitivity analysis report (SRK, 2021c), but a sensitivity analysis on site precipitation was not conducted.

The use of average annual and average monthly predictions for site water quality and average precipitation, runoff, and infiltration without considering climate change will underestimate potential maximum concentrations that will require treatment or management.

5.2 Important contaminants and contaminant pathways are not included in the model

Contaminants excluded: Blasting of the open pits will leave blasting residue in pit wall fractures, waste rock, ore, tailings, waters draining facilities that include these materials, and in pit waters. The primary constituents in blasting residue are nitrate and ammonia. Nitrate is included in the SWWC model, but ammonia is not. Ammonia is toxic to aquatic life at concentrations that are dependent on water temperature, pH, and whether salmonids or fish early life stages are present (US EPA, 2013).

The SWWC model (SRK, 2021b) includes nitrate loading from the TSF Buttress (Section 5.8), backfilled pits (Section 7.7), and from walls of the West End Pit (Section 8.5). Ammonia concentrations in WTP influent are discussed briefly in Brown and Caldwell (2021a, p. 8-10) as likely being <0.3 mg/L as N, based on a 1988 paper on open pit waters; it is likely that the concentrations in pit and influent waters at the site will be higher. The treatment objective for ammonia is 2.1 mg/L as N (Brown and Caldwell, 2021a, Table 8-9). However, ammonia removal was not evaluated; instead, the water management plan states that treatment plant influent concentrations will be monitored, and the treatment process will be modified if needed (Brown and Caldwell, 2021a, p. 8-10).

Selenium is another contaminant that is not fully evaluated in the SWWC model or as part of mine water treatment requirements. The primary contaminants of interest (COI) are arsenic, silver, cadmium, copper, mercury, nickel, nitrate/nitrite, lead, antimony, thallium, and zinc, and these are the only constituents that were evaluated for their potential presence in treatment plant influent water quality during operation. However, the Water Management Plan (Brown and Caldwell, 2021a, p. 8-10) notes that the Idaho Pollution Discharge Elimination System (IPDES) permit limits and/or monitoring requirements may be required for temperature, pH, total suspended solids, ammonia, cyanide, cadmium, and selenium. HCT development rock and tailings samples also leached selenium (SRK, 2021b, p. 33 and 35). A treatment objective for selenium is not included for the WTP (SRK, 2021b, Table 8-9).

Conceptual model and contaminant pathways excluded: The ModPRO2 SWWC conceptual model is described in SRK (2021, Section 10.1) as follows:

> "The results of the individual facility geochemical models for the TSF Buttress (Section 5), TSF (Section 6), the backfilled Hangar Flats, Yellow Pine and Midnight pits (Section 7), West End pit lake (Section 8) and WTP effluent water quality (Section 9) have been incorporated into a site-wide water chemistry (SWWC) model to provide an overall prediction of current and future chemistry in Meadow Creek, the EFSFSR, West End Creek and Sugar Creek. The purpose of the SWWC model is to assess surface water chemistry at a series of nine prediction nodes downgradient of the mine facilities."

Although graphical conceptual models are included for the individual facilities, a conceptual model for the overall SWWC model does not exist. As noted in my 2020 comments (Maest, 2020), stream sediment and the food-chain pathway for fish (i.e. sediment to periphyton/macroinvertebrates to fish) is still not included in the SDEIS or the SWWC model. The Water Resources Monitoring Plan (Brown and Caldwell, 2021c) does not include monitoring of stream sediment for contaminant content, and sediment quality standards are not included in the proposed environmental standards.

Groundwater contaminant pathways are considered in the water balance model, as noted in the SWWC model report (SRK, 2021b, p. 144). The water balance model assumes that mine-influenced water can enter streams from groundwater via:

- Leakage through the TSF liner and the TSF Buttress/Embankment (to Meadow Creek)
- Groundwater outflow from the backfilled Hangar Flats pit to the Meadow Creek alluvial aquifer
- Groundwater outflow from the backfilled Yellow Pine pit to the East Fork of the South Fork of the Salmon River (EFSFSR), and
- Outflow from the West End pit lake to groundwater (to West End Creek and Sugar Creek).

Particle tracking from the pits indicates that outflowing groundwater will reach several surface water assessment nodes. However, the SDEIS (p. ES-15) states that groundwater contamination is not being considered because there are no active domestic wells within 15 miles of the site. The SDEIS further implies that groundwater is unlikely to be used for drinking water in the future based on a 20-year-old Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment report conducted for the existing mine site (SDEIS, p. 5-423 – 5-424). The ATSDR (2003) report states that the public health assessment conducted for the mine site existing at that time eliminated groundwater from consideration as a pathway as a public health concern (SDEIS, p.). However, this 20-year-old assessment was for the mine site that existed at that time and says nothing about whether groundwater could be used as a drinking water source in the future. Further, ATSDR was completing an assessment of the site to fulfill its congressional mandate for preparing a public health assessment within one year of US EPA proposing a site to the National Priority List (Superfund). In contrast, the proposed SGP is a new proposed mine plan subject to applicable groundwater quality standards. The potential for groundwater use as a drinking water source in the future cannot be discounted and should be evaluated in a Revised SDEIS. Interest in future groundwater use should be evaluated in consultation with local tribes and communities.

5.3 Climate change is not considered in the SWWC model

The water balance model is presented in Brown and Caldwell (2021b). Climate change is discussed in the SDEIS but is not considered in the SWWC model (see SRK, 2021a). Meteorological conditions (air temperature, barometric pressure, wind speed, and precipitation) have only been monitored at the site since 2013, and past Parameter-elevation Regressions on Independent Slopes Model (PRISM) data[2] are being used to extend the precipitation and temperature data to capture *historic* variability (Brown and Caldwell, 2021a, Section 3.1). However, *future* climate projections and the use of climate change air temperature and precipitation predictions are not included in any SDEIS evaluations. Because the mine life is proposed to be 20 years (including construction, operation, closure, and reclamation; SDEIS, p. ES-5), TSF seepage is predicted to last for 40 years (SDEIS, p. ES-15), and post-closure and active management of the site would last in perpetuity, it is unacceptable that climate change has not been incorporated into the predictions for the proposed project. Executive Order 14008 requires the Chair of Council on Environmental Quality and the Director of the Office of Management and Budget to ensure that Federal permitting decisions consider the effects of greenhouse gas emissions and climate change (Federal Register, 2022). Greenhouse gas emissions are quantitatively estimated in the SDEIS (p. ES-10 and Table 2.9-1, p. 2-136). However, climate change has not been considered in any meaningful way in the water balance or in facility sizing. Climate change must be incorporated into all water balance estimates and the SWWC model in a Revised SDEIS.

[2] The PRISM interpolates a database of climate records onto a spatial grid covering the United States.

5.4 The water treatment approach and application need to be reevaluated

More details on water treatment are provided in the SDEIS compared to the DEIS, but treatment is proposed to last for only 25 years (to mine year 40). Climate change is not considered in the water balance model or the SWWC model and is consequently not considered for sizing of the WTP or any other mine facility. Water treatment details are included in Brown and Caldwell (2021a, Section 8).

During construction and early operation, the mine sources proposed to need water treatment are:

- Contact water from dewatering the Yellow Pine, Hangar Flats, and West End pits
- Stormwater runoff from the pits, TSF Buttress, Bradley tailings, SODA, Hecla heap leach, ore stockpile, truck shop, and ore processing facility
- Toe seepage from the TSF Buttress and long-term ore stockpiles, and
- Sanitary wastewater.

According to the SDEIS (p. 2-73), a modular, mobile, two-stage iron coprecipitation system would be used and then replaced by a two-stage iron coprecipitation system located near the ore processing facility. However, the Water Management Plan (Brown and Caldwell, 2021a, Section 8.6.1) states that the WTP technology during construction and operation would consist of oxidation, two-stage iron coprecipitation, mercury precipitation, ion-exchange, and solids separation. The discrepancy is not addressed.

According to the SDEIS, during closure, a new WTP would be built to treat water from the TSF and would include iron coprecipitation and reverse osmosis membrane treatment. According to the Water Management Plan (Brown and Caldwell, 2021a, Section 8.7.2), treatment during reclamation, closure, and post-closure would consist of oxidation, sulfide precipitation of mercury, softening with lime and soda ash, and RO membrane treatment, which will create a brine and permeate water.[3] The permeate water would be pH adjusted using calcite prior to an IPDES-permitted outfall to Meadow Creek. WTP residuals from the post-operational WTP will be placed in a storage area located on the northeast corner of the TSF, referred to as the closure water treatment residuals storage cell (Brown and Caldwell, 2021a, Section 8.7.5).

After mine closure and reclamation of the TSF Buttress and pit backfill surfaces, the plan assumes that contact water treatment would no longer be needed, but TSF process water treatment would continue through year 40 (SDEIS, p. 2-73). Note that neither treatment approach assumes the need to treat acidic water, which traditionally requires lime precipitation.

The water treatment approach and assumptions are based solely on desk studies. No bench-scale or pilot scale testing has been conducted. The importance of testing is noted in Brown and Caldwell (2021a, p. 8-30): “Confirmation testing required. Laboratory bench-scale testing is needed before WTP design and construction to determine the operating conditions needed to achieve the treatment objectives.” Confirmation WTP testing should be conducted as part of the Revised SDEIS.

[3] Permeate water is the water that flows through the membrane and is considered treated.

Predicted maximum dissolved WTP influent concentrations during reclamation, closure, and post-closure are presented in SRK, 2021b, Table 8-7. Very high influent concentrations are predicted for many parameters, including arsenic, copper, mercury, antimony, and sulfate in mine year 22, and concentrations increase for mine years 23-36. The increase is due to only capturing TSF tailings consolidation water that was previously (to year 22) diluted by TSF runoff due to the cover not being in place. This same table includes influent concentration predictions zero for many constituents. Although a footnote in Table 8-11 states that the water treatment plant operations schedule will be extended as long as is required to treat water to the applicable water quality standards prior to discharge, after year 36, influent concentrations are not included in Table 8-7. Similarly, toe "pop-out" seepage chemistry from the TSF Buttress and Embankment is predicted to stop in mine year 19 (SRK, 2021b, Table 5-6); the explanation in the tables notes "Post-mining the application of a low permeability geosynthetic cover to the TSF Buttress and Embankment means any toe/popout seepage will report to groundwater." The assumption of zero for WTP influent concentrations for many constituents and the assumption of no mine water capture and treatment being needed after the TSF cover is in place are both highly unrealistic.

The assumption that any TSF seepage will report to groundwater implies that it is acceptable to contaminate groundwater. As noted in Sections 5.2 and 6 of this memorandum, groundwater under the proposed TSF Buttress/Embankment does not currently exceed standards but is predicted to exceed water quality standards as a result of mining. The degradation of groundwater quality should not be allowed. Avoiding this degradation could require perpetual capture and treatment of mine-influenced waters.

As noted above, the treatment approach is based entirely on desk studies, and the references used for arsenic and antimony removal by iron by Fe coprecipitation are outdated (references range from 1979 to 2011; Brown and Caldwell, 2021a, Section 8.5.2). An alternative antimony and arsenic removal approach by electrocoagulation using iron-aluminum electrodes is described by Song et al. (2014). An article by Inam et al. (2019) describes the effects of water chemistry on antimony removal by chemical coagulation and concludes that oxidized dissolved antimony (Sb(V)) removal did not occur at alkaline pH values. And issues associated with removal of antimony using iron-based coagulants was examined by Cheng et al. (2020), who found that antimony removal was inhibited by the presence of humic acids and phosphate, as well as by oxidation and aeration. This last finding contradicts the approach proposed by Brown and Caldwell (2021a, Section 8.7.2) that includes an initial oxidation step.

Summary: Shortcomings in the SWWC model include the extensive use of averages that will underestimate potential maximum concentrations in surface waters, the lack of evaluating the effects and removal of ammonia and selenium, a missing conceptual model for the full SWWC model, and not considering stream sediment and the food-chain pathway in the model. In addition, future use of groundwater for drinking water has been excluded from consideration, and climate change is not considered in the SWWC model. The treatment approaches proposed have not been evaluated using laboratory bench studies, and the desk study performed used outdated references whose conclusions have been contradicted by more recent studies. These many shortcomings indicate that the SWWC model and associated studies need to be thoroughly reevaluated in a revised SDEIS. Perpetual capture and treatment of mine-influenced water should be evaluated in a Revised SDEIS.

6. Comparison to Relevant Water Quality Standards

The SWWC model predicts concentrations of COIs at surface water prediction nodes. The model results are presented in SRK (2021b, Appendix G) and compared to the strictest potentially applicable surface water quality criteria. Lack of aquatic life criterion for antimony is a concern, especially if surface water is not designated for drinking water use. The British Columbia Ministry of Environment and Climate Change Strategy has a chronic aquatic life guideline for antimony of 0.009 mg/L (British Columbia MOE, 2021), and this guideline should be considered for IPDES permit limits if the Idaho drinking water standard of 0.006 mg/L is not included. The selenium aquatic life standard used in Appendix G may not reflect the most updated approach used by US EPA (2016).

The SWWC model only predicts mining-influenced groundwater quality for groundwater under the TSF Buttress and Embankment and under the TSF (SRK, 2021b, Tables 5-7 and 6-8, respectively). For some constituents, including arsenic and antimony, groundwater quality under the TSF Buttress and Embankment does not exceed standards under current conditions but does as a result of the project. For existing alluvial and bedrock groundwater under the TSF Buttress and Embankment (SRK, 2021b, Table 5-7), measured arsenic and antimony concentrations are below relevant standards, but predicted arsenic and antimony concentrations during and after mining exceed Idaho groundwater standards. For groundwater under the TSF, predicted arsenic and antimony concentrations during and after mining do not exceed Idaho standards, but predicted concentrations during and after mining do exceed existing alluvial groundwater concentrations (SRK, 2021b, Table 6-8). The project is not allowed to worsen groundwater quality. The current lack of active domestic wells should not discount the potential for future use of groundwater as a drinking water source, as discussed in Section 5.2 of this memorandum. The Forest Service must demonstrate that the proposed mine plan is in compliance all applicable state and federal laws.

The current Idaho arsenic groundwater standard of 0.05 mg/L is applied for existing and predicted concentrations under the TSF Buttress and Embankment and under the TSF. In addition, pit water is considered groundwater, and the current Idaho groundwater standard of 0.05 mg/L arsenic is applied (SRK, 2021b, p. 115). The current Idaho groundwater standard does not reflect the federal drinking water standard of 0.01 mg/L arsenic, which was updated in 2006 (US EPA, 2022). The US EPA disapproved Idaho's human health criteria for arsenic in 2016 and then extended the deadline for Idaho to address its arsenic standard to November 15, 2023 (Idaho Department of Environmental Quality (IDEQ), 2022). The current federal drinking water standard for arsenic should be used to compare against predicted groundwater concentrations resulting from the project.

Summary: The surface water quality standards that could become part of an IPDES discharge permit need to consider the use of an aquatic life guideline for antimony in case the groundwater standard for antimony is not considered relevant. The selenium standard used to compare to predicted surface water concentrations in the SWWC model may not reflect the most updated approach used by US EPA. The use of groundwater at the site as a drinking water resource in the future should require that the project cannot worsen groundwater quality. Idaho's arsenic groundwater standard of 0.05 mg/L does not reflect the current federal drinking water standard of 0.01 mg/L and should be updated and used to compare against predicted groundwater concentrations resulting from the proposed project. The Forest Service must demonstrate that the proposed mine plan is in compliance all applicable state and federal laws.

7. Qualifications

Ann Maest is an aqueous geochemist with Buka Environmental in the historic mining town of Telluride, Colorado. She has over 25 years of research and professional experience and specializes in the environmental effects of hardrock mining, baseline water quality, the fate and transport of natural and anthropogenic contaminants, geochemical testing methods and modeling, and responsible mining certification. She has evaluated more than 150 Environmental Impact Statements for large-scale mines in the United States, Latin America, Asia, and Africa and provides training to US and foreign government agencies on EIS evaluation, the environmental effects of mining, and best practices. The results of her research have been published in peer-reviewed journals including Applied Geochemistry, Canadian Journal of Fisheries and Aquatic Sciences, Chemical Geology, Minerals, Applied and Environmental Microbiology, and Environmental Science and Technology. After completing her PhD, Dr. Maest was a research geochemist in the U.S. Geological Survey's National Research Program, where she conducted research on metal-organic interactions, metal and metalloid speciation, and redox geochemistry in surface water and groundwater systems. She has served on several National Academy of Sciences committees and a Board related to earth resources and has been an invited speaker at universities and national and international fora, including presenting on technical challenges and solutions for the mining sector at the United Nations. Ann holds a PhD in geochemistry and water resources from Princeton University and an undergraduate degree in geology from Boston University.

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8. References Cited

Note: Where discrepancies exist between reports listed as references in the SDEIS and those available on the USDA Forest Service website (see Table 1), the more recent references used in this memorandum are listed in this section.

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Appendix 1. Identified DEIS water quality and geochemistry issues and coverage in SDEIS

DEIS Issue	Addressed in SDEIS?	Comments	SDEIS Citations
Geochemical test units not identified or used in sampling and analysis	No	SRK, 2021a, Figs. 2-1 and 2-2 show areas of known mineralization, but the mineralization refers only to the economic mineralization areas (gold, silver, antimony). The lithologic units are not broken down into specific mineralized units that different types of hydrothermal alteration that will have different leaching characteristics. See Table 6-2 in USDA Forest Service, 2022. Many sections of the SRK 2021a report document the differences within a lithology depending on the amount and type of hydrothermal alteration different parts have experienced, but there is no information confirming that the geochemical test samples took the alternation into account in terms of sample selection and representation.	SRK, 2021a, Figures 2-1 and 2-2 and Sections 2.3.1, 2.3.5, etc. USDA Forest Service, 2022, Section 6.2.1 and Table 6-2.
Neutralization potential of Stibnite waste and ore samples consistently overestimated	No	Same approaches are used. No new ABA samples were analyzed. New results from certain Phase 2 kinetic tests presented in SRK, 2021a. Phase 1: 2011-2017; Phase 2: 2017-2019.	SRK, 2021a, p. 1. "…the overall conclusions of the characterization program have not changed from the 2017 Baseline Geochemical Characterization report"
Source terms underestimate likely releases (some samples	Yes, some. Source terms for development rock and ore were	Source terms are the inputs to the water quality model used to predict surface water	SRK, 2021b, Appendix A

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producing acid not included, legacy materials not considered, source term variability not evaluated in sensitivity analysis, use of average steady-state rates, samples with higher release rates excluded (HC-3, HC-8 with highest As/Sb releases), DRSF source terms presented as rates not concentrations, assumed surface water inflow source terms will have no mining influence)	updated to incorporate latest block model, data from Phase 2 HCTs, additional characterization data for alluvium. Source terms were developed for the legacy materials. Source terms for TSF Buttress, ore stockpiles, pit walls, backfilled, pits, TSF were added/updated.	concentrations in water bodies.	
Groundwater quality not included in site-wide model	Yes		SRK, 2021b, The only locations where groundwater quality is predicted are under the TSF Buttress/Embankment (Section 5.9.3) and under the TSF (Section 6.5.2).
Extensive use of averages in SWWC model and underestimates of downstream sulfate, arsenic, and antimony concentrations	No	Averages are still used for acid-base accounting (ABA), short-term leach test (MWMP), and kinetic test (HCTs) results.	SRK, 2021a. ABA: Tables 3-8 - 3-10. MWMP: Tables 3-14, 3-15. SRK, 2021b, Appendix A.
Food chain/dietary pathway for fish not considered in conceptual models, existing conditions, or current/future modeling efforts	No	Metal/contaminant concentrations in macroinvertebrates is not mentioned in the SDEIS.	NA

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Arsenic and mercury concentrations in sediment exceed Canadian probable effects level, but sediment-macroinvertebrate-fish pathway not considered	No	In general, sedimentation and suspended sediment *quantities* are only considered. Alluvial samples are compared to average crustal abundance in SRK, 2021a, Table 5-2. Arsenic and antimony are >12 times higher in all three areas (Hangar Flats, Bradley Dumps, West side EFSFSR alluvium) and mercury is 3-6 times higher than average crustal abundance.	See, e.g., SRK, 2021a, Table 5-2.
Arsenic and antimony speciation effects on toxicity not considered	No	Speciation of arsenic and antimony in surface water samples was not determined.	NA
Just one HCT sample used to represent all potentially acid generating (PAG) rock	Yes, to some extent. Now three samples used to represent PAG rock.	Results remain about the same; PAG HCT samples still did not produce acid	SRK, 2021b, p. 35
Legacy SODA materials proposed to be used for tailings impoundment embankment construction have highest arsenic and antimony release rates and highest initial mercury concentrations in HCTs	No	Legacy SODA materials are still proposed to be used for the TSF Embankment.	SDEIS, Table 2.4-9
Perpetual mine water treatment needed but climate change not considered and little detail on treatment methods	More details on water treatment provided but proposed to last for only 25 years. Climate change not considered in SWWC model.	<u>Water Treatment</u>: SDEIS Tables 4.9-9 and 4.9-10 show predicted WTP influent and effluent concentrations. SDEIS Figure 4.9-12 shows closure WTP flowsheet. Closure/Post-Closure	Water treatment details are in Stibnite Gold Project Water Management Plan (Brown and Caldwell 2021a). SDEIS, p. 2-73: "During construction and early in

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		water treatment only through ~Yr 40 (SDEIS, Table 2.2-1). Closure water management and treatment to continue for 25 yrs (Mine Years 16-40; SDEIS, p. 2-8). Using iron coprecipitation alone will not reduce concentrations enough (look at B&C 2021b). Climate Change: Climate change is discussed in the SDEIS but is not considered in the SWWC model (see SRK, 2021b and Brown and Caldwell, 2021b, Section 3.1). Only have a 7-yr record at the site, and using PRISM data to extend for a total of 30 years. No mention of future projections and use of climate change temperature/precip predictions.	operations, a modular, mobile, two-stage iron coprecipitation system would be utilized. Early in operations, this system would be replaced by a two-stage iron coprecipitation system located near the ore processing facility.”
Adaptive management and development rock management plans do not exist.	Yes for the DRMP, but limited; no for the AMP	AMPs for individual components are mentioned in the SDEIS (e.g., for solids removal from Yellow Pine Pit (SDEIS, p. 2-68), and for the EMMP (Environmental Monitoring and Management Plan, Brown and Caldwell, 2021d; SDEIS, p. 2-92). But identification of performance measures, impact thresholds, and operational adjustment options are not included in any document. The EMMP contains a framework for adaptive management but no details.	Brown and Caldwell (2022) is the development rock management plan (DRMP).

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		The Water Resources Monitoring Plan (Brown and Caldwell, 2021c) contains just 1.5 pages on adaptive management and states: "The specific thresholds and actions will be added to the WRMP when the permits are issued" (Brown and Caldwell, 2021c, p. 5-1). The DRMP has only two pages on adaptive management (Brown and Caldwell, 2022, Section 8).	
Source for DEIS issues: Maest, 2020.			