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TECHNICAL MEMORANDUM

To: Bonnie Gestring, Earthworks
From: Ann Maest, PhD; Buka Environmental
Date: 15 October 2024
Re: Stibnite Gold Project, Idaho: Objections to the Final Environmental Impact Statement (FEIS) Related to Geochemistry and Water Resource Issues

1. Introduction

The objections contained herein address shortcomings in the Stibnite Gold Project Final Environmental Impact Statement (FEIS; USDA Forest Service, 2024). Many comments that I provided for the SDEIS were not addressed. I discuss these here and also provide additional comments on the FEIS. A summary of key points is included as Section 3 of this memorandum.

2. Objections

2.1 The effects of climate change are not included in the water models.

My SDEIS comment: 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. (Maest, 2022, pgs. 1, 3, 4, 20)

Response in FEIS, App. B: Climate change was not explicitly incorporated into numerical water chemistry modeling. SDEIS Section 4.4.2.2 qualitatively describes climate change implications for water quality. (pg. B-234)

And in response to Samuel Penney on a similar topic: Quantitative description of potential climate change effects on precipitation and evaporation is outside the scope of the EIS analysis. Qualitative descriptions of the potential effects of climate change on the affected environment are included in SDEIS Section 4.4. (pg. B-277)

Comments on FEIS and why this is important: Quantitative assessment of the effects of climate change must now be included in the scope of the EIS analysis. As noted in my SDEIS comments (Maest, 2022), 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. Additional orders may be applicable at this point in time. Neither the site-wide water balance model report (Perpetua, 2021g by B&C) nor the SWWC report included in the FEIS (SRK, 2021b) mention climate change. It is not adequate to use the past climate record to predict future climate conditions. Climate change will change precipitation amounts and timing, and that will strongly affect water balance and water quality. The climate change specialist report (USDA Forest Service, 2023b) only addresses the impacts of the project on climate change, not the impacts of climate change on site water balance, water chemistry, or facility design and sizing. Climate change will increase precipitation variability, which will require mine facilities to be constructed to withstand larger storms to avoid overtopping and the movement of mine-influenced waters (MIW) into groundwater and surface water resources.

The effects of climate change on water quantity and quality could be handled quantitatively in the water models. For example, MIKE SHE is an integrated climate-groundwater-surface water code that is routinely used to incorporate climate change. As noted on their website (DHI, 2024, MIKE SHE enables users to assess the impact of various factors like land use changes, climate variability, and water management interventions on water resources and ecosystems and allows the user to predict future water resource challenges with robust simulations of climate change impacts on hydrology.

The Forest Service should require Perpetua to use an integrated hydrogeologic/hydraulic code, such as MIKE SHE, to quantitatively evaluate the potential effects of increased future climate variability on the Project, and mine facilities should be redesigned to protect against overtopping in future storm events.

2.2 The proposed water treatment approach is untested

My SDEIS comment: Bench-scale testing of the proposed mine water treatment methods is needed; the current evaluation only uses a desk study with outdated references. (Maest, 2022, pgs. 1, 4, 20, 21)

Response in FEIS, App. B: The coprecipitation water treatment technologies proposed by the Project have been used effectively for mine water treatment for more than 20 years. Therefore, there is a reasonable expectation that they would be able to achieve water treatment objectives. (pg. B-234)

Comments on FEIS and why this is important: The response does not indicate whether coprecipitation is effective for the specific COIs at the Stibnite Gold Project. The predicted maximum antimony concentrations in water treatment plant influent water (FEIS, pg. 4-231, Table 4.9-9) are the highest I have ever seen in my many years of working on mine water chemistry. In addition, predicted influent concentrations of arsenic, fluoride, and nitrate/nitrite are highly elevated, as shown in Table 1, and these constituents and antimony are not easy to remove and often need specialized approaches that are not considered in the FEIS.

Table 1. WTP influent sources and their predicted maximum arsenic, boron, fluoride, antimony, sulfate, and nitrate+nitrite concentrations, using results from SRK 2021b,* Appendix D

Source[1]	Mining Years	As (mg/L)	F (mg/L)	Sb (mg/L)	SO_4 (mg/L)	NO_2+NO_3 (mg/L as N)
Hangar Flats Pond	-2 to 4	22	9.0	7.2	576	298
SODA Pond	3 to 17	6.4	9.0	2.8	576	307
Plant Ponds	-1 to 17	6.4	3.3	2.8	316	14

Source[1]	Mining Years	As (mg/L)	F (mg/L)	Sb (mg/L)	SO_4 (mg/L)	NO_2+NO_3 (mg/L as N)
West End Pond	-1 to 10	31	31	0.29	2,298	3,874
Midnight Pond	-2 to 12	1.07	0.65	0.118	35	69
Predicted maximum WTP influent concentrations[2]		30.08	5.6	8.51	7,508	401
Strictest water quality standard used in the water quality analysis[3]		0.010	2	0.0052	250	10

1 The five sources in this table are the contact water collection ponds listed as inflows to the water treatment plant in SRK (2021b, Table 9-1)
2 FEIS, pg. 4-231, Table 4.9-9, for all phases of mining; SO4 concentrations of 7,508 mg/L is from tailings decant solution chemistry (FEIS, Table 3.8-7)
3 FEIS, pg. 3-149, Table 3.9-1
NA not applicable
** Note that the wrong SRK 2021b reference is cited in the FEIS (pg. 7-39). It should be the 2021 SRK SWWC model report from October rather than the 2021 SRK SWWC model sensitivity analysis report DRAFT from November.*

I believe the comment reviewers did not read my report, which discusses the shortcomings of this approach and new options (Maest, 2022, pg. 21): "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."

No antimony speciation results are provided, but it is highly likely that oxidized antimony (As(V)) will be present in MIW entering the water treatment plant (WTP), and, using this treatment approach, even reduced antimony will become oxidized, resulting in higher effluent antimony concentrations than predicted in the FEIS (FEIS, pg. 4-232, Table 4.9-10).

In addition, the WTP should have a surge pond or similar to allow mixing of higher and lower concentration MIW. A surge pond to handle and store MIW entering the WTP does not exist. The WTP is unprepared for such high concentrations.

At a minimum, Perpetua should prepare water with predicted maximum concentrations of COIs and do a bench scale experiment to see the effectiveness of the proposed and untested treatment system.

2.3 Comments on the Site Wide Water Chemistry (SWWC) Model

2.3.1 Use of averages underestimates water quality impacts and WTP influent values

My SDEIS comment: 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

Stibnite Gold Project. 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. (Maest, 2022, pg. 3, 17, 21)

Response in FEIS, App. B: None. This comment was included by Bonnie Gestring, Earthworks, as Comment 82 (p. B-234), but no response was provided.

Comments on FEIS and why this is important: The FEIS did not change its approach to using averages. The use of average annual and average monthly predictions for site water quality and average precipitation, runoff, and infiltration without considering climate change and maximum concentrations derived from laboratory leach tests will underestimate potential maximum influent concentrations that will require treatment or management. Importantly, because of the use of average water quantity and quality and minimization of source terms (see Section 2.3.3 of this report), the "maximum" influent concentrations presented in FEIS Table 4.9-9 are not technically maximum values – they are instead maximum average values, and the title of this table should be changed to reflect its derivation. Using averages to derive input values means that the WTP cannot be relied upon to meet target effluent concentrations. The use of averages for meteorology and hydrologic characteristics also means that the mine facilities will not be designed to withstand the predicted extremes in precipitation expected from climate change. Designing for unrealistic smaller storms will result in overtopping, increased infiltration to groundwater, and transport of MIWs to surface waters.

2.3.2 Important mine contaminants are not included in the model or in water treatment, and errors exist in the FEIS target effluent concentration table

My SDEIS comments: 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 may require monitoring and permit limits for both of these mine-related contaminants. The treatment evaluation does not consider the removal of ammonia or selenium. (Maest, 2022, pg. 3)

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). (Maest, 2022, pg. 18)

Response in FEIS, App. B: Project effects on selenium and ammonia concentrations are described in SDEIS Section 4.9.2.2. (pg. B-234)

Comments on FEIS and why this is important: My comment is also about the importance of including selenium and ammonia removal targets for the WTP, and of ensuring that the WTP can remove other COIs, and this part of the comment was not responded to. It is clear that selenium, ammonia, and other mine-related constituents of interest (COIs) will be present in MIWs, but the FEIS does not consider them in the treatment scheme. Excluding these COIs from treatment threatens groundwater and surface water quality in the Project area.

The FEIS (pg. 4-233) states “Constituents that do not have a target effluent concentration were assumed to be unaffected by the treatment process.” Target effluent objectives are listed in Table 4.9-10 (FEIS, 4-232). No targets are included for aluminum, barium, chloride, fluoride, manganese, or selenium, so we must assume that the WTP would not remove these COIs. Aluminum, fluoride, manganese, and selenium were elevated above applicable water quality criteria in the humidity cell, meteoric water mobility, and/or the tailings decant water chemistry test results (FEIS, Tables 3.9-8, 3.9-6, 3.9-7, respectively). Fluoride exceeded applicable standards only in the tailings decant solution, and chloride was elevated in these same samples (57.5 mg/L; FEIS, Table 3.8-7). Cyanide was also elevated above applicable standards in the tailings decant samples. Although ammonia has a listed target effluent concentration of 2.1 mg/L as N in FEIS Table 4.9-10, its removal in the WTP is not specifically evaluated.

Ammonia

The primary source of ammonia in MIWs is blasting. None of the geochemical tests included materials that were derived from blasting, so of course it would not be present in the test results. However, blasting will elevate both ammonia and nitrate concentrations during operations. Leakage from open pits and mine wastes to groundwater will cause blasting residues (ammonia and nitrate) to reach groundwater resources. Ammonia should have been included in the groundwater chemistry model in the FEIS, but it was not (FEIS, pg. 4-197 – 4-198). Ammonia is also a concern for groundwater-surface water interactions – where groundwater discharges to surface water – because it can adversely affect fish, especially salmonids and early life stages, at low concentrations, depending on the pH and temperature of the receiving water (IDEQ, 2024a; US EPA, 2013).

The predicted maximum WTP influent concentrations of ammonia during construction, operations, and post-closure are all listed as <0.3 mg/L as N in Table 4.9-9 in the FEIS, based on the incorrect assumption that any ammonia from blasting will be oxidized to nitrate, as described in Brown and Caldwell (2021b).

According to Brown and Caldwell (2021b, pg. 8-10), “Ammonia is not shown in Table 8-5[1] because it was not modeled in the SWWC model. Literature data from many other open pit mines show MIW ammonia concentrations of less than 0.3 milligrams per liter (mg/L) as nitrogen (Ferguson and Leask 1988), which is lower than the treatment objective in Table 8-9. Ammonia concentrations in the treatment influent will be monitored, and the treatment process will be modified if needed.” The Ferguson and Leask 1988 document is not listed in the references in the Brown and Caldwell 2021b report. After some searching, I found the report on a Canadian

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[1] Table 8-5 is titled Predicted Maximum Dissolved Concentrations for the Comingled MIW During Construction and Operations

government website and have included it in the references to my report (Ferguson and Leask, 1988). First, this report is for surface coal mines, not hardrock metal mines such as Stibnite. Further, the results in the report discuss notable percentages and concentrations of ammonia in effluents from the coal mines examined. Three excerpts from the report are informative:

> Most of the nitrogen in effluents was present in the nitrate form (average 87%) with lesser amounts as ammonia (11%) and nitrite (2%). At the receiving water sites upstream of the mines, about 47% of the inorganic nitrogen was present as nitrate and 43% and 9% was present as ammonia and nitrite, respectively. Downstream of the mines, 87% of the inorganic nitrogen was present as nitrate, 10% was present as ammonia, and 3% was present as nitrite. The increase in the proportion of nitrate downstream of the mines compared to upstream reflects the large nitrate loadings from mine effluents. Since explosives contain large amounts of both nitrate and ammonia, the relatively high proportion of nitrate in effluents indicates significant conversion of ammonia to nitrate (nitrification) occurs between the source of nitrogen (pits and waste dumping) and the effluent discharge to receiving waters. Predictions for other mines should assume that the majority of inorganic nitrogen released will be present as nitrate. (Ferguson and Leask, 1988, pg. iv)
>
> and
>
> For all receiving waters, about 69% of the inorganic nitrogen was present as nitrate with 25% and 11% as ammonia and nitrate, respectively. (Ferguson and Leask, 1988, pg. 115)
>
> and
>
> Table 29 in Ferguson and Leask, 1988, show mean ammonia concentrations (mg/L as N) in Kootenay coal field mine "effluents" ranging from 0.008 to 1.531 mg/L, with only 5 of the 14 data points <0.3 mg/L, and many of the "effluents" are in creeks draining the mine rather than in effluents (one is noted as being upstream).

Adding ammonia removal to the WTP could require a new circuit – it may not be removed by the proposed approach.

A more appropriate comparison is the Buckhorn Mine in northern Washington State. The Buckhorn Mine is a small, underground gold mine that closed in 2017 and if anything used lower amounts of blasting agents than what will be required for blasting open pits at the Stibnite Project. Buckhorn WTP influent ammonia concentrations from the start of mining (January 2008) to February 2014 averaged 4.90 mg/L as N, with a range of 0.01 to 39.3 mg/L as N (n = 156) (Appendix 1). Buckhorn WTP influent nitrate+nitrate concentrations (mg/L as N) averaged 20.4 mg/L and ranged from 0.43 to 106 mg/L (n=388). Nitrate+nitrate concentration results are available from December 2007 to December 2023 (in the most recent data delivery). Note that reporting of influent ammonia concentrations was discontinued in 2014, but monitoring for ammonia continued in the WTP effluent and groundwater and surface water monitoring locations. Figure 1 shows that during operations (2008-2017) WTP influent concentrations of nitrate+nitrite and ammonia exceeded the strictest potentially applicable water quality standards/criteria for the Stibnite Project (10 for nitrate/nitrite and 2.1 for ammonia, mg/L as N). Influent nitrate+nitrate concentrations at the Buckhorn Mine were up to 10 times higher, and ammonia concentrations were up to 18 times higher, than the strictest potentially applicable Stibnite water quality values. As expected, influent nitrate/nitrite concentrations dropped after mining ceased, but during operations, concentrations of nitrate/nitrite and ammonia were quite elevated. Adding ammonia removal to the Stibnite WTP could require a new circuit – it may not be removed by the proposed approach. The Stibnite FEIS does not address the removal of ammonia in its WTP, and this lack of technical attention puts aquatic life at risk in Project receiving waters.

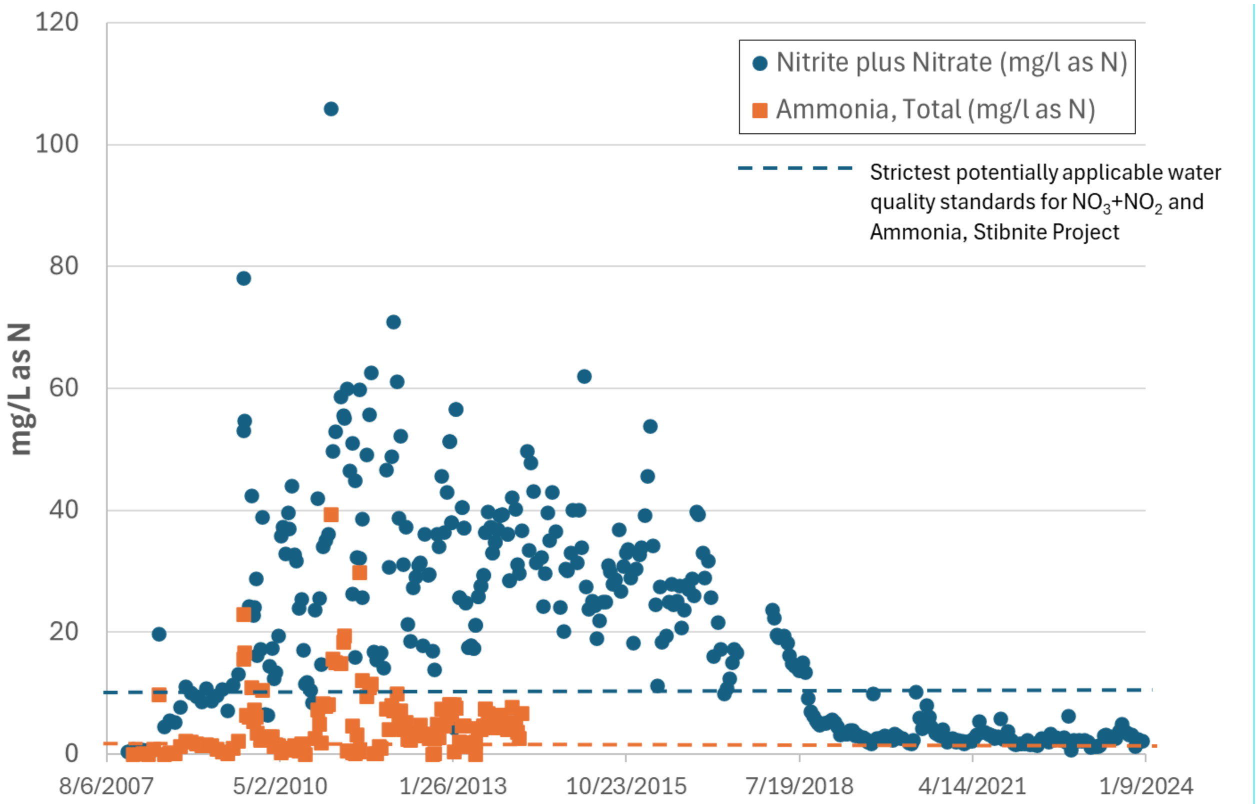

Figure 1. Buckhorn Mine WTP influent water quality for nitrate+nitrate and ammonia concentrations from the start of mining (January 2008) to December 2023. Stibnite water quality standards are included as dashed lines (10 mg/L as N for nitrate+nitrite and 2.1 mg/L as N for ammonia).

Selenium

Selenium was detected in baseline bedrock and alluvial groundwater samples (B&C, 2021b, Tables 3-12 and 3-13). According to the report, “There were no detections of selenium in any humidity cell samples; therefore, provisions for selenium treatment have not been contemplated in this WMP” (B&C, 2021b, footnote to Table 8-5). However, the baseline geochemical characterization report states “Other parameters including mercury and selenium were predominantly only elevated during the initial first flush (weeks one to four) (SRK, 2021a, pg. xviii).” Therefore, the decision to ignore the first flush concentrations has an important effect on what contaminants are considered for treatment in the WTP. Selenium removal could require a separate treatment approach, which would increase costs for Perpetua.

Also note that the FEIS Table 3.9-1 lists the selenium surface water quality standard value used in the water quality analysis as 0.0015 mg/L, but all the tables in Chapter 4 list the Strictest Potentially Applicable Surface Water Quality Criteria for selenium as 0.0031 mg/L, as does Table 3.9-6a and b (average MWMP results). No explanation for the difference is provided. The Idaho surface water rule (IDEQ, 2024a) appears to follow the US EPA criteria for selenium (US EPA, 2021), which prioritizes egg/ovary concentrations over fish tissue (in mg/kg) over water column concentrations (IDEQ, 2024b).

The FEIS includes a maximum predicted influent selenium concentration during construction, operations, and post-closure (Table 4.9-9), but it does not list a WTP effluent target (Table 4.9-10). As noted above, if a COI does not have a WTP effluent target, it is assumed to be “unaffected” by the treatment process (FEIS, pg. 4-233). There is ample evidence that selenium is leached from mined materials, and an effective removal mechanism should be included in the WTP, especially because its aquatic life criterion value is so low. In fact, the strictest potentially applicable surface water quality criterion for selenium in FEIS Chapter 4 tables is incorrect. It is listed as 0.0031 mg/L (see, e.g., FEIS Table 4.9-3), and it should be 0.0015 mg/L, as shown in FEIS, Table 3.9-1.

As noted in SRK (2021b, p. 139), “Predicted water quality for the West End Pond and Hangar Flats Pond suggest selenium concentrations will be above the water quality standard and require treatment during Year -1 and Year -2. The source of the higher selenium concentrations in these ponds is attributed to toe seepage from the TSF Buttress and the West End In-pit Development Rock Storage Facility (DRSF). However, selenium concentrations were below method detection limits in almost all HCT results <u>that were used to develop the source terms</u> (emphasis added) for the TSF Buttress and West End In-pit DRSF. In Year -1 and Year -2, the amount of infiltration through these facilities is significantly lower than subsequent years and peak concentrations of several constituents (e.g., sulfate, arsenic, etc.) occur during these years as a result of the lower water to rock ratio. Selenium concentrations are elevated as a result of scaling laboratory data that are near the detection limit to field conditions during these low infiltration years. Therefore, the elevated selenium concentrations are considered an artifact of the modeling approach and treatment for selenium is not likely needed.”

However, selenium was elevated in the first flush samples, which have been ignored in the development of the source terms for the SWWC model. As noted by SRK (2021b, pg. 232): “Several constituents were mobile under the neutral to alkaline pH conditions of the SODA HCTs. … For the sample with the highest sulfide content, aluminum, iron, manganese, mercury, selenium, silver and sulfate were flushed from the cell during the first five weeks of the test, and concentrations of these constituents were above the strictest potentially applicable water quality criteria for these parameters.” Please see Section 2.3.3 for more information on the problematic treatment of source terms, related to ignoring first flush results.

Other COIs

As noted above, no water treatment plant targets are established for aluminum, barium, chloride, fluoride, manganese, or selenium, so we must assume that the WTP would not remove these COIs.

Chloride: Ion exchange is proposed to be used to remove nitrate and nitrite (Brown and Caldwell, 2021b, pg. 8-23). Not only will chloride not be removed, it will likely be added by the proposed treatment approach, specifically ion exchange. Ion exchange is one of the primary methods proposed to remove COIs. According to Brown and Caldwell (2021b, pg. 8-23), "Ion exchange targeting all of the dissolved constituents in the WTP influent would produce a residual—waste brine—that cannot be disposed in the TSF because of high arsenic concentration that would likely make the brine a hazardous waste. Therefore, it would have to be transported off site for disposal. Discharging brine to the TSF would also add hundreds of tons of chloride to the ore processing circuit, potentially forming hydrochloric acid in the autoclave and damaging it. The amount of brine requiring disposal, which is a function of the frequency of regeneration, would depend on the total amount of ions that would be removed, not only mercury and arsenic; antimony, phosphate, and potentially manganese and sulfate could also impact it."

In addition to the expected toxicity resulting from ion exchange brine in the proposed treatment scheme, the high chloride concentrations would also show up in the effluent that is planned to be discharged to Meadow Creek. The chloride would result from ion exchange of chloride for sulfate, which is expected to be up to 7,508 mg/L during post-closure as WTP influent and have high concentrations in some sources during operations (see Table 1). The SWWC model did not determine whether this excess chloride would exceed the chloride surface water quality standard of 230 mg/L.

The Buckhorn Mine in northern Washington State started out with an ion exchange mine water treatment system and replaced it with reverse osmosis as the primary approach after seeing chloride concentrations rise precipitously in the effluent that was being discharged to area streams. Figure 1 shows chloride concentrations in WTP influent and effluent from December 2007 through December 2024 (and see Appendix 2). Note that effluent chloride concentrations were higher than influent concentrations until about mid-2010 as a result of the ion exchange system. After the WTP system was changed to a primary RO system, effluent chloride concentrations were low and consistently lower than influent values. Perpetua has not considered the addition of chloride to WTP effluent using the proposed water treatment approach.

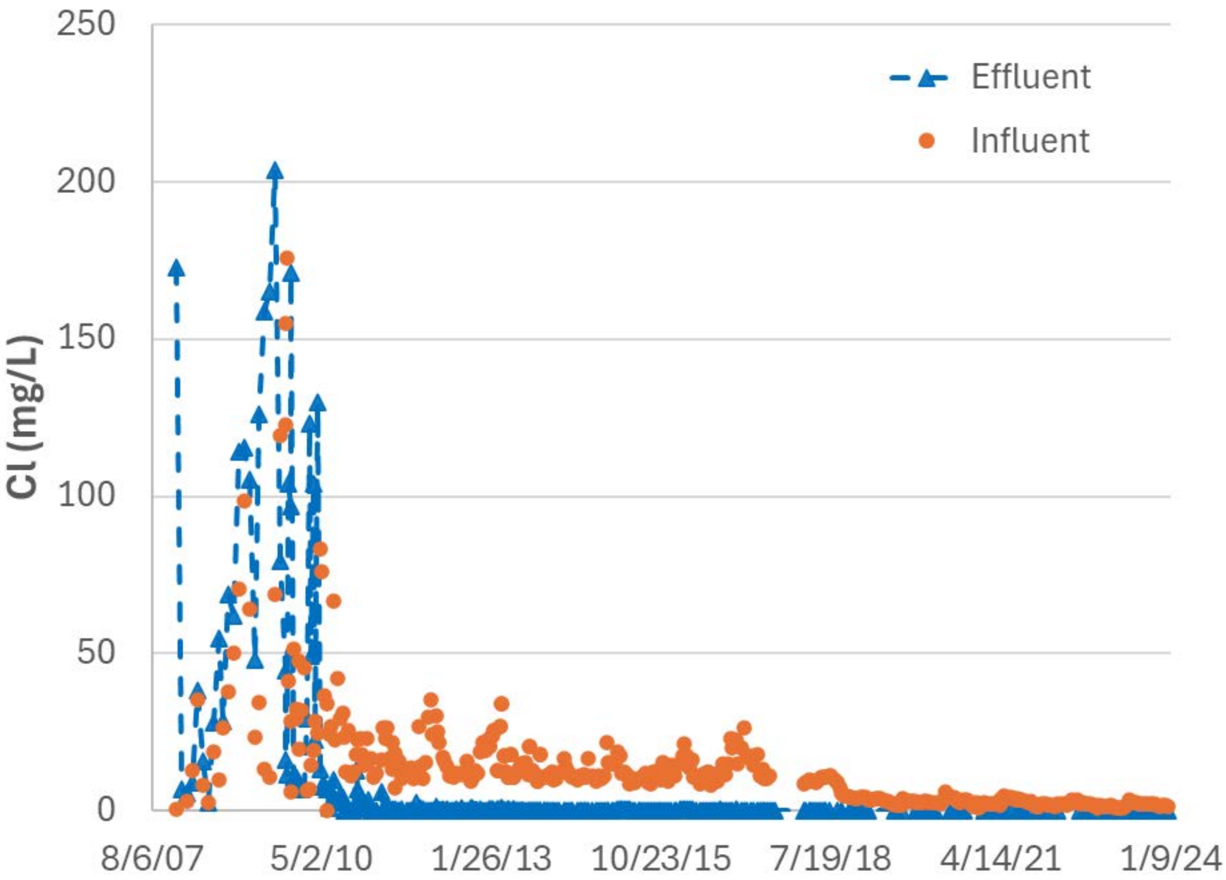

Figure 2. Chloride concentrations at the Buckhorn Mine in water treatment plant influent and effluent from December 2007 through December 2024.

<u>Cyanide</u>: Cyanide was included in the SWWC model, but only for the TSF cover surface water chemistry predictions. Although cyanide has a target effluent concentration (FEIS Table 4.9-10) and is included as a parameter in FEIS Tables 2-4 and 3.9-1, it is not included in two tables in FEIS Chapter 4 related to TSF water quality (Tables 4.9-1 and 4.9-3), even though cyanide is expected to be present in the TSF, including in the TSF buttress and embankment, which will be affected by process water in the TSF. It is also not included in FEIS Chapter 4 tables related to the pits and surface water monitoring locations. Depending on water management plans, cyanide may not be present in the pits; however, it could be present in surface water monitoring locations that receive groundwater input from TSF leakage.

The recently released Biological Opinion (US Department of Commerce, NOAA, 2024, pg. 244) states "Cyanide is also considered a contaminant of concern given its toxicity and presence in the TSF. Even after accounting for liner leakages, cyanide was not included in the SWWC model because it is not expected to persist at detectable concentrations because geochemical conditions that favor rapid breakdown of the cyanide molecule exist at the site (G. Fennemore, personal communication, July 2, 2024)." In addition to not providing a reference for the Fennemore personal communication or any other reference that would support this opinion, cyanide plumes in groundwater and its presence in surface water related to mining has been a relatively common occurrence, as described in Kuipers and Maest, 2006. For example, "Of the 25 case study mines, 19 (76%) had mining-related exceedences in surface water or groundwater. However, nearly half of the mines with exceedences (8/19 or 42%) predicted low contaminant leaching potential in their EISs. The constituents that most often exceeded standards or that had increasing concentrations in groundwater or surface water included toxic heavy metals such as copper, cadmium, lead, mercury, nickel, or zinc (12/19 or 63% of mines), arsenic and sulfate (11/19 or 58% of mines for each) and cyanide (10/19 or 53% of mines)." (Kuipers and Maest, 2006, pg. ES-9 and ES-10). Actual adverse impacts of cyanide to groundwater and surface water included:

- Cyanide polluted alluvial groundwater at the Pogo Mine in Alaska (pg. 71)
- A cyanide plume from tailings seepage existed at the Golden Sunlight Mine in Montana (pg. 71 and 137)
- The Royal Mountain King Mine in California had exceedences of cyanide in groundwater from heap leach operations (pg. 119)
- The Grouse Creek Mine in Idaho found cyanide in groundwater and surface water due to tailings contact water leakage into groundwater (pg. 123)
- The Beal Mountain Mine in Montana contaminated groundwater and surface water from land application of treated mine water (pg. 131),
- At the Mineral Hill Mine in Montana, tailings leachate escaped the liner system and caused exceedences in alluvial groundwater and surface water (pg. 139)
- Multiple 100+ year storm events caused extensive groundwater and surface water contamination with cyanide and other mine pollutants at the Zortman and Landusky Mine in Montana (pg. 147).

Although these cases are older, they show that escape of cyanide from mine facilities through groundwater to surface water, causing exceedences of water quality standards, can be a common occurrence. These results indicate that cyanide should be included as an analyte in all monitoring locations downgradient of cyanide sources.

Errors in the FEIS target effluent concentration table

Table 4.9-10 in the FEIS has some important errors and should be corrected in a Supplemental FEIS. The source for the table is listed as Brown and Caldwell 2021b; Footnote 1 states "Treatment objectives are equivalent to the strictest potentially applied water quality standard." The footnote implies that the treatment targets should be equivalent to the strictest of the applicable groundwater or surface water standards, whichever is lower. Several tables in the FEIS list water quality standards, including Table 2-4 (groundwater and surface water standards), Table 3.9-1 (groundwater and surface water standards), and various tables in Chapter 4 (Tables 4.9-2, -3, -6, -12, -18, -19, -20; all for surface water standards). The errors or questionable entries in Table 4.9-10 are:

- <u>pH</u>: The pH treatment objective is listed as 6.9 – 9.0, but it should be 6.5 – 9.0 for surface water or 6.5 – 8.5 for groundwater (see Table 3.9-1); the Chapter 4 tables list the upper end as pH 9 without a decimal. Not including a decimal will allow a larger acceptable range of pH values.

- Chromium (III): Although Brown and Caldwell lists a treatment objective for Cr(III) in Table 8-9, but no tables in the FEIS include it – with the exception of Table 4.9-10 (WTP targets). Chromium is not even included in the Brown and Caldwell (2021c) Environmental Monitoring and Management Plan – note that the date is incorrect in the FEIS references section (pg. 7-5; it should be September, not May 2021).
- Chromium (VI) and total chromium: The parameter in FEIS Table 4.9-10 is listed as "Chromium (IV)," but it should be Chromium (VI) (typo?). FEIS Table 2-4, groundwater and surface water guidelines/standards, lists the chromium standard as 0.1 mg/L for groundwater and 0.0106 for surface water and states that the surface water standard is for Cr(VI) based on Water Effects Ratio. FEIS Table 3.9-1 lists the groundwater and surface water quality standards as 0.1 mg/L for total chromium.
- Copper: The target effluent objective in FEIS Table 4.9-10 is 0.0025 mg/L, but it is listed as 0.002 mg/L for surface water in Table 2-4, 0.0024 mg/L in Table 3.9-1, and 0.002 mg/L in the remaining tables in FEIS Chapter 4. Which is it?
- Thallium: The target effluent objective in FEIS Table 4.9-10 is 0.005 mg/L, but it is listed as 0.00017 mg/L in Table 2-4 and Table 3.9-1 and the remaining tables in Chapter 4.
- Cyanide: Nearly all the entries in FEIS Table 4.9-10 match those in Brown and Caldwell, 2021b, Table 8-9, WTP Treatment Objectives, with the exception of total cyanide and WAD cyanide: the entries in the FEIS table are switched (that is, total cyanide is 0.0039 mg/L in Brown and Caldwell, while it is 0.0052 mg/L in the FEIS table; the WAD cyanide entries in the FEIS table are similarly switched); total cyanide should be 0.0039 mg/L and WAD cyanide should be 0.0052 mg/L in the FEIS table. However, the Idaho rules state that cyanide should be analyzed as WAD for groundwater (IDEQ, 2024b) and "expressed as WAD" for surface water (IDEQ, 2024a). The applicable standards for cyanide are therefore confusing (should they all be for WAD cyanide?), and the correct parameter and analytical method should be corrected in all FEIS tables.
- Selenium: Selenium does not have a target effluent concentration in Table 4.9-10 and is not included in the SWWC model. As noted in my comments on selenium in this Section, FEIS Table 3.9-1 lists the selenium surface water quality standard as 0.0015 mg/L, but all the tables in Chapter 4 list the Strictest Potentially Applicable Surface Water Quality Criteria for selenium as 0.0031 mg/L, as does Table 3.9-6a and b.
- Missing targets: As noted earlier in this Section, no effluent targets are included in Table 4.9-10 for aluminum, barium, chloride, fluoride, manganese, or selenium, even though these COIs are present in leachate from mine sources. We therefore must assume that the WTP would not remove these COIs.

The multiple errors and omissions found in this single table add to the errors in the EIS references noted in by SDEIS comments and in this document and demonstrate a lack of care and quality control on the Stibnite EIS documents released to the public.

2.3.3 Source terms used in the SWWC model ignore likely maximum releases from mined materials

My SDEIS comment: 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. (Maest, 2022, pg. 2-3)

Response in FEIS: The use of first flush kinetic test leaching data is described in SDEIS Section 3.9.4.2 with potential implications for predictive modeling described in SDEIS Section 4.9.2.4. (FEIS, B-233)

FEIS, Chapter 3, Section 3.9.4.2, pg. 3-172: In the development of source terms, the initial flushes from the HCTs were not utilized (SRK 2018a) because the first flush chemistries would be indicative of material leaching during the mine operating period, when leachate would be collected as contact water for water treatment or would be expected to dissipate in the near-term due to dilution and/or solubility controls.

Comments on FEIS and why this is important:

Source terms used in the SWWC model are one of the most important controls on model results: if source terms are consistently underestimated, the predicted concentrations in surface water, groundwater, and MIW will also be consistently underestimated. The response in FEIS Section 3.9.4.2 is incorrect in several ways, as discussed in the following subsections.

First flush results: First flush chemistries are indicative of exposed mined material leaching during all phases of mining after a storm event that follows a dry period and after snowmelt.

A comment from Perpetua (FEIS, App. B, pg. B-297) states "Steady state chemistry is typically considered more representative for use in geochemical predictions (Maest and Kuipers, 2005; Price 1997)." Although that sentence is included in my 2005 report, Perpetua neglects to include the subsequent two sentences: "These inputs are used to predict future water quality based on laboratory or field-scale experiments. However, differences in weathering rates and reactants produced under field and laboratory conditions can cause large differences between experimental and actual conditions, especially if reactive surface areas are not included in the model." In addition, my more recent 2017 paper (Maest and Nordstrom, 2017) states "Unlike early flush behavior in the laboratory, secondary salt dissolution in the field repeats continually and is linked to precipitation events. Early flush and maximum sulfide oxidation results from HCTs should be retained and used in environmental models and facility design."

First flush concentrations are often, but not always, the highest values in HCT results. First flush results should have been incorporated into the SWWC by taking them into account when creating source terms. This would allow the WTP to be able to remove high concentrations when relevant meteorological or hydrological conditions exist.

Leachate and contact water capture: The capture of leachate and contact water is never 100% effective. MIW from waste piles, ore stockpiles, and open pits can and will infiltrate to groundwater, and runoff and infiltration from these facilities can and will escape capture despite best efforts. If this were not the case, we would not see the extensive groundwater plumes that are so common at existing and closed mine sites. See related comments in Section 2.3.2 and 2.3.5.

Dissipation of leachate: The dissipation of leachate concentrations by dilution and/or solubility controls can be and supposedly has been handled in the SWWC model – this is not a reason to ignore first flush concentrations. Many other mines do incorporate first flush results, typically by incorporating them in average values. While this is not ideal and will likely underestimate potential maximum leachate concentrations from sources, it is an acknowledgment that first flush results do indicate the presence of contaminants that will be leached over time at mine sites. The FEIS has instead chosen to completely ignore first flush values and use unrealistic source term values.

2.3.4 Comparison to relevant water quality standards

My SDEIS comment: Surface water quality standards must be protective of aquatic life. The lack of aquatic life criteria for antimony is concerning. The SDEIS must consider the potential impacts of antimony on aquatic life. As described in more detail in Maest (2022), a chronic aquatic life guideline for antimony should be incorporated to provide adequate protections for fish and other aquatic life. The selenium standard used to compare to predicted surface water concentrations in the SWWC model may not reflect the most updated approach used by the U.S. EPA that includes monitoring of not only water but also aquatic biota. (Maest, 2022, pgs. 4, 22)

Response in FEIS, App. B (pg. B-235): An antimony standard of 0.0052 mg/L applied for surface water was based on a drinking water standard. This value is lower than the 0.190 mg/L standard for aquatic life.

As described in SDEIS Table 3.9-1, the selenium standard utilized is the EPA freshwater aquatic life criteria.

Comments on FEIS and why this is important: The FEIS is using a surface water antimony standard of 0.0052 mg/L (dissolved). This value is not a drinking water standard – it is a criterion for the protection of human health, based on the consumption of water and fish (IDEQ, 2024a, Table 2). The groundwater quality standard listed in FEIS Table 3.9-1 of 0.006 mg/L is a primary drinking water standard. The response also states that this value is lower than the 0.190 mg/L standard for aquatic life. However, this is not a standard for protection of aquatic life; it is also a criterion for the protection of human health, based on consumption of fish only (IDEQ, 2024a, Table 2).

The antimony standards listed in the FEIS tables is protective of human health, and probably also aquatic life (considering that the British Columbia chronic aquatic life guideline for antimony is 0.009; Maest, 2022, pg. 22), but the response in FEIS App. B serves as another example of the lack of care or experience in finalizing the FEIS.

2.3.5 Important contaminant pathways are not included in the model

My SDEIS comment: 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. The potential for domestic groundwater use in the future cannot be discounted. The Forest Service is obligated to ensure that the proposed mine plan is in compliance with all applicable state and federal laws. (Maest, 2022, pg. 3).

Response in FEIS, App. B (pg. B-234): Project component conceptual models are incorporated into the overall conceptual model depicted in SDEIS Figure 4.9-1. Surface water chemistry analysis incorporates sediment control measures as described in Chapter 2 of the EIS to limit effects of Project-related sediment.

Drinking water was not considered as a potential exposure pathway in the assessment of human health effects as described in SDEIS, however the drinking water standard of 0.010 ppm As is the lowest applicable criteria for the project as the South Fork is designated as a drinking water source. S Section 4.18.2.2 (sic). However, the water quality analysis compares predicted groundwater analyte concentrations to drinking water standards and existing conditions which do not currently meet drinking water standards. The SDEIS notes that under the current condition, water treatment is required for use of groundwater as a drinking water source.

Comments on FEIS and why this is important: The conceptual models form the basis of modeling and monitoring at mine sites. Note that the FEIS, in Figure 4.9-1 Project Management Components, indicates that percolation of contact water from the TSF Buttress, pit backfill, development rock, ore stockpiles, and the tailings storage facility (TSF) underdrain flow will not be captured. The diagram further assumes that dewatering of the open pits will capture 100% of their contact water that has percolated to groundwater. The response to one of the SDEIS comments in FEIS App. B (pg. B-222) states “Tailings storage facility underdrain flow would consist of groundwater emerging below the facility liner and would not be in contact with the tailings materials.”

The conceptual model for the TSF is shown in FEIS Figure 4.9-5. The diagram shows the liner but no underdrain and indicates that process water from the facility will seep to groundwater during operations, post-closure prior to cover placement, and post-closure after cover placement, presumably by defects in the liner – contradicting the response in FEIS Appendix B. The Brown and

Caldwell (2021b, pg. 1-10) Water Management Plan report states that the TSF underdrains will collect spring and seep flows beneath the impoundment to a monitoring sump, where flows will be monitored for water quality, then, depending on the results, either discharged to Meadow Creek, used as makeup water, or sent to a contact water pond for later use, evaporation, or treatment and discharge. The FEIS (pg. 4-143) states that the TSF underdrain water below the liner would report to a sump where water flow and quality would be monitored. The FEIS does not discuss the disposition of TSF underdrain water depending on the monitoring results.

The FEIS discussion, including in Appendix B, and its depiction of contact water capture is inconsistent and does not accurately reflect the underlying consultant reports. The FEIS should be corrected in these instances and a Supplemental FEIS should be produced and released for public comment.

3. Summary of key points

- The FEIS has some critical errors and omissions regarding water chemistry, modeling, and mine planning that affect the predictions of potential impacts to water quality. These errors and omissions, outlined in this document, should be corrected in a Supplemental FEIS. For example, see the many errors in FEIS Table 4.9-10 which lists important targets for treated effluent. The multiple errors and omissions in the FEIS demonstrate a lack of care and quality control on the Stibnite EIS documents released to the public.
- Many comments I provided on the SDEIS have not been addressed by the Forest Service, and it appears that they did not review or comment on my individual SDEIS report (Maest, 2022). All underlying technical documents submitted as comments on the SDEIS should be reviewed and responded to in a Supplemental FEIS.
- SWWC problems – ammonia excluded based on 36-year old results from coal mines…
- The water quality predictions for the water treatment plan influent, contact water from facilities, and groundwater and surface water monitoring locations downgradient/downstream of mine sources remain underestimated due to the extensive use of averages and the elimination of first flush leach test results. Consequently, the adverse effects to the environment and the potential maximum influent water treatment concentrations are also underestimated, and mine planning will need to be revisited to ensure environmental protection.
- The water treatment scheme remains untested and out-of-date. Given the very high predicted influent arsenic and selenium concentrations, which, as noted in my comments, are likely underestimated due to the use of averages and underestimation of source term concentrations, the treatment approaches need to be reevaluated using bench-scale experiments. Alternative methods for removal of nitrate, ammonia, and selenium especially need to be reexamined. Unintended consequences of the proposed treatment approaches, including the addition of chloride to the effluent from the use of ion exchange, also need to be evaluated.
- The effects of extreme storms resulting from climate change on facility design and sizing remain unaddressed. The potential for overtopping of facilities, increased infiltration of

process water, and increased influent volumes to the treatment plant has not been adequately examined. Incorporation of climate change into mine design and planning is one of the most important shortcomings of the FEIS.

- The FEIS discussion, including in Appendix B, and its depiction of contact water capture is inconsistent and does not accurately reflect the underlying consultant reports. The FEIS should be corrected in these instances and a Supplemental FEIS should be produced and released for public comment.

4. Qualifications

Ann Maest is an aqueous geochemist with Buka Environmental in the historic mining town of Telluride, Colorado. She 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 assessments. 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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