Yukon Environmental and Socio-economic Assessment Board
Mayo Designated Office
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December 13, 2018

RE: Project 2018-0087 Response to Information Request - SVI

The Government of Yukon, Assessment and Abandoned Mines Branch (AAM) has received and reviewed the October 4, 2018 information request and has compiled responses to the requested information in this letter. The questions are provided in advance of responses for context.

1. *[ECCC 2018-0087-069-1 and LSCFN 2018-0087-072-1] The WTP is reported to be beneficial "for the removal of secondary parameters of interest including aluminum, arsenic, cadmium, and zinc with some benefit to manganese." The WPT is also intended to address elevated sulphate found in the tailings seepage collection pond. The bench scale test results do not seem to support this conclusion. For example, both dissolved and total manganese increased as a result of the bench scale test (5.88 mg/L to 6.34 mg/L and 6.21 mg/L to 7.19 mg/L respectively for dissolved and total manganese). Sulphate, zinc, and cadmium also either increase or show minimal reduction between influent and effluent concentrations as a result of the bench scale testing (e.g. sulphate increased from 696 mg/L to 744 mg/L and total zinc increased from 0.02 mg/L to 0.03 mg/L). Moreover, proposed water quality objectives for sulphate in Victoria Creek is cited as 429 mg/L in section 7.3.3.4.5, while table 7.3-6 cites a sulphate WQO of 309 mg/L. More details about the water quality objectives are provided in Appendix 7A where the objective for Victoria Creek appears to be cited as 218 mg/L.*

   a) *Clarify the water quality objective for sulphate in Victoria Creek*

Separate water quality objectives (WQOs) are proposed for Victoria and Dome Creeks. The proposed sulfate WQO for Victoria Creek is the hardness-dependent British Columbia Water Quality Guideline (BC-WQG [2013]). The guideline is tiered as a function of hardness (see Table 2-2 below of Project Proposal Appendix 7A – Proposed WQO).

Table 2-1: BC Sulfate Water Quality Guideline for Protection of Freshwater Aquatic Life.

Water hardness (mg/L)	Sulphate guideline (mg/L)
Very soft (0-30)	128
Soft to moderately soft (31-75)	218
Moderately soft to hard (76-180)	309
Very hard (181-250)	429
>250	Need to determine based on site water

Based on historic data from 2012 to 2016, observed hardness in Victoria Creek at VC-UMN (downstream of Dome Creek) has ranged from 36 to 248 mg/L (Figure 1). The corresponding sulphate WQO would therefore have ranged from 218 to 309 to 429 mg/L, depending on the observed hardness (Figure 1). Calculated model estimates of hardness are comparable to the range of observed hardness levels for the 2012-2017 data set, as shown in Figure 1 below. Note that both the observed and modeled sulfate concentrations for this timeframe are well below their respective, calculated, hardness-based WQO (Figure 2).

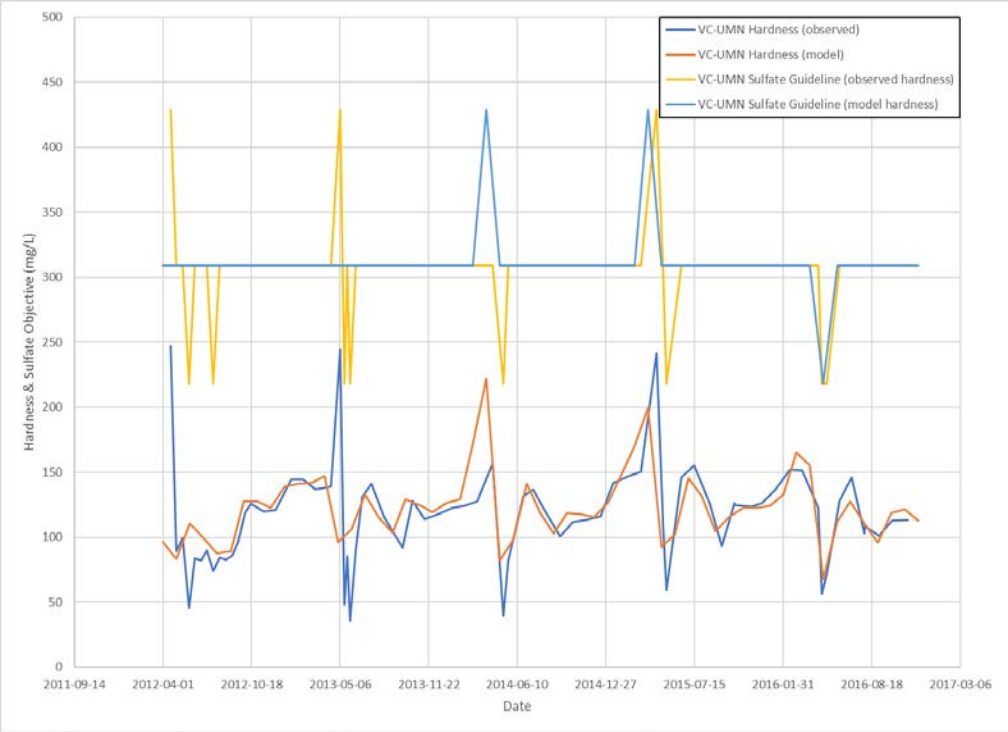

Figure 1: Victoria Creek Upstream of Minnesota Creek (VC-UMN) – measured and modeled hardness and corresponding hardness-based sulphate guideline (Table 2-2).

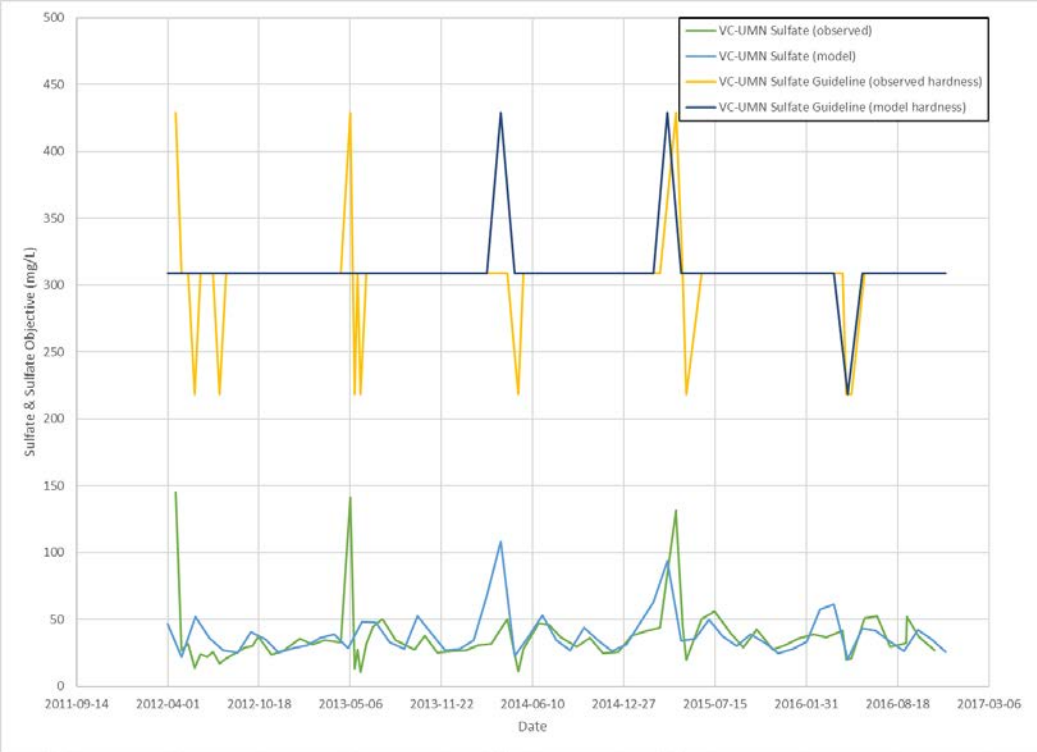

Figure 2: Victoria Creek Upstream of Minnesota Creek (VC-UMN) – measured and modeled hardness and corresponding hardness-based sulphate guideline (Table 2-2).

There is some inconsistency in the application regarding the stated WQO value for sulphate. For example, the sulphate WQO in Section 7.3.3.4 of the project proposal (*Ecological Objectives of Valued Components*) is 309 mg/L (Table 7.3-6 of the project proposal). Meanwhile, the text in Section 7.3.3.4.5 of the project proposal (*Sulphate*) states the sulphate WQO for Victoria Creek is 429 mg/L. This inconsistency is due to the corresponding different hardness values that were used to derive the stated WQO value, which ranges from 218 to 309 to 429 (as described above and as shown in Table 2-2 and Figure 1).

For clarity, the proposed sulphate WQO for Victoria Creek is consistently the hardness-dependent BC Guideline (Table 2-2) throughout the project proposal, which varies as a function of hardness. In this regard, the examples provided in question 1 of the request for information (i.e., Section 7.3.3.4.5, Table 7.3-6, Appendix 7A) would benefit clarifying footnotes that read: **the sulphate WQO for Victoria Creek varies with hardness, as per the British Columbia Water Quality Guideline (2013).*

b) Clarify the extent to which the WTP is effective at removing secondary parameters of interest (i.e. sulphate, aluminium, arsenic, zinc, and manganese).

The proposed water treatment plant (WTP) is designed to provide quantitative removal of total suspended solids (TSS) and iron with qualitative benefit to other parameters of interest including total aluminum, arsenic, cadmium, manganese and zinc. The water treatment bench scale test work conducted by Veolia Water Technologies was designed to optimize removal of TSS and iron only. Due to the removal of TSS (particulate material) in the WTP, decreased effluent concentrations are expected for total metals that make up part of that particulate, including aluminum, arsenic, cadmium, manganese and zinc. Some benefit to dissolved metals is also expected to occur with iron removal (e.g., through iron scavenging of cations). The removal of these constituents cannot be quantified until field-based commissioning is conducted; however, an indication of the iron scavenging effects on cation removal is evidenced by a comparison of the concentration of metals in seepage collection pond water at the time it was collected for the bench test (22

February, 2017; analytical sample taken at the same time as bulk sample collection) to bench study influent concentrations (Table A below; the same unpreserved source water on March 6, 2017 but after transportation). The comparison shows that the bench study influent concentrations are significantly lower than concentrations at the time of collection for most secondary parameters of interest including dissolved aluminum, dissolved arsenic, dissolved cadmium, and dissolved zinc.

The WTP is not designed to remove manganese or sulphate. The concentrations of manganese and sulphate are not expected to change (or increase) during WTP operation.

As a point of comparison, observed effluent quality concentrations for all parameters of interest are lower than the concentrations assumed in the modelled effluent (Table A). These assumed effluent concentrations underpin the Project effects assessment.

Table A: Summary of Measured Water Quality for Water Treatment Plant Bench Studies and Assumed Model Effluent.

Sample ID		Seepage Collection Pond	Bench Test - Polymer - Raw Influent	Bench Test - Polymer - Clarified Effluent	Bench Test - Sludge Production - Raw Influent	Bench Test - Sludge Production - Effluent	Model Assumption Effluent*
Analysis		ALS	Veolia	Veolia	Veolia	Veolia	NA
Sample Date		22-Feb-2017	06-Mar-17	08-Mar-17	16-Mar-17	16-Mar-17	NA
Parameter	Units						
Total Suspended Solids (TSS)	mg/L	45	33	<4	17	6	15
Sulfate (SO4)	mg/L	697	696	744	728	745	900
Aluminum (Al)-Total	mg/L	0.019	0.01	0.01	0.004	<0.01	0.07
Aluminum (Al)-Dissolved	mg/L	0.014	<0.01	<0.01	0.01	<0.01	0.07
Arsenic (As)-Total	mg/L	0.096	0.098	0.004	0.042	0.002	0.050
Arsenic (As)-Dissolved	mg/L	0.064	0.004	0.003	0.003	0.002	0.050
Cadmium (Cd)-Total	mg/L	0.0004	0.0005	<0.0005	0.0003	<0.0002	0.0004
Cadmium (Cd)-Dissolved	mg/L	0.0003	<0.0002	<0.0005	<0.0002	<0.0002	0.0004
Iron (Fe)-Total	mg/L	20.5	13.4	0.5	6.9	0.2	0.5
Iron (Fe)-Dissolved	mg/L	18.3	0.04	<0.05	0.04	<0.05	0.1
Manganese (Mn)-Total	mg/L	6.1	6.2	7.2	7.1	6.8	9.5
Manganese (Mn)-Dissolved	mg/L	6.0	5.9	6.3	5.7	5.7	9.5
Zinc (Zn)-Total	mg/L	0.040	0.039	0.029	0.039	0.026	0.06
Zinc (Zn)-Dissolved	mg/L	0.043	0.020	0.030	0.028	0.026	0.06

Note: *Not to exceed effluent water quality values assumed in the model. Where influent values are lower, effluent is set equal to influent.

c) Is there a potential that concentrations of secondary parameters of interest will increase in effluent discharge or in Dome Creek at any point due to the WTP's operation?

Further to the response provided in 1 b) above, concentrations of secondary parameters of interest, including aluminum, arsenic, cadmium, manganese, zinc, and sulphate, are not expected to increase in effluent discharge or in Dome Creek during WTP operation. Veolia Water Technologies reports that the observed increase in sulphate concentrations between bench scale influent and effluent samples was due to the use of ferric sulphate as coagulant. Coagulant addition was required for the bench scale test work because the total iron concentration of the bulk seepage water sample (representing WTP influent) decreased significantly from the time of collection to the time of arrival at Veolia's laboratory in Montreal (as detailed in the response to question 2b above). Coagulant addition is not expected to be required during operation of the WTP since the ferrous iron naturally present in seepage water will function as a coagulant in the

WTP influent. During WTP operation, ferrous iron will oxidize into ferric iron and will act as coagulant. In the unlikely event that coagulant addition is required, ferric *chloride* coagulant will be used (as opposed to the ferric sulphate used during the bench scale test) to ensure effluent sulphate concentrations do not increase during WTP operation.

During the bench study, an increase in the concentration of numerous soluble ions was observed between influent water and clarified (treated) water, including manganese (Table A). Five totes of seepage collection pond water were collected on 22 February 2017 (Table A) and shipped to Veolia, Montreal. The water in these totes were used as source water in the bench scale study. The bench study was conducted using these "batches" of water, which were not composited and well mixed throughout the bench study program. Subtle variability in water quality between the totes may explain the difference (increase) between raw water and treated water (effluent) in the WTP bench study. The variability in water quality is inferred from the comparison of raw water quality for the polymer bench test (Table 11 of Appendix A of Appendix 5D of the Project Proposal: *WTP Technical Data Report*; March 6, 2017) and the raw water quality for the sludge production bench test (Table 19 of Appendix A of Appendix 5D of the Project Proposal: *WTP Technical Data Report*; March 16, 2017) and summarized in Table A of this document (raw water quality of total manganese varied from 6.2 to 7.1 mg/L; clarified (treated) water quality of total manganese varied from 6.8 to 7.2 mg/L). Veolia stands by its statement that no significant increase in manganese concentration is expected with the proposed treatment process.

2. *[ECCC 2018-0087-069-1] Neither the Aquatic Effects Management Plan (AEMP) nor the Adaptive Management Plan (AMP) describes how the surface water quality monitoring data in Dome Creek or Victoria Creek will be compared to the surface Water Quality Objectives (WQOs) proposed in Appendix 7A. As described, it seems that further action would only be taken if the WTP makes water quality worse than the baseline, i.e. data collected from 2014-2016.*

   a) Clarify if the surface water monitoring data from the AEMP will be compared to the WQOs and how this will influence and inform the AMP narrative triggers and specific thresholds following the installation of the WTP

The AMP does not currently refer to the proposed WQO. The AMP refers to "current baseline" as defined by 2014-2016 observations. Once treatment is implemented, an interim period will follow whereby surface water quality is expected to improve in the receiving environment downstream of the WTP. A new baseline will be established during this post-treatment implementation, upon which the AMP will be updated with new triggers and associated decision-making (Section 9.2, Section 10.2 and Appendix A Section 1.3).

As outlined in the AEMP, monitoring data will be evaluated for spatial and temporal trends on a regular basis to inform overall aquatic health of the receiving environment and to inform the AMP including operation of the WTP. Temporal trends in AEMP data will be conducted at regular intervals consistent with data collection and analysis (e.g., annually during baseline or every three years during regular monitoring) and will include a comparison to water quality guidelines. Spatial trends will be evaluated using the control-impact or BACI method.

3. *[LSCFN 2018-0087-072-1] YG completed a Dam Safety Review in 2013 and cites the Dam Safety Guidelines (Canadian Dam Association [CDA]) in the Project Proposal and operational plans. Dam Safety guidelines, standards and approaches for mining dams have changed substantially since 2013; The CDA released a Technical Bulletin "Application of Dam Safety Guidelines to Mining Dams" in 2014, describing updated approaches for managing mining dams. Second, the dam failure at Mt. Polley in 2014 led to many changes in the regulation and management for mining dams in Canada.*

    a) *Clarify if the monitoring of the Tailings Storage Facility (section 5.1.4) and Site Security and General Inspections (section 5.2.1) are in accordance with the CDA Application of Dam Safety Guidelines to Mining Dams and regulations for mining dams in Canada*

The last formal dam safety review was completed in 2013, prior to the release of the noted CDA technical bulletin and associated regulation changes. Notwithstanding the release of the technical bulletin and associated regulations, the current monitoring of the *Tailings Storage Facility* and *Site Security and General Inspections* meet or exceed the standards outlined in the CDA Application of Dam Safety Guidelines to Mining Dams and regulations for mining dams in Canada. For example, engineering inspections are conducted on the dam twice per year, and routine monitoring is conducted on a daily basis. The next dam safety review will be conducted in 2020 or within one year of the site transferring ownership, whichever is sooner.

References

British Columbia Ministry of Environment (BC MOE). 2013. Ambient Water Quality Guidelines for Sulphate. Technical Appendix Update April 2013. Prepared by Cindy Meays and Rick Nordin. Water Protection & Sustainability Branch, Environmental Sustainability and Strategic Policy Division, BC Ministry of Environment.