TECHNICAL MEMORANDUM

Date: **July 4, 2022**

To: **Pat Moss, Northwest Institute**

From: **Patrick Littlejohn, Ph.D., P.Eng.**

Subject: **Technical Review of Tenas Coal Environmental Assessment Certificate Application**

Background

Source Environmental Associates Inc. (Source) was engaged by the Northwest Institute to conduct third party technical review of the Tenas Coal Project Environmental Assessment Certificate Application (the Application). This review was conducted by Dr. Patrick Littlejohn, P.Eng., Senior Chemical/Metallurgical Engineer with Source and a Qualified Professional in BC in the area of mine water treatment and discharge planning. This review was conducted to support the Northwest Institute during the public comment period for the Application.

This review was conducted with the following focus areas and questions in mind:

1. Geochemical sampling program – are the mineral samples collected representative of coal ore, ore halo & waste rock? Was the geochemical testing program rigorous? How much selenium is present in project rock?
2. Source control – does the Project apply appropriate Acid Rock Drainage (ARD) mitigation measures in ways that make sense and align with overall mine plan and water balance (i.e. Potentially Acid Generating (PAG) rock submergence, waste rock pile design)? What is the potential for selenium release?
3. Site water balance – is site water management infrastructure robust and capable of handling a wide range of weather conditions (i.e. wet years, dry years, extreme weather events)?
4. Mine contact water quality – how contaminated is mine contact water expected to be and are predictions reasonable? How sensitive are predictions to things that may be uncertain, like PAG characterization, site water balance?
5. Water treatment approach and capacity – how is water treatment applied, and are water treatment goals achievable with the technologies describe? Is water treatment capacity sufficient? Will treatment address potential selenium contamination?
6. Discharge location – does the project design follow BC best available technology/initial dilution zone policy?

Summary of Findings

Significant risks were identified with the Application in each of these subject areas. To summarize:

1. The geochemical sampling program is not sufficiently robust to characterize the ML/ARD potential of the disturbed material. The proposed approach to MLARD management relies entirely on source control, which leaves no room for error in materials identification and handling. Significant risk of onset of acid rock drainage, neutral metal leaching and selenium contamination exists with the proposed project.
2. The Application contains insufficient evidence/analysis supporting the idea that the implementation of source control is practical and can be executed under a range of climate conditions or in the context of geochemical uncertainty.
3. The Application includes water management features that are designed to meet 1-in-10 year storm events. Discussion of variable climate conditions (i.e. climate change) are limited. Given that the project is to operate for over 20 years with a total lifespan including closure/post-closure of close to 50 years, use of shorter or less conservative design basis adds risk of impacts to the environment.
4. Expectations of mine water quality are optimistic and do not entertain the possibility of onset of ARD if any aspect of the mine plan does not go according to plan (i.e. mishandling of PAG material, failure of source control measures, higher than expected geochemical source terms, or flushing of oxidation products prior to material submergence).
5. Water treatment is not included in the application. Any contamination that occurs in mine contact water is proposed to be released directly to the receiving environment without treatment. This is a significant deviation from best practices in BC and represents a major risk to the downstream environment.
6. The Application proposes site specific water quality targets that are significantly less conservative than BC's generic guidelines using a process that does not align with BC's policy. The Application does not include use of Best Available Technology to prevent contamination and so does not follow BC policy on initial dilution zones.

Overall, the project design is predicated on an optimistic interpretation of limited geochemical data and the ability to execute a mine waste and water management strategy with little margin for error. Modeling conducted by the proponent indicates that they expect the immediate receiving environment to be degraded with mine-borne contaminants including a 200 fold increase in selenium concentration in local creeks. The project does not follow BC policy on application of Best Available Technology to prevent contamination in the downstream environment. All of these factors mean that there is significant risk of the project having both short and long term negative impacts on water quality in the downstream environment.

Documents Reviewed

To conduct this review, Source reviewed the Application as available on the the Environmental Assessment Office Project Information Center (EPIC), including the following project related documents:

- 01.0 – Project Overview
- 04.3 – Surface Water
- 13.05 – Discharge Management Plan
- 13.06 – Explosives Management Plan
- 13.11 – Minesite Water Management Plan
- 13.12 – MLARD Management Plan
- 13.15 – Reclamation and Closure Plan
- Appendix 01.0 – AD Closure Cover Assessment
- Appendix 01.0 – AE Initial Dilution Zone Modeling
- Appendix 01.0 – F Water Management Report
- Appendix 01.0 – M Supplemental Geochemical Characterization
- Appendix 01.0 – Q PAG Management Alternatives
- Appendix 13.5 – B Water and Load Balance Report
- Appendix 13.5 – G Selenium Bioaccumulation Model
- Appendix 13.5 – J Selenium Management Plan
- Appendix 13.5 – K Calcite Management Plan
- Appendix 13.12 – A MLARD Characterization
- Tenas Metallurgical Coal Project Definitive Feasibility Study Results (March 2019)

The purpose of this memo is to summarize Source's findings on the focal questions and related topics.

Comments on the Application

1. Lack of Appropriate Water Treatment and Failure to Follow BC Policy on Initial Dilution Zones

The Application identifies the significant risks of acid rock drainage, selenium contamination, and blasting residues that will contaminate mine contact water. However, the Application fails to propose any water treatment beyond sedimentation, which will at best address only suspended solids in mine contact water and not any dissolved species. This is wholly inappropriate for a greenfield project and represents a failure to follow BC's policy on use of an initial dilution zone in mine water discharge planning. Technical Guidance 11, Development and Use of Initial Dilution Zones in Effluent Discharge Authorizations (April 2019) states the following:

> *The Ministry of Environment and Climate Change Strategy (ENV) considers an Initial Dilution Zone (IDZ) only for authorized point source discharges to surface water and only if the following conditions are met:*
>
> *a) Best management practices (BMPs) for preventing or limiting harmful impacts to the environment should be applied;*
>
> ***b) Best Achievable Technology (BAT) has been considered in the proposed discharge plan. An IDZ should not be used as an alternative to reasonable and practical treatment of effluent or effluent stream.***

The Application does not include a Best Available Technology assessment or 'reasonable and practical treatment of effluent', meaning that the use of an IDZ is premature and inappropriate. The Application describes use of source control to prevent onset of ARD. Source control indeed falls under best management practices, but source control alone is not a sufficient mitigation for preventing impacts to the receiving environment from mine water discharge. The Application mentions active treatment as a potential contingency but no further information about the nature of such a contingency, how it would be executed, or what would trigger its execution was included in the Application.

There is no shortage of reasonable and practical water treatment approaches that could be considered for the Project that have precedent in BC. Treatment of ARD, neutral metal leachate and nitrogen species is very common. The application focuses on the risk associated with PAG rock and onset of ARD, but neutral metal leaching can release environmentally relevant concentrations of metals including selenium, zinc, cadmium and copper. Similarly, nitrogen species such as ammonia, nitrate and nitrite enter mine contact water through residue leftover from blasting. They dissolve in water readily and can have negative environmental impacts. Source control as described in the Application can be effective at preventing ARD but does not prevent other mechanisms for contaminant release into mine contact water.

The following section lists some relevant reference mine sites from BC that use active water treatment but is not an exhaustive list:

- Equity Silver, Britannia Mine - historic sites that use lime neutralization to treat ARD
- Silvertip (Coeur) - operating mine that treats metals and nitrogen species from contact water
- Premier (Ascot) - brownfield mine that includes a metals and nitrogen treatment system to support mine restart
- Blackwater (Artemis) - greenfield mine that includes water treatment for ARD, metals, nitrogen species and sulphate

- Cariboo Gold (Osisko) - brownfield mine that includes water treatment for ARD, metals, nitrogen species and sulphate
- Kemess (Centerra) is a brownfield mine that uses ion exchange for selenium and precipitation for neutral metal leaching

In BC's coal sector, a wide array of water treatment approaches have been implemented to remove selenium from mine contact water in response to the environmental impacts observed at some coal mines. For example:

- In the Elk Valley, Teck uses active biological treatment as well as saturated rock fill technology to remove selenium and nitrogen species from contact water in 3 separate treatment systems
- Brule (Conuma) uses biochemical reactors for selenium and nitrogen species removal from contact water
- The Wolverine-Hermann expansion (Conuma) proposes to use reverse osmosis and biological treatment to remove selenium and nitrogen species from contact water

All of these examples come from BC and include legacy, operating, and proposed mines. This indicates that practical and achievable treatment options exist to address the types of contamination likely to be generated by the Tenas project. Failure to consider these or other types of treatment in a Best Available Technology assessment indicates that the Tenas project is not following BC policy guidance.

Risk: The failure to follow BC policy on use of a Initial Dilution Zone and failure to include use of suitable water treatment that addresses the likely forms of contaminants represents a major risk for the project. Lack of treatment significantly increases the risk of environmental impacts in downstream creeks and rivers through increased release of contamination. If source control is less effective than expected and/or if disturbed material has greater metal leaching potential than expected then there is no backup mechanism to prevent contamination from entering the environment.

2. Contingency Water Treatment

The Application mentions active water treatment as a contingency that could be implemented if necessary. No information about what deployment of active treatment may entail or how it may be implemented is presented in the Application, so it is difficult to consider this as an actual contingency plan. That said, taking the statement at face value, there are two major challenges with implementing water treatment as a contingency, one financial and one practical.

Financial: The Application states that the project's initial total capital cost is estimated $123.5 M CAD. The total effluent flow rate ranges between ~16,000 m^3/d during operations and ~27,000 m^3/d during closure. The capital cost of implementing active treatment for ARD, nitrogen species and selenium as would likely be in the range of $10-30 M CAD depending on the nature of the

system, with an operating cost of treatment in the range of \$0.5-1.5 CAD/m^3, or ~\$0.3-\$2.4 M CAD/a during operations given the amount of surplus water requiring management. These figures are an appreciable percentage of the total initial capital cost (~10-25%). While such a figure is achievable at numerous other projects in BC and aligns with best practices, a project like Tenas that is expected to generate a relatively small amount of revenue compared to the size of the environmental liability may find this level of financial burden unmanageable.

Further, if long term water treatment is required by a project then it is incorporated into reclamation security cost estimation and bonding for a site's environmental liability. If the cost of water treatment is not incorporated into the initial project plan and bond, then the mine operator may not be able to cover this liability if water treatment proves to be required later in the project. This risk is particularly relevant since onset of ARD typically occurs over a period of years, meaning that the need to execute contingency treatment may not be apparent until after a significant portion of the total project revenue has already come and gone.

This comment should not be misinterpreted - for many projects in BC the application of effective active water treatment is well within the financial capacity of the project. There are many such examples such as those listed in Comment #1. If a project is only financially viable if responsible management of environmental liabilities is excluded, then a project is not financially viable.

Risk: If the project were to proceed as proposed, then there would be a significant risk that treatment would be required, adding a significant unexpected financial burden to the mine operator. If the mine operator was not able to afford to implement treatment then the BC government/the public would be forced to cover the environmental liability of the project.

Practical: Given the limited water storage capacity described in the Application, there is likely to be insufficient time between recognition that contingency water treatment would be required and implementation of treatment at site to avoid uncontrolled release of water. In the event that contingency water treatment were required, the site operator would have to recognize this requirement, select and design an appropriate treatment system, construct, commission and then operate the system, all before water storage capacity at site was exhausted.

The Application states that in an average year the project is expected to release between 0.7 and 1.7 Mm^3 of surplus water from the site. The Tenas Control Pond is the main water storage body for the project and is designed to have a maximum capacity of approximately 1.0 Mm^3. With a minimum water volume of ~0.1 Mm^3 and a requirement to maintain ~0.1 Mm^3 of flood event storage capacity, the Tenas Control Pond would have approximately 0.8 Mm^3 of capacity at best. This is just over the amount of surplus water the site generates in an average year, and less than would be accumulated in a wet year. In practice, this would mean that all of the implementation steps listed above would need to be executed in ~6-12 months. This is not a realistic timeline for execution.

Risk: Implementation of contingency water treatment at site would likely not be achievable in the timeframe allowed by site water storage capacity. This would increase the risk of release of contaminated water to the receiving environment.

3. Relaxation of Water Quality Targets

The Application proposes use of Site Performance Objectives (SPOs) for selenium and other species rather than generic BC Water Quality Guidelines (BC WQG) as targets in the receiving environment. The proposed SPO for selenium is 0.008 to 0.034 mg/L compared to 0.002 mg/L as the BC WQG, 4 to 17 times higher than the generic guideline. Elsewhere in the Application, a discharge target of 0.05 mg/L selenium (25 times the generic guideline) is proposed. For reference, Goathorn Creek and other nearby watercourses have natural background levels of selenium on the order of 0.00015 mg/L, well below BC WQG and approximately 200 times lower than the proposed SPO.

Similarly, an SPO for nitrite of 0.0524 mg/L is proposed, above the long term (chronic) BC WQG of 0.02 mg/L and approaching the short term (acute) BC WQG of 0.06 mg/L. The natural background level of nitrite in Goathorn Creek is 0.0005 mg/L.

Use of site-specific targets rather than generic water quality guidelines is allowable in BC through development of Science Based Environmental Benchmarks (SBEBs). Development of SBEBs requires undertaking a rigorous process as per BC's policy document Technical Guidance 8, A Framework for the Development and Use of Freshwater Science-Based Environmental Benchmarks for Aquatic Life in Environmental Management Act Permitting for Mines (March 2016). Two critical criteria required before consideration of an SBEB can be entertained are:

- A Best Available Technology (BAT) study has been incorporated into the project
- Unique site characteristics such as high background water quality or absence of sensitive species in the receiving environment.

As stated in Comment #1 of this document, a BAT study including treatment of mine contact water has not been incorporated into the project. Natural background levels of selenium in the local environment are well below BC WQG. Appendix 13.5-G describes the selenium bioaccumulation model developed as the basis for the proposed SPO. The model is based on data from other sites and does not appear to use site specific data on the conditions and aquatic life in the local receiving environment. Technical Guidance 8 specifically states, "Development of an SBEB based solely on peer-reviewed scientific literature will not be accepted."

Technical Guidance 8 states that "only standard, peer-reviewed scientifically defensible models that are vetted through the ministry at the SBEB development plan stage are acceptable. For selenium bioaccumulation modelling, guidance on an acceptable approach is provided in the

ministry's Companion Document to Ambient Water Quality Guidelines for Selenium Update (MOE 2014)." Detailed comparison between the modeling conducted and ministry guidance was outside the scope of this review but it is notable that the selenium SPO memo in the Application does not reference the cited Companion Document, nor does it provide a rationale for using the chosen models.

Overall, there does not appear to be reason to develop a site specific water quality target for the site instead of using generic BC WQG.

Risk: The proposal to significantly relax generic water quality objectives in the receiving environment may cause impacts to the receiving environment and aquatic life. Use of site specific objectives is not unheard of but requires a rigorous assessment to ensure that site specific objectives are still protective of the receiving environment. Use of SPOs as targets in the receiving environment rather than generic BC WQGs on the basis of data from other sites is a significant divergence from established policy in BC regarding the use of site specific water quality objectives.

4. Robustness of the Geochemical Sampling Program

A major risk of the project is the large-scale onset of ARD, which would add a significant load of metal contaminants and acidity to mine contact water entering the receiving environment. The Application describes how the primary means of mitigating this risk is source control, whereby potentially acid generating rock is submerged in management ponds and non-acid generating rock is used for covers, as construction material, dams, and is not submerged. If PAG material is left unsubmerged for the long term (i.e. used as construction material or incorporated into covers) then onset of ARD will occur and mine contact water will be contaminated. Since there is no active water treatment proposed for the project, there is no margin for error in the placement of PAG material. As such, a robust and conservative understanding of the geochemistry of disturbed material is required for this mitigation strategy to succeed.

The Mine Environment Neutral Drainage (MEND) ARD Prediction Manual which covers best practices on ARD management in the sector, describes minimum sampling frequency required to adequately characterize geochemistry of disturbed material and clearly understand potential for ARD. Table 1 below summarizes the number of samples required for assessing ARD potential. For large units of rock between 1 Mt and 10 Mt in size, MEND recommends that at least 26 and 80 samples are required to adequately characterize material sufficiently to understand its geochemical characteristics. Given the project design, whereby no active water treatment is proposed or feasible to implement in a timely manner (see Comment #2, subsection on practicality) and where determining the boundary between PAG and NPAG rock is of critical importance for executing effective source control, the geochemical program should be much more robust than the minimum guidance in industry best practices.

Table 1: Suggested initial sampling frequency based on tonnage when sampling without prior information (adapted from BCAMDTF, 1989), MEND 2009

Tonnage of Unit (metric tonnes)	Minimum number of Samples
<10,000	3
<100,000	8
<1,000,000	26
<10,000,000	80

The Application describes a number of categories of rock, including material from the different rock units/zones of the open pit, overburden, and materials that are proposed for use as construction material for the access road, rail station, etc. However, the Application does not clearly lay out the total tonnage of all units of rock and the corresponding number of geochemical samples collected. It is not clear from the Application if the sampling program conducted to date meets the minimum guidance suggested by MEND to understand ARD potential. This is a significant gap in the Application as a whole and in Appendix 13.12-A, the MLARD Supplemental Geochemical Characterization Report, as confidence on this topic is critical to prevent environmental impacts.

While the Application does not explicitly discuss the tonnage and number of samples of each rock unit and whether or not the program is sufficient to meet MEND's minimum guidance, Source found indications that the program is insufficient. Table 4-5 of Appendix 13.5, the water and load balance describes the tonnage of several different zones the Application identifies as PAG. This table states that the size of zones 1a, 55 and 6 are in the range of 4.5 Mt of material while zones 2, 3, 4 and 5 are over 10 Mt[1]. According to MEND guidance, these units would require minimum 26 and 80 samples to adequately assess ARD potential. Review of Appendix 13.12-A, shows that these zones of material were each sampled between 9 and 22 times, well below MEND's minimum guidance of 26 to 80 samples for rock units of this size. Further, the ARD maps in Appendix 13.12-A, the MLARD Supplemental Geochemical Characterization Report show a paucity of sampling on the central west portion of the pit.

A related concept is the distribution of minerals with acid generating/neutralizing potential in the bulk material. Depending on how acid generating and neutralizing minerals are disseminated throughout the material, then the functional acid generating potential and neutralization potential

[1] Assuming 2 tonnes/bench cubic meter of rock

of the bulk material may be over or underestimated. The difference in distribution could affect the timing of onset of ARD and should be assessed and incorporated into the choice of NPR ratio used for categorization of NPAG/PAG.

One other area of the Application where further detail is required is in the number of humidity cell tests that were used to inform source term development for use in the water and load balance for the project. Humidity cell tests are key geochemical characterization tests that reveal important information about both initial flushing of metals as well as long term potential generation of acidity. The water and load balance appears to use a very limited number of humidity cell tests to inform this model, which is a foundational to the overall water management strategy. Appendix 13.5, the model report, describes how certain humidity cell tests from highly PAG materials were excluded from the model on the basis that they are not representative of the bulk properties of the rock. Given the limited geochemical program conducted compared to MEND guidance, this statement is not sufficiently supported to make this claim.

Risk: The geochemical characterization program appears insufficient to confidently characterize material as PAG or NPAG and to quantitatively predict the quality of contact water from the site. Given that source control is the first and only line of defence against onset of ARD, uncertainty in geochemical predictions could lead to inappropriate mine design and subsequent impacts to the environment.

5. Neutralization Potential Ratio Threshold for PAG Classification

Neutralization Potential Ratio (NPR) is the relative magnitude of the neutralizing minerals (NP) and acid generating minerals (AP), which is the main criteria to classify materials whether it is PAG or NAG. The standard convention for NPR cut-off, assuming accurate AP and NP measure, indicates potentially net acid generating if NPR < 1, not potentially net acid generating if NPR > 2, and uncertain if NPR is between 1 and 2. The Application brings in the site-specific NPR value of 1.2 as the classification criteria for rock mined at the site. This implies that any mine rock material with NPR less than 1.2 is considered PAG, and it is NAG material if otherwise. For all other materials (overburden, processed rock, and coal) a NPR threshold of 2 is selected.

The geochemical properties of the deposit are described based on the stratigraphical zone. A total of 21 drill holes were distributed around the proposed pit area to sample different zones of material. The geochemical testing results indicate that all zones contain some PAG material, but with the use of the site-specific NPR and the average bulk properties, the ARD potential of the stratigraphical zones was classified as follows:

- PAG: Zone 1a and Zone 2/3
- Non-PAG: Zone 1, Zone 4, Zone 5, Zone 55, Zone 6, Zone 7, and Zone 8

The choice of NPR threshold will have a significant impact on the amount of NPAG material available for construction and the amount of PAG material requiring submersion.

Risk: Use of a PAG/NPAG threshold of 1.2 is lower than standard industry practice and appears to not be conservative, as there is little margin for error given the size of the rock units and the wide use of material classified as NPAG as construction material. Sensitivity analysis associated with the NPR cutoff threshold with respect to construction material availability and management pond capacity is warranted. As observed in each stratigraphic zone, areas with NPR far less than 1.2 are present in the NAG classified zone, some of which are concentrated at a particular section of the zone. Even if the material used for construction material, dams, or etc., is considered as NAG based on the average bulk properties of the zone, there is still potential for portions of PAG material not being submerged and contaminating contact water in the future.

6. Availability of the Proposed Coverage for PAG Rock and Construction Materials

Chapter 12 (ML/ARD) lays out the requirements for management of PAG material to mitigate risk of oxidation, metal leaching and acidity. These mitigation measures for various areas of the mine include coverage with various depths of inert materials salvaged during the mining process. Moreover, various construction materials will be sourced onsite including for construction of buttresses and dams. While the Application provides the schedule of production for different types of materials at the mine site, it is not clear if enough material will be available for implementation of the proposed cover or various aspects of construction as envisaged.

Risk: The primary mitigation measure proposed for ML/ARD mitigation from mining waste includes submergence of PAG materials to avoid release of contaminants. Failure to provide adequate coverage is expected to result in accelerated release of contaminants including sulfate, aluminum, arsenic, cadmium, copper and iron. The Application does not provide detailed discussion on the availability of NPAG material when needed for construction or the availability of pond capacity when PAG submergence is required.

7. PAG Material Submersion Timing

Chapter 12 (ML/ARD) states that coal samples were not included in the ML/ARD testing conducted recently but that historic testing has shown potential for immediate ARD generation. The plan also states that due to the uncertainty in the timing to the onset of acidic conditions in coal, stockpiles will be monitored and if acidic drainage occurs, the stockpile material will be placed in management ponds. The plan does not provide any details on the ability to submerge this material immediately within the management ponds. More importantly, the plan does not consider the impact of moving large quantities of already acidic and weathered stockpiles on the storage conditions of the management ponds. Although not evaluated in the Application, weathered and partially oxidized coal will release contaminants upon initial and continued exposure to water.

Risk: The timing and feasibility of submersion of any PAG material on site must be clearly presented in the Application including the potential movement of coal to the management ponds. This is a significant risk because the initial acidic plume and release of contaminants from weathered surfaces will add metal and acidity loading to water in the management ponds. This is a significant risk as no water treatment is available on site beyond sedimentation ponds.

8. PAG Materials Submergence in Dry Period

Modelling results presented in the water and load balance modelling report indicate periods of reduced process water supply during dry conditions. The report also states that the minimum process water volume has not been included in the model but that it is expected water supply will be maintained and that PAG materials will continue to be submerged. Evidence is required to support this statement and that the potential shortage of process water, or the presence of dry periods do not affect the submergence schedule for the PAG materials.

Risk: Process water needs may increase the likelihood of PAG exposure beyond the 6-12 months estimated in the Application, increasing the likelihood of onset of ARD.

9. Management of Zone 7 Material

The geochemical testing on Zone 7 results in numerous sampling locations with NPR less than 1.2, indicating this material is potentially acid generating. However, according to the MLARD Management Plan, Zones 7 and 8 will be handled as NPAG and will not be submerged if there is a plan to mine this area. NPAG rock is prevalent in the northern, western, and southern part of the pit. However, the eastern section of the pit is filled with PAG rock.

Risk: Various samples within Zone 7 show NPR under 1.2, with several significantly less than 1.0. This material represents a significant risk of ARD if it is mined and handled as NPAG.

10. Acid Generation Potential of Exposed Pit Wall

At closure, a high pit wall will exist above the pit lake composed mainly of Zone 6 sedimentary rock. Although the site-specific criterion concludes that zone 6 is NAG, the existing geochemical testing result within Zone 6 indicates various locations showing high acid generating potential. If PAG material is left exposed at the end of mining, onset of ARD will occur.

Risk: The exposed high wall of the pit at closure is expected to be a contributor of metals and acidity to the pit lake.

11. Availability and Geochemical Stability of Cover Materials

Overburden materials are planned for use in the construction of the dams and buttresses as well as for use as covers for PAG rock in management. The MLARD characterization report states that solid-phase analysis of samples of overburden materials showed appreciable quantities of metals including arsenic and cadmium. Arsenic, selenium, and other contaminants can be

expected to be released from the material even under neutral conditions when exposed to the elements. The application states that overburden is depleted in sulfide and is expected to be NPAG with confirmatory testing planned at a frequency of one sample per 10,000 m^3 of excavated overburden. Metal leaching potential of these cover materials is important and must be considered in the water quality modelling. This is especially important for consideration in the analysis and modelling of seepage from the management ponds and other infrastructure.

Risk: If cover material is not suitable for use as covers owing to neutral metal leaching potential, then there will not only be reduced material available for covers, potentially reducing cover efficacy, but there may be additional material requiring covering.

12. Design Basis of Water Management Structures

The Application states that the Design Basis for operations phase diversion channels is to meet the 1 in 10-year 24-hour storm event for erosion protection (Table 6.3-2 of Minesite Water Management Plan). It is not clear if or how climate change was factored into this 1 in 10-year 24-hour storm event design basis. In any case, given that the proposed duration of the operations phase is 26 years, this design basis does not seem sufficiently conservative as it implies reasonable odds that the diversion will fail multiple times in the project lifespan. Erosion of engineered channels may deposit sediment into the receiving environment.

Similarly, Table 6.3-16 in the Minesite Water Management Plan describes that the minimum retention volume for sedimentation ponds including the Tenas Control Pond are based on the 1 in 10-year 24-hour flood event. Water inflow beyond this would be discharged via the pond spillways into the receiving environment.

Risk: Several water management features are designed using the 1 in 10-year 24-hour storm event as the design basis. Given that the total project lifespan is to be over 20 years of operations followed by closure, the 1 in 10-year basis is insufficient as failure and challenges with mine water management are likely to occur.

13. Release of Seepage and Contact Water at Closure

During operations, seepage from the East and North Management Ponds is to be collected and directed to the Tenas Control Pond via the channels C-01 and C-03. At closure, these two channels are to be breached and seepage from these ponds will be released directly to the environment. While waste rock and processed rock in the management ponds are to be submerged at this point, neutral metal leaching and reductive dissolution can contribute environmentally meaningful loading of contaminants even in the absence of ARD. Should metal loading from materials be greater than anticipated by the project proponent, large revisions would need to be made to the design of mine water management infrastructure to allow capture and containment of contact water.

Risk: The quality of seepage and other contact water at closure could be poor owing to reductive dissolution and neutral metal leaching from material in management ponds. Like the operations phase, the proposed closure plan for the project involves release of seepage and contact water to environment without treatment. This could impact water quality in Goathorn, Tenas and Four Creek and the downstream environment. Further evidence of this risk is provided in Appendix 13.5B, the water and load balance, which identifies seepage as a driver of exceedances of water quality guidelines in closure.

While the risk associated with release of untreated contact water to the receiving environment exists during both operations and closure, the risk is higher during closure for two main reasons. First, onset of ARD is generally a gradual process that occurs some time after material has been placed. As such, overall contamination and metal loading is likely to be worse in the later stages of operation and into closure than at the beginning of operations. Second, notwithstanding Comment #2 on contingency water treatment, during operations the site would be staffed and earning revenue, making it more likely that contamination would be observed earlier. In theory, the mine operator would have the financial means of executing mitigations if contact water was significantly contaminated during operations. In contrast, once the project is closed and no longer earning revenue, then the likelihood of implementing timely and effective mitigations drops precipitously.

14. Care and Maintenance Planning

Care and maintenance or temporary closure is an important aspect of mine planning. The potential for environmental impacts is significantly increased when a project is designed assuming a straight path from construction through operations and into closure/post-closure. Many mines in BC have entered period(s) of care and maintenance and can do so without a need to amend a permit or without any significant warning. Best practice is for mine proponents to evaluate a potential prolonged period of care and maintenance with water balance/water quality modeling and assessing the level of environmental risk.

Risk: Care and maintenance is not discussed in the Application. In the context of the Tenas Project, a significant risk during a period of care and maintenance is that disturbed PAG material that has not been placed and covered will generate ARD, causing contact water from site to be much more contaminated than would be expected in the case of going straight from operations to closure.

15. Integration of Mill Reagents into Water Quality Modeling Source Terms

The Application states that the water used for coal processing will be recycled. However, the use of chemical mill reagents do not appear to be considered in the development of source terms used for water quality modelling. The impact of recycling process water on mill process efficiency does not appear to be considered in the Application. The effect of accumulation of organic

reagents (collectors and frothers) on process efficiency may limit the recyclability of process water.

Risk: If process water is less recyclable than anticipated then process water would have to be bled into the control pond, ultimately reporting to the environment without treatment. The lack of consideration of process reagents on water quality modeling is a gap in the Application.

16. Metallurgical Coal versus Thermal Coal

The Application describes the Tenas project as a metallurgical coal mine, i.e. coal extracted is suitable for steelmaking rather than thermal coal used for power generation. The Application describes variability in the coal ore in terms of moisture content, rank etc. but it isn't clear if the proponent expects that all coal produced would be suitable for steelmaking. Often coal from a single mine varies by rank, meaning that a portion is sold for steelmaking and a portion is sold for power generation.

Risk: The absence of discussion on whether any portion of the coal is expected to be thermal is relevant because the markets of the two products are different and their marketability may vary over the 20 year proposed life of the project. While steelmaking coal is expected to be in demand for the near future as alternatives to metallurgical coal are developed and deployed, demand for thermal coal is already softening owing to increased use of alternative power generation methods that are less carbon intensive. If the project is relying on revenue from thermal coal and thermal coal demand falls (or is subject to carbon taxes, etc.) then part of the project assets may become stranded, heightening environmental risk due to increase financial stress on the mine operator.

17. Contingency use of Management Ponds as Saturated Rock Fills

The Water and Load Balance report states that the management ponds could be used as saturated rock fills to remove contaminants from water (see Comment #1). However, the Application provides no discussion of how the management ponds would be designed with this purpose in mind or how such a contingency would be executed.

Risk: Use of management ponds as saturated rock fills is not described in any detail. Without a basis for this assertion there is risk that this contingency measure is not practical.

Closing

Thank you for the opportunity to provide third party technical review of the Tenas Coal project. If you have any questions about the points raised in this document, please contact the undersigned.

Yours sincerely,

Source Environmental Associates Inc.
per:

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