

MINESITE DRAINAGE ASSESSMENT GROUP
(A Division of Morwijk Enterprises Ltd.)

www.MDAG.com, contact@mdag.com
Surrey, British Columbia, Canada

BY EMAIL

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MiningWatch Canada
Suite 508, City Centre Building,
250 City Centre Avenue,
Ottawa, Ontario K1R 6K7
Attn: Mr. Ugo Lapointe

Dear Mr. Lapointe,

**RE: Harper Creek Project, British Columbia-
Review and Comment on the EIS Pertaining to Acid Rock Drainage (ARD), Metal
Leaching (ML), Water Contamination, and Related Issues**

Introduction

As you requested, we have reviewed the Harper Creek Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS), Rev E1, dated January 2015, as posted on the CEAA website. We have focussed on issues related to the predicted contamination of waters around the site, which is locally referred to as “ML-ARD” (metal leaching and acid rock drainage).

It is important to note that the term, ML-ARD, is often mis-used in EIS documents in British Columbia, where most of the emphasis is placed on ARD and much less on ML. As shown in Figure 1, ML represents the larger, more general issue of water contamination, whereas as ARD is a subset of ML. Also, numerous water-treatment plants at minesites can confirm that annual treatment costs for ML can equal or exceed those for world-class ARD. Therefore, ML requires significant emphasis in an EIS.

Summary of This Review on Predicted Water Contamination

The proposed Harper Creek minesite will be a relatively large, open-pit operation for the recovery of copper, gold, and silver. The site is located near, and eventually drains to, the North Thompson River. Because of its size, potential environmental impacts, vicinity and cumulative effects to a major river, the Harper Creek EIS should exceed typical environmental work and be very cautious. For the issue of ML-ARD, the Harper Creek EIS fails in this.

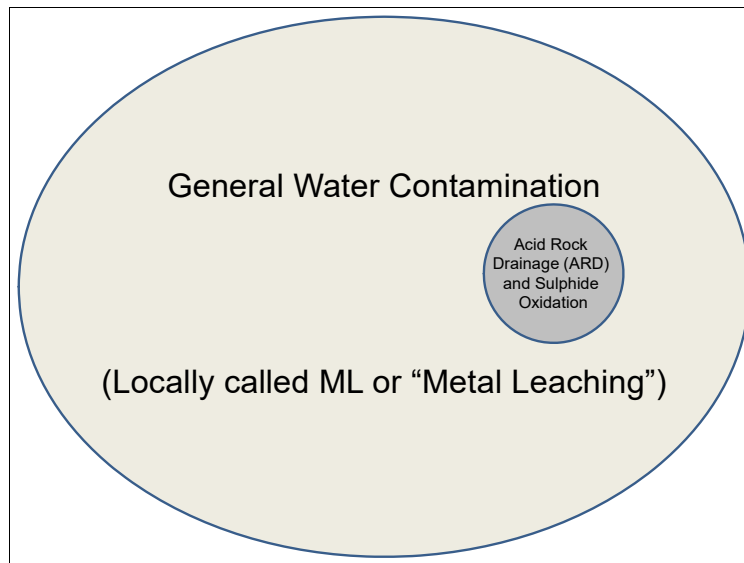


Figure 1. Water contamination at minesites, locally called “ML”, with ARD as a subset of ML.

The lack of detail and reliability on the larger ML issue is a major environmental weakness in the Harper Creek EIS. We expect ML and water contamination will be worse than predicted in the EIS.

Furthermore, despite the emphasis on ARD in the EIS, the predictive work fails to meet current standards in British Columbia, such as the number of full acid-base accounts (ABA). Because the proposed ARD mitigation is submergence in the tailings impoundment within two years, it is important to reasonably show the amount of mined materials requiring submergence will fit into the allotted space. However, we find the ARD predictions to be of low reliability. Thus, the EIS fails to provide reliable information that the proposed ARD mitigation will prevent ARD at the proposed site.

Additional discussions of these findings are provided below.

Prevention by CEAA of Full ML-ARD Review

Typically, our ML-ARD reviews include checks on mathematical calculations, statistics, and resulting predictions. This requires that we extract data from the documents, or data are provided as spreadsheets. We believe there are mathematical and statistical errors in the EIS related to ML-ARD, particularly Appendix 6-A and 13-E. However, we cannot extract data to confirm, because these documents posted on the CEAA website for public review are password protected. Therefore, the suspected errors, which may invalidate some predictions, cannot be confirmed.

It may be possible to request from CEAA the EIS as non-password-protected. However, due to the short one-month review period, we had to begin our review immediately and could not wait for such files, if they are even available.

For this reason, we suspect the reliability of predictions for water contamination and ML-ARD in the EIS is weakened further by the mathematical errors. However, CEAA has effectively stopped us from pursuing this.

Predictions in the EIS for Water Contamination and ML

As shown in Figure 1, ML is a locally used acronym for water contamination at a minesite. ARD (discussed below in the next section) is a subset of this.

We have found that predictions of ML and water contamination in the Harper Creek EIS have underestimated the likely contamination. This is due to errors as well as the approach used in the predictions.

Examples are the simplest way to illustrate how the predictive approach used in the EIS failed to reveal the real potential for aquatic toxicity and contamination. Table 1 below contains simple illustrative examples.

The Harper Creek EIS explains in several places that all water-contamination predictions reflect average annual concentrations. By definition, an average value means there will be values less than, and greater than, the average. That is basic statistics. The EIS makes the effort to point out there will be lower concentrations, such as:

“Seasonal variations were not considered though experience indicates that source concentrations may decrease during high flow events such as spring snowmelt.”

However, there was no mention at all that the opposite (higher values) will be encountered. That is the problem in the EIS. As the examples in Table 1 show, the average annual concentration can be below toxicity levels, yet aquatic life can still be devastated for a month or more each year. Furthermore, those seasonal toxic concentrations could eliminate, each year, any recovery in the ecosystem.

The lowering of predicted contamination for Harper Creek goes even further in the EIS. Section 5.2.1 of Appendix 6-A explains that the average-annual predictions were lowered even further by “scaling factors”, “expected solubility”, and the “assumption that pore water pH exceeds 8”.

Please note that a critical factor like pH is just an “assumption” for the Harper Creek predictions, which is a bad idea when it is so important to define ARD. Yet the EIS uses assumed pH as a major predictor of ML. This becomes even stranger, because the predicted source terms in the EIS actually contain predictions of “H⁺ concentration” that correspond to acidic pH 4.5. This prediction was apparently dismissed in favour of an assumed alkaline pH that would allow lower predictions of many other contaminants. There are errors in the predictions.

Table 1. Examples of annual-average concentrations of water contamination masking and failing to predict significant toxicity and damage to the downstream ecosystem (this problem exists in the source-term predictions in the Harper Creek EIS)

In these examples, a toxic concentration is 1 mg/L, so any concentration exceeding 1 mg/L will kill aquatic life and degrade an aquatic ecosystem

<u>Month</u>	Example 1	Example 2
	<u>Concentration (mg/L)</u>	<u>Concentration (mg/L)</u>
1	0.01	0.01
2	0.01	0.01
3	0.01	0.01
4	1.5	0.01
5	2.0	0.01
6	3.0	0.01
7	0.01	0.01
8	0.01	0.01
9	0.01	0.01
10	0.01	0.01
11	0.01	3
12	0.01	0.01
Average Annual Concentration (mg/L)	0.55	0.18

The Harper Creek EIS uses average annual concentrations for predictions of water contamination. In the two examples above, the average annual concentration would declare the water to be below toxicity. In these examples, for a month or more each year, the minesite drainage is toxic, and any recovery of the ecosystem would be destroyed by the next year's toxic concentration.

As a result, the Harper Creek EIS fails to predict toxic concentrations that could persist for months. Where this issue is discussed in the EIS, it adds, "Seasonal variations were not considered though experience indicates that source concentrations may decrease during high flow events such as spring snowmelt". However, note the glaring omission that, by definition, there must also be higher concentrations, above the average value, which is not mentioned.

With the assumed (preferred) alkaline pH contradicting the predicted acidic pH, Appendix 6-A links pH directly to iron concentrations, which is wrong. At minesites around the world, iron concentrations also depend on other factors like redox and complexation, which could make the iron predictions in the EIS hundreds or thousands of times too low.

Regarding the aforementioned “scaling factors”, predictions were multiplied by several values less than 1, to lower the contaminant predictions generally by factors of 50 to 100! One such factor ranged from 0.3 to 0.5 to reflect the site temperature. In reality, most experts on ML-ARD know that sulphide-oxidation generates heat making a large rock pile warmer than its surroundings, and thus this scaling factor (as well as others) are not justified. In any case, these less-than-one scaling factors (none greater than zero were used) are another reason the predicted contamination at Harper Creek is underestimated.

Regarding the aforementioned "solubilities", they cannot be adjusted by scaling factors. Basic chemistry and thermodynamics define equilibrium solubility as scale- and path-independent. They are also site-dependent, so using some published solubility of a mineral does not suffice for reasonable predictions. The author of the ML-ARD Appendix 6-A, SRK Consulting, went through this same issue on the Prosperity Project. Reviews and testimony by senior scientists at Natural Resources Canada and Environment Canada showed predicted contaminant concentrations even based on solubilities were still markedly and unreasonably too low.

Is this a case of history repeating itself? Will the senior scientists at Natural Resources Canada and Environment Canada once again show how this underestimation of water contamination is wrong and not acceptable? Will they ask why the solubility-based predictions for selenium at Harper Creek are based on one single published paper, apparently from a site in Spain. Will they ask why Harper Creek kinetic tests showed some leaching of toxic thallium, but this is not addressed in detail in the EIS?

Additionally, the EIS, such as Section 6, predicts ML based on solid-phase analyses. This is a major error, as many decades of work around the world have shown that the leaching rate and the concentration of an element into water are not often related to its solid-phase abundance. If it were, then most water on the earth would be loaded with silicon, aluminum, and iron, some of the most abundant elements. Nevertheless, the EIS explains,

“Evaluation of whole rock concentrations showed that relative to global average concentrations for comparable rock types, rock at the Project Site is primarily enriched with respect to copper, selenium and zinc. These elements are associated with sulphide minerals, and therefore higher ML potential can be expected to be correlated with rock with higher ARD potential, and in the case of copper selenium, correlation with ore can also be expected.”

Note again the emphasis on ARD and sulphide minerals, whereas the larger issue of ML can originate from any minerals, like carbonates and aluminosilicates.

Even more problematic with the solid-phase analyses, the ML predictions considered any solid-phase level less than “ten times global averages values tabulated by Price (1997)” would not be a

problem. This implies Price (1997) tabulated ten times the global averages, but that is wrong. In fact, Price (1997) never mentions ten times, or even three times. This “ten times global averages”, which incorrectly means most waste-grade rock in the world will never release ML, was made up based on no reliable information, and carries no predictive weight.

Although aqueous species like nitrate, nitrite, and ammonia are not metals, they can be toxic and require predictions under ML. They mostly arise from explosives residue. The EIS says Harper Creek predictions were based on the method of “Ferguson and Leask” from 1988. However, that study was for a drier climate, for coal mines, and subsequent decades of field studies showed that method typically underestimated the contaminant levels by a factor of 10 or more. Thus, contaminant aqueous concentrations of nitrate, nitrite, and ammonia at Harper Creek will likely be substantially higher than predicted in the EIS.

Finally, the EIS explains that mine wastes with higher ML potential will be submerged. However, this does not automatically mean that the remaining unsubmerged wastes will not have a substantial ML capacity. In fact, that is what the above comments show - water contamination in and around the minesite will likely be higher and more toxic than the EIS says from unsubmerged mines materials.

Predictions in the EIS for Acid Rock Drainage (ARD)

Recent mining EIS documents in British Columbia use acid-base accounting (ABA) as a starting point for ARD predictions. Recent EIS for larger mining projects like Harper Creek typically contain 500-1000 ABA for mine rock, plus dozens to hundreds more for tailings, overburden, and quarries. Amazingly, Harper Creek only has a total for all lithologies of somewhere around 191. Table 6 in Appendix 6-A says 191 ABA, but we cannot confirm that due to password protection of the data, and the EIS text does not seem to support that number. Also, we do not know how many ABA are just for mine rock. Nevertheless, this low number of ABA, for such a large mine near a major river, is markedly inadequate.

In the Harper Creek EIS, these relatively few ABA are correlated with assays of rock, to create thousands of “surrogate ABA”. For example, Leco-measured sulphur from the limited ABA was correlated with the corresponding four-acid sulphur from thousands of assays. That is a good idea, but the reliability of any correlation depends on the original number of samples. Therefore, the surrogate ABA for Harper Creek cannot be any more reliable than the errors inherent in the inadequate number of full ABA analyses.

Table 6 of Appendix 6-A also mentions the number of other types of tests: 21 humidity cells, 8 SFE, 5 MWMP, 5 saturated columns, 5 unsaturated columns, and 4 field barrels. The numbers of these tests are also inadequate relative to the size of the minesite and its proximity to a major river.

To see the emphasis on ARD in the mine plan, here are some quotations from the EIS:

“For the Project, a TMF is required with sufficient capacity to contain approximately 585

million tonnes (Mt) of tailings and the co-store (to minimize oxidation) of up to 237 Mt of PAG waste rock, together with an anticipated surplus water volume of up to 180 Mm³. It is envisaged that the balance of the tailings from low grade ore processed in Years 24 to 28 of the life of the mine will be deposited into the open pit.”

“Waste rock will be segregated. Potentially acid-generating (PAG) waste rock will be placed in the tailings management facility (TMF) and buried under tailings material. The non-potentially acid generating (non-PAG) material will be used in construction activities or stored in a waste rock stockpile.”

In the EIS, all mine materials at Harper Creek are divided into “potentially acid generating” (PAG) and “non-potentially acid generating” (non-PAG). It is important to understand that virtually all “non-potentially acid generating” materials at Harper Creek will in fact generate acid. Some will generate more acidity than PAG materials, but with the hope that they contain excess “Neutralization Potential” (NP).

So the EIS terminology is misleading, but has the intent to imply non-PAG materials are “okay”. They will be so “okay” that they will be used right away during construction, and used around the site for many purposes. Now, please understand that this “okay” “non-potentially acid generating” material at Harper Creek is exactly the material we talked about above under ML and water contamination. This “non-potentially acid generating” material will contaminate water, but the EIS has minimized ML predictions and used terminology to give a wrong impression of “okay”.

As explained in the previous paragraphs, there is a hope that the “non-potentially acid generating” material contains excess NP, so that it will never release ARD despite generating acidity. That of course depends on NP estimates. With regard to the all-important NP values to mathematically make PAG become non-PAG, we cannot reproduce NP statistics to confirm NP was evaluated properly. In Appendix 6-A, for example, we cannot obtain the same values for “upper” and “lower” confidence levels for NP*. Even then, it is important to remember that this material will contaminate water more than predicted in the EIS (see the previous section on ML), and treatment of non-acid ML can be more expensive than world-class ARD.

To show how ARD has also been minimized for overburden and quarry rock, here are two quotations from the EIS:

“Overburden from outside the footprint of the open pit had low ARD potential due to APs typically less than 10 kg CaCO₃/t. APs were higher for pit overburden reflecting the presence of mineralized rock and sulphur concentrations exceeding 1%. Three samples were classified as PAG due to NP/AP < 1.”

“Chemical analysis indicated granitic quarry samples had low sulphur levels, ranging between 0.03 and 0.04%. ARD potential of quarry is considered negligible. Chromium concentrations were found to be enriched using the same methodology as described in Section 6.3.3.1 though chromium is not expected to be in a mineralogical form that allows it to be mobilized.”

First, overburden APs of 10 represent elevated sulphur of 0.3%S. Second, decades of studies and even a recent publication from the Diavik diamond minesite showed rock with even 0.03 %S, such as found in the quarry, can release ARD. The earlier studies also showed no detectable value at 0.01%S or higher could be considered “negligible” ARD potential. So overburden and quarry rock at Harper Creek do indeed have significant ML-ARD potential.

This contradicts the water-contamination predictions of Appendix 6-A, but is consistent with Appendix 5-B which says oxidized overburden “is often strongly acidic”. In any case, apparently only six samples of quarry rock (we cannot confirm that number), with no kinetic testing and with significant discrepancies between NP and TIC NP, do not inspire confidence that, “ARD potential of quarry [sic] is considered negligible”.

Therefore, we have concerns when we read the EIS about ARD mitigation, like:

“A total of approximately 542Mt of waste rock and overburden will be mined from the open pit. The results of a waste characterization study and 3D modeling indicate that approximately 237Mt of the waste material is PAG.”

We suspect there is much more PAG material than that. Unfortunately, the quotation on Page 7 of this review showed that the impoundment would only hold “up to 237 Mt” of PAG material. So, there is already that much PAG for submergence as the preceding quotation says, and the impoundment can only hold up to that amount, there is no additional underwater storage in case there is more ARD-releasing rock, tailings, overburden, and quarry rock. Therefore, the excess material cannot be submerged and ARD will appear at Harper Creek.

Closing

In closing, we expect ARD at some point if Harper Creek goes ahead, and serious ML and water contamination can be expected even if ARD is mitigated. This unpredicted and thus unexpected ML-ARD would require treatment of contaminated water, likely for centuries based on similar minesites. In turn, this would likely costs many hundreds of millions of dollars each century. Such large costs should be estimated in advance of mining, and financial security to pay for them should be scheduled into the operation. This was not done in the EIS, because ML-ARD has been markedly underestimated, as we showed above.

Sincerely,

Kevin Morin, Ph.D., P.Geo., L.Hydrogeo.
President