Valentine Gold Project EIS Comments

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22 December 2020

Introduction

The following review comments have been developed on behalf of MiningWatch Canada for the proposed Valentine Gold Project Environmental Impact Statement (EIS), IAAC registry number 80169, NLDECCM registration number 2015.

These comments are based on my professional training and experience. I have an extensive background with more than 37 years involvement in mining metals and minerals including in the full-life cycle of exploration, project development, project permitting, construction, operations, reclamation, and closure. I graduated in 1983 with a B.S. in Mineral Processing from Montana School of Mines. In addition to growing up in a mining family and gaining practical experience prior to entering university, I have worked as a senior engineer, chief metallurgist, mill superintendent, mine manager, project manager, and consulting engineer. Since 1996, I have been the principal consulting engineer with Kuipers & Associates. My work during that time has focused on providing technical expertise to public interest groups, Tribes and First Nations, and governments concerning mining and environmental concerns. The primary areas of expertise I have provided have included site characterization, water quality predictions, mine planning and mitigations, tailing storage facilities, mine reclamation and closure, site investigations and remediation, water treatment, financial assurance, and economic evaluations.

2.1 CHANGES TO THE PROJECT SINCE ORIGINALLY PROPOSED

According to *Table 2.1 Key Refinements, Heap Leach Process and Infrastructure, Revised Project Design, With removal of the heap leach process, most of the low-grade ore that would have been processed via heap leach will now be stockpiled and processed within the milling process later in the mine life. <u>A relatively small percentage of the lowest grades may not be processed at all and will end up mixed in with waste rock</u>.* (underline added) *Ultimately, this percentage will depend on a number of factors, including market prices for gold and operating costs at any stage of the mine life.*

Do the geochemical characterization and water quality predictions in the EIS account for the potential impacts to waste rock discharges that might occur due to this change? What is "*a relatively small percentage*?" A range should be provided by the proponent relative to the market price of gold, and consideration should be given to the potential impact on water quality predictions associated with the waste rock piles should this occur, based on the actual range of percentages and geochemical characterization of the low-grade ore that could be reclassified as waste rock. If potential impacts are reasonably possible, which would best be confirmed by modelling this scenario versus the base case, the water quality predictions in the EIS should include a scenario that addresses this possibility.

According to *Table 2.1 Key Refinements, Tailings Management Facility Location, Revised Project Design, A detailed siting/location assessment for the TMF was completed as part of the PFS, which assessed a total of 14 potential locations up to 12 km from the previous TMF location. After reviewing the environmental, engineering and economic factors of the potential locations, the TMF was relocated to the north of its originally proposed location. The updated TMF footprint avoids fish bearing and/or navigable waterbodies.*

The EIS in Section 2.3.4.1 states that *Golder first proceeded with a <u>high-level options evaluation</u> to select the best tailings deposition method and TMF site.* (underline added) As the assessment is not actually referenced or provided, whether it is "high-level" or "detailed" cannot be determined. However, as the assessment did not involve a Multiple Accounts Analysis such as recommended by MAC 2019,[1] we do not believe it could be considered to be a "detailed" analysis.

According to *Table 2.1 Key Refinements, Tailings Management Facility Location, Benefits to… and Stakeholders, Eliminates potential interaction and risks associated with the Victoria Dam and Victoria Lake Reservoir.*

The idea of locating the TSF where it could result in potential interaction and risks associated with the Victoria Dam and Victoria Lake Reservoir to begin with was highly ill-advised from the standpoint of fundamental facility engineering safety considerations. The choice of this critically flawed approach is an example of the limited capacity of an exploration company to develop a major mining project.

According to *Table 2.1 Key Refinements, Tailings Deposition Type, Benefits to… and Stakeholders,*

- *Increases tailings stability within the TMF and therefore decreased dam height. Also reduces the risk of TMF failure due to piping in the dam or tailings liquefaction.*
- *Substantially reduces water storage within the tailings impoundment (storage component of the TMF), thereby reducing risk of a TMF failure due to piping or overtopping.*
- *Reduces tailings effluent (water), improving the general water quality within the TMF as direct precipitation acts to dilute.*
- *Reduces water within the TMF, decreasing the risk of groundwater infiltration, and reduces the potential inundation area (the area impacted by tailings and/or water) in the unlikely event of a dam failure.*
- *Increases the deposited density of the tailings, which should improve settlement with time and aid in mine rehabilitation and closure, as well as the longer term, post-closure stability of the facility.*

The EIS should avoided the use of generalizations and provide actual values whenever possible. How much is the tailings stability increased (e.g., minimum FOS increased from x to y)? How much was the dam height decreased as a result of increased tailings stability? By what actual volume is water storage reduced? How does reducing the volume reduce the risk of TMF failure due to piping or overtopping? How much is tailings effluent water reduced, or water quality within TMF improved? How much is the risk of groundwater infiltration decreased, or potential inundation area reduced? How much does the deposited density of the tailings increase, and how will that improve settlement over time and aid in mine rehabilitation and closure and post-closure stability of the facility?

While there may be some small improvement in some of the tailings and TSF characteristics as suggested, they are overstated if they are compared to other tailings deposition types such as paste or filtered tailings. In some cases, the benefits are limited. For example, while increasing the deposited density of the tailings will increase the rate at which consolidation of tailings takes place, allowing mine rehabilitation and closure to take place more quickly, it will not by itself improve the long-term tailings density, and therefore will not significantly (e.g., by more than a few years over the longer term) aid in post-closure stability of the facility. These values should be put in perspective as compared to paste or filtered tailings.

According to *Table 2.1 Key Refinements, In-Pit Tailings Deposition, Benefits to… and Stakeholders.* See list of benefits in EIS. The EIS should avoided the use of generalizations and provide actual values whenever possible.

- *Tailings deposited within the exhausted open pit do not pose a risk of release due to dam failure.*

The EIS should note however that the tailings deposited within the exhausted open pit do post a potential risk of release of Mining Influenced Water (MIW) via groundwater.

- *The size of the Leprechaun open pit provides additional storage volume in the event that additional tailings are generated by the Project*

[1] Mining Association of Canada (MAC). A Guide to the Management of Tailings Facilities, Version 3.1, 2019. https://mining.ca/wp-content/uploads/2019/03/MAC-Tailings-Guide_2019.pdf

Has co-disposal of waste rock and tailings in open pit to bring to original contours been considered?

According to *Table 2.1 Key Refinements, Waste Rock Piles, Benefits to… and Stakeholders,*

- *Pile design now considers aesthetic features for closure (revegetation).*
- *Note that current designs include ditching and ponds to manage and treat water runoff prior to release.*

The inclusion of revegetation as part of closure as well as capture of water runoff during operations are both long recognized best practices, and rather than being refinements, should be considered as fixes to fatal flaws in the original design. It is concerning that the exploration company that proposes to advance and ultimately operate the project would not, on their own, have included standard design and reclamation practices such as revegetation and stormwater capture in their original plans.

According to *Table 2.1 Key Refinements, Ore Stockpiles, Benefits to… and Stakeholders,*

- *The stockpiles added are temporary as the materials will be processed in the mill; therefore, the stockpile areas can be completely rehabilitated after use, whereas the heap leach pile would have simply been covered and revegetated.*

What assurance is there that the low-grade stockpiles will be processed if the price of gold drops?

2.2.3 Operation Phase Overview
and **2.3.5.1 Water Management Complexes**

According to the EIS, *Note that Figure 2-6 shows the Leprechaun waste rock pile overprinting water management infrastructure. During summer 2020 field work, it was determined that the NL 1:50,000 mapping contains an error in relation to the extent of Stream VIC-15, which extends eastward approximately 200 m farther than mapped. The Leprechaun waste rock pile has been adjusted to avoid this fish habitat, however, the design of the water management infrastructure design could not be updated in time for the EIS submission. The water management design will be updated as part of the Feasibility Study that is scheduled to be completed in early 2021.*

The updated water management design is important with respect to mitigation and should be required to be completed and included in the EIS.

2.2.4 Closure Phase Overview

According to the EIS, *…disturbed areas will be graded, covered with overburden and organic materials, and seeded to promote natural revegetation.*

What about topsoil? The EIS is not consistent. Is topsoil = organic materials?

The Rehabilitation and Closure Plan will detail methods to be used for progressive and closure rehabilitation and post-closure monitoring.

The lack of a requirement for a detailed Rehabilitation and Closure Plan (RCP) is not typical of best practice, which instead suggests that the entire mining life-cycle should be considered at the initial design stage for planning and environmental assessment. A conceptual but reasonably detailed RCP is required in order to consider the effects of the proposed project as discussed further in these comments.

2.2.6 Project Schedule

According to *Table 2.4 Anticipated Timeframes, Frequencies and Durations of Main Project Activities, Post Closure and Long-Term Monitoring,*

- *Commencing following closure rehabilitation in 2036 (Y14), with anticipated duration of 6-10 years for post-closure monitoring, may be shorter as major infrastructure (pits, TMF) will start closure in 2031*
- *Monitoring plans to be developed once design and operation activities have been sufficiently advanced.*

What is the basis for the presumption of no post-closure maintenance or any activity past Year 10? Why are monitoring plans not being included in the EIS?

2.3.2.2 Topsoil and Overburden Stockpiles

What is the material balance of the organics stockpiles, and are “organics” = topsoil?

2.3.2.3 Ore Stockpiles

Approximately one-half of the Marathon’s LGO is conservatively classified as PAG. The minimum ARD onset time in PAG LGO is approximately six years, based on maximum laboratory leaching rates. There were no exceedances of MDMER limits observed in humidity cell leachates from LGO under neutral conditions. Based on kinetic testing, Al, P and Zn have moderate leaching potential. The Marathon LGO stockpile effluent has been segregated from other mine component flow streams in the overall mine design to facilitate collection and further ARD treatment, if required. About 10% of LGO from Leprechaun pit is estimated to be PAG. The LGO stockpile is not expected to generate ARD before all the LGO has been processed at the mill. Kinetic testing suggests moderate leaching potential for Al and P and no exceedances of MDMER limits.

The EIS, as well as the RCP and financial assurance estimate, should consider the potential for the ore stockpiles, in particular the LGO, to be left in place and not processed. A contingency for moving the LGO to the waste rock pile at closure should be considered in the event the company at some point were to abandon the mine.

2.3.4.1 Tailings Management Facility

According to the EIS, *Golder Associates Ltd. (Golder) was engaged to complete a pre-feasibility level TMF design*. However, the actual design study is not formally referenced by this section of the EIS, or included as a reference to this section of the EIS. It is, however, identified in Appendix A, Dam Safety:

> Golder Associated Ltd. (Golder) (2020a). Marathon Gold: Prefeasibility Study for Tailings Disposal at the Valentine Gold Project, Newfoundland. Report prepared for Marathon Gold Corporation, Mississauga, Ontario. March 2020.

Also, according to the EIS, *As part of its mandate, Golder first proceeded with a high-level options evaluation to select the best tailings deposition method and TMF site.* No actual options evaluation is formally referenced by this section of the EIS. However, the EIS does reference:

> Golder Associates Ltd. 2020a. Valentine Gold Project - Tailings Storage Facility Site Selection Study. Technical Memorandum. Prepared for Marathon Gold.

While Appendix A ,Dam Safety includes the following reference:

> Golder (2020b). Design Basis Memorandum: Design Basis for the Dam Breach and Inundation Assessment – Valentine Gold Project. Report prepared for Marathon Gold Corporation, Mississauga, Ontario. May 2020.

After review of the EIS with the expectation of locating these documents within its contents, the reviewer was unable to locate them. Without this information, a thorough review of the proposed TMF design is not possible. However, ultimately, we would expect to be disappointed in the level of detail provided for a pre-feasibility level

TMF design. Based on our recent experience in performing technical reviews and working with independent review panels on multiple TSF design projects over the past 5 years, a higher level of design is necessary prior to permitting to provide the necessary basis for assessment. Otherwise, the purpose of the technical and independent review is compromised, as those reviews might decide to reconsider the siting location, dam design, or tailings methods proposed in the EIS. In particular, we would note that without a rigorous site characterization, geotechnical and geological hazards analysis, climate analysis, geohydrological analysis, as well as other critical information such as a detailed Rehabilitation and Closure Plan, the EIS must depend more on speculation and proposals for what is to be done, than on actual scientific findings of fact.

According to the EIS, *It is a requirement that the TMF dams are founded on compact to dense native tills and/or bedrock with low permeability characteristics to limit seepage.*

This is the only location in this section of the EIS that addresses TMF lining other than suggesting earlier in the section that *A geomembrane liner will be incorporated into the upstream slope of the embankment to retain water within the impoundment.* The EIS should clarify if the primary purpose of the geomembrane liner on the upstream slope of the embankment is based on limiting seepage, or based on stability concerns related to allowing water to seep into the embankment. Depending on dense native tills and/or bedrock with low permeability characteristics to limit seepage is speculative, particularly in the absence of a reliable site characterization, and a preferable approach would be to use a geomembrane liner over the entire interior of the TMF. **This alternative should be considered by the EIS.**

According to the EIS, *The dam safety program established in NL requires that dams must be designed, operated and maintained to meet the requirements of the Canadian Dam Association (CDA) and Mining Association of Canada (MAC) guidelines, Global Industry Standards on Tailings Management (ICMM et al. 2020), as well as applicable provincial requirements.*

The Global Industry Standards on Tailings Management (GISTM)[2] is considered by most practitioners to be the current industry standard. Many of the reviewer's comments and suggestions are based on application of the GISTM to TSF design and environmental assessment processes with ICMM member companies that have been undertaken with a concerted effort to meet GISTM requirements.

The GISTM is based on the following 14 principles:

- Principle 1 - Respect the rights of project-affected people and meaningfully engage them at all phases of the tailings facility lifecycle, including closure
- Principal 2 - Develop and maintain an interdisciplinary knowledge base to support safe tailings management throughout the tailings facility lifecycle, including closure.
- Principal 3 - Use all elements of the knowledge base - social, environmental, local economic and technical - to inform decisions throughout the tailings facility lifecycle, including closure.
- Principal 4 - Develop plans and design criteria for the tailings facility to minimise risk for all phases of its lifecycle, including closure and post-closure.
- Principal 5 - Develop a robust design that integrates the knowledge base and minimises the risk of failure to people and the environment for all phases of the tailings facility lifecycle, including closure and post-closure
- Principal 6 - Plan, build and operate the tailings facility to manage risk at all phases of the tailings facility lifecycle, including closure and post-closure
- Principle 7 - Design, implement and operate monitoring systems to manage risk at all phases of the facility lifecycle, including closure.

[2] https://globaltailingsreview.org/wp-content/uploads/2020/08/global-industry-standard_EN.pdf

- Principle 8 - Establish policies, systems and accountabilities to support the safety and integrity of the tailings facility.
- Principle 9 - Appoint and empower an engineer of record.
- Principle 10 - Establish and implement levels of review as part of a strong quality and risk management system for all phases of the tailings facility lifecycle, including closure.
- Principle 11 - Develop an organisational culture that promotes learning, communication and early problem recognition.
- Principle 12 - Establish a process for reporting and addressing concerns and implement whistleblower protections.
- Principle 13 - Prepare for emergency response to tailings facility failures.
- Principle 14 - Prepare for long-term recovery in the event of catastrophic failure

The GISTM contains specific requirements relative to each principle. We believe it would be highly informative for the project proponent and their consultant, and the responsible regulatory agencies, to perform a gap analysis for the project and its present status with respect to the GISTM Principles requirements. Performance of the gap analysis would show that the current level of design and information provided in the EIS is not consistent with those requirements and would provide the parties a sound basis for both resolving the inadequacies of the present EIS and as project plans proceed.

2.5.3.1 TMF Dam Raises

According to the EIS, *The embankment has a 3.5H:1V upstream slope and 2.0H:1V downstream slope.*

Why is the downstream slope at 2.0H:1V with no benches, instead of a more preferable 2.5H:1V or 3H:1V slope, with benches, for rehabilitation and closure purposes?

2.6 REHABILITATION AND CLOSURE ACTIVITIES

According to the EIS, *A complete Rehabilitation and Closure Plan has not yet been developed for the Project; however, the following sections outline the rehabilitation and closure philosophies and concepts that will be used in the development of the Project's Rehabilitation and Closure Plan. This plan will be drafted and finalized in consultation with NLDIET upon release from the EA process.*

The outlined information provided in the EIS is insufficient to meaningfully inform the impact analysis for the EIS. The EIS provides detailed information with respect to the proposed construction and operations period over the initial 12-year period, but only cursory information is provided on the RCP that will be used to ensure for future generations restoration of lands, protection of water quality, and post-mining land use.

As has been noted throughout the history of abandoned mine cleanup in Canada and elsewhere, the environmental as well as many of the societal issues with mining are most typically not associated with its operational period, but rather once mining stops, whether permanently or intermittently. Therefore, it is recognized that if the potential impacts of a mining project are to be assessed, adequate information must be provided and or otherwise developed for the full mine life-cycle, including reclamation, closure, and post-closure. This includes describing the site characteristics at the end of mining with respect to hydrology, geochemistry, and water quality, as well as the reclamation and closure plans for each individual facility, as well as the project site as a whole, that will be carried out to mitigate any impacts. It is widely recognized by industry, regulators, and scientists and engineers involved in mine design and permitting that it is critical that the entire life-cycle of mining, from cradle to grave, be addressed from the beginning of the process, rather than as an afterthought following initial permitting.

As a result of the recognition of the need for this information in environmental assessments, when an application is submitted for a major mine permit, in nearly all cases, this project being a notable exception, a detailed stand-alone rehabilitation and closure plan, together with supporting information, is submitted with the application. In some cases, the reclamation and closure plan may also be accompanied by a financial assurance cost estimate. **A detailed RCP is essential to a reasoned choice among the alternatives.**

The lack of a detailed RCP is a critical data gap in the EIS. Without this information, the EIS does not provide adequate context for assessment of impacts to wetlands, groundwater and surface water, or other impacts, including to wildlife, fish and aquatic resources, subsistence resources, and other human uses and activities, as it fails to provide specific rehabilitation and closure information necessary to develop a science-based finding as to post-mining impacts or mitigation. **Given the critical need for this information the applicant should be required to provide a detailed RCP.**

As an example, for comparison to this EIS, the Guidelines for the Preparation of an Environmental Impact Statement for the New Prosperity Project in British Columbia[3] should be considered. The New Prosperity EIS Guidelines contain a much higher degree of specificity than was provided for the Valentine EIS, where the Federal and Provincial Guidelines require the proponent to *outline a preliminary decommissioning and reclamation plan.* The New Prosperity Guidelines required the EIS to include the following information:

- proposed land use end objectives for the various mine site components;
- productivity or capability objectives and the general means by which these objectives will be achieved; plans for removal of structures and equipment and remediation of contaminated soils;
- plans for reclaiming roads and other linear disturbances;
- waste rock dump and stockpile reclamation plans, including final configurations, proposed re-sloping, soil replacement, and revegetation methods;
- tailings impoundment reclamation plans, including final impoundment configuration and water levels, re-sloping, soil replacement and revegetation methods;
- open pit filling times and final configuration;
- site water management plans for all facilities and including re-establishment of post-mine watercourses;
- concepts for monitoring and research programs that will assess reclamation success and for meeting overall closure objectives;
- conceptual monitoring programs for permanent structures to ensure long-term geotechnical stability;
- conceptual long-term monitoring programs for surface and groundwater quality; and
- management plans for final closure as well as temporary closure and/or early permanent closure.

2.6.1 Approach to Rehabilitation and Closure

According to the EIS, *As the Project design process moves forward, the volume of soils required for all rehabilitation activities will be assessed, and a materials (rock and soils) balance and Soil and Rock Management Plan will be developed for the overall Project to ensure that sufficient soils are available for rehabilitation, while avoiding excavating and stockpiling soils in greater quantities than those required, thereby resulting in increased Project footprint and soils excavation, management and closure impacts.*

The EIS should contain a rehabilitation soils mass balance based on the proposed mine plan and conceptual RCP and consistent with the other data in the EIS. The EIS should contain the information necessary to perform this

[3] https://fonv.ca/media/pdfs/GuidelinesNewProsperity.pdf

evaluation based on the disturbed area of the proposed facilities that in the future will be covered, and the amount of overburden and topsoil/organic material proposed to be stored (see EIS Table 2.7). However, as a notable exception to this EIS and any other of which this reviewer is aware, in this EIS's Section 2, *there are almost no descriptions of the actual area or footprint of the proposed facilities/disturbed areas*. Instead of a table containing the area of each facility (e.g., open pit, waste rock pile, overburden pile, topsoil pile, TSF, facilities, roads, man camp), the only area mentioned, apparently inadvertently as otherwise it is conspicuous that this key information is missing from the EIS, is on p. 2.59 where it is mentioned that the polishing pond would have a footprint of approximately 4.1 hectares.

EIS Section 2.6.2 suggests the "anticipated" total thickness of the cover is 0.3m over the waste rock. Typically, an EIS level RCP would identify the total thickness of the cover for each facility, and provide a materials mass balance showing how the required quantity of cover materials would be recovered and stockpiled for future use.

2.6.2 Progressive Rehabilitation

According to the EIS, *when a bench is finished in one area, the horizontal bench and downhill slope will be covered with overburden / organics (anticipated 0.3 m in total thickness) and revegetated.*

A total cover thickness of 0.3m is marginal and technically infeasible in our experience. From a practical standpoint, given the relatively coarse gradation of the underlying waste rock and the proposed overburden cover materials, covered by a thin layer of organics, in order to achieve a <u>minimum</u> 0.3m cover thickness, an <u>average</u> cover thickness of 0.45m or more is required. If the cover material is available, most reclamation experts would prefer to have 0.6m of cover material as this also allows for long-term erosion and minimizes the need for cover replacement. It also should be noted that the idea with reclamation is to mimic the surrounding landforms and vegetation, and not just apply a veneer of cover materials as if the facility is an agricultural field.

The EIS does not describe the revegetation process other than to suggest that during this stage the proponent would be *Completing revegetation studies and trials*. The EIS should provide a description of the intended studies and trials. It should also provide a conceptual or provisional revegetation plan describing the intended revegetation species, their distribution, the planting methods, and to what extent any amendments (compost, fertilizer, other) are intended to be used. This information is not only necessary to evaluate the potential effectiveness of the RCP measures, but additionally, as the proposed life of mine cannot be insured and therefore financial assurance must be required based on that eventuality, this information is needed to establish a cost estimate for that purpose.

According to the EIS, *Decommissioning and rehabilitating the TMF while Project operation continues, once tailings deposition moves from the TMF to the Leprechaun open pit in Year 9 of the operation phase (noting that decant water from the TMF will continue to be recycled for process water).*

It would be advantageous if this sequence of events were to occur as it would allow for some level of TSF closure to occur while mine operations were still active. However, we would also note that as a result, the highest cost year for future reclamation, will likely occur in Year 9, should the operator for some reason, such as economics, cease the mining operation, and the government become responsible for the implementation of the RCP.

2.6.3 Closure Rehabilitation
2.6.3.1 Open Pits

Natural filling of the pits is forecast to require from 34 to 38 (Marathon pit) and 37 to 42 (Leprechaun pit) years without supplementing inflow. It is also proposed to pump water from Valentine Lake and Victoria Lake Reservoir to further expedite filling of the Marathon pit and Leprechaun pit, respectively, reducing the flooding times to within the closure and anticipated post-closure monitoring periods. Water would be withdrawn from Victoria Lake Reservoir (0.178 m3 /s) and Valentine Lake (0.145 m3 /s) over an eight-year period. Monitoring of water quality *within the open pit during filling will be completed to assess the potential discharge water quality and to determine if any water treatment could be required until water quality meets the appropriate criteria.*

While the opportunity to more rapidly fill the mined-out open pits over an eight-year period is generally favoured in order to shorten the time-frame of filling during which stability, safety and geochemical concerns are more prevalent, the potential need to conduct additional water treatment, particularly for the Leprechaun Pit after partial backfilling with tailings, should be considered in the RCP and EIS and in the financial assurance estimation.

2.6.3.2 Waste Rock Piles

The EIS contains a single paragraph describing rehabilitation and closure of the waste rock piles. The description is general and non-specific except for suggestion that the piles will be sloped for final closure at three horizontal to one vertical (3H:1V).

2.6.3.3 Tailings Management Facility

The EIS description of closure for the TMF is highly non-specific and contradictory. According to the EIS, *When the tailings deposition is moved to the Leprechaun open pit in Year 9, the process of closure and rehabilitation of the TMF will commence. It is expected that the water treatment plant and polishing pond components of the TMF will operate <u>for some time</u>, and that water collecting within the TMF (drainage from the tailings, as well as precipitation) will continue to be pumped to the mill as reclaim water.* (underline added)

Exposed tailings will be covered with overburden and revegetated, and as water quality and flows reach equilibrium within the facility, a larger, closure spillway will be constructed to lower the water level within the tailings impoundment. <u>At this time</u>, the water treatment plant and polishing pond will be removed and water flowing from the tailings impoundment will be channeled to release to the environment. (underline added)

The RCP should be based on a post-closure water balance that estimates how long the water treatment plant and polishing pond components of the TMF will be required to operate, and the time-frame for converting the TMF to either an active or passive closure phase. The EIS does not make it clear as to whether the TMF will be closed as a wet facility. While the EIS does suggest *as the Project progresses, Marathon will evaluate the tailings impoundment and consider options to further dewater the stored tailings working towards classifying the TMF as a landform (under the CDA closure guidelines) and therefore alleviating the requirements for maintaining and inspecting the dams post-closure* this also suggests that otherwise the TMF will not be closed as a landform. This is reflected in the further statement in the EIS that Marathon will establish a plan for long-term inspection and maintenance of the dams. **Given the present public awareness of the potential for catastrophic failures of TMFs the EIS does not even begin to provide adequate information to address this potential from the standpoint of rehabilitation and closure.**

Experience has shown that the consolidation of tailings is highly variable and site specific, and that final reclamation can require significant additional time than is inferred, since it is not described in detail, in the DEIS. The Mount Polley Independent Expert Review Panel[4] identified three principles for Best Available Technology (BAT) for existing TSFs as: no surface water; unsaturated conditions, and; achieve dilatant conditions by compaction. The Canadian Dam Association (2014) describes TSF closure in four phases related to the management of risk of TSF's depending on their state of closure. The four phases are summarized below:

<u>Phase I – Transition</u>

- When the TSF has reached its capacity and ceases to be operated, or when the mine or processing operation is terminated permanently, the Transition Phase of closure commences. Activities include:
- Decommissioning as a water retaining structure

[4] https://www.mountpolleyreviewpanel.ca

- Breaching the TSF dam
- Modifying the dam, spillways and discharge structures to remove and no longer allow a surface ponds while safety passing storm events (PMF)
- The transition phase can be lengthened by the need to contain and treat surface supernatant, which can require a period of up to five years in some cases

Phase II – Active Care
- This phase involves active care of a TSF, including monitoring, inspection, water management, operation of a water treatment system, etc. after the Transition Phase is completed
- Seepage from the TSF may continue at a relatively high rate for from five to fifty years or more until a steady-state seepage rate is achieved
- Surveillance and maintenance (i.e., inspections, maintenance of erosion protection, vegetation management, inspection of the cover system, etc.) and monitoring to verify actual performance versus design of the TSF during this phase where the supernatant pond has been eliminated
- The time required for this phase could be a few years to decades, or longer

Phase III – Passive Care
- No active operations
- A sufficient period of monitoring has taken place and the TSF is considered to be in a steady state condition
- There is no requirement for water treatment or intervention by operating. personnel to manage water levels in the TSF.
- A spillway has been established to release stormwater water and potentially erodible exterior slopes have been reclaimed
- This period has no time limit, but can be defined as being necessary until the tailings dam, in the opinion of the regulatory authorities, is considered to have achieved Phase IV - Landform

Phase IV – Landform
- When, in the opinion of the regulatory authorities, is considered to be physically, chemically, ecologically, and socially stable and no longer poses a risk to life or the environment.
- No inherent or remaining risk so might not require regulatory oversight
- Could lead to a “walk away” condition

The EIS should be based on an RCP that identifies what stage of TSF closure is expected to be achieved and when in accordance with CDA recommendations. The EIS should also identify stable landform closure as an alternative for the TSF if it is not clear that the proposed action would result in that condition being achieved within a reasonable time-frame. The EIS should also address mitigation such as using intervention techniques (e.g., wick drains and loading with waste rock or borrow material) to achieve stable landform conditions.

2.6.5 Post-Closure and Long-Term Monitoring

According to the EIS, *The post-closure monitoring program will continue after final closure activities are completed for an estimated 6 to 10 years… The post-closure and long-term monitoring plans are yet to be developed.*

In contrast to the EIS for the proposed Valentine Project, the Donlin Gold Project Final EIS[5] (April 2018) Section 2.3.2.5.2 CLOSURE AND POST-CLOSURE contains detailed information on long-term monitoring and maintenance, which should be considered the minimum necessary for the Valentine EIS.

In terms of post-closure management, the proposed Valentine Project will require extensive monitoring and maintenance. **Monitoring should include water quantity, water quality, fish, wildlife, aquatic biota, revegetation, erosion, dam stability, and other monitoring to ensure that rehabilitation and closure measures are performing**

[5] Donlin Gold Project Final EIS, 2018. http://dnr.alaska.gov/mlw/mining/largemine/donlin/pdf/dgfeis.pdf

as intended and within acceptable standards. Monitoring would also determine when maintenance and corrective actions are needed to maintain roads, covers, stormwater channels, and other measures to ensure that reclamation remains viable over time. **These monitoring and maintenance activities, in addition to operations that will be performed in perpetuity, and should be described in the EIS in detail.**

2.8 APPROACH TO ADDRESSING PROJECT REFINEMENTS POST EIS/EA

According to the EIS, *Adaptive management (i.e., learning from monitoring and adjusting mitigation and monitoring accordingly) and post-EA consultation and engagement may also result in refinements during the life of the Project. Marathon will implement contingency measures and adaptive management throughout all Project phases, as applicable.*

Rather than just mention adaptive management planning, given the high degree of uncertainty around any major mining project, the project proponent should have provided a preliminary Adaptive Management Plan (AMP) that could be weighed as an additional and critical mitigation measure.

Adaptive management is an approach to environmental management that is appropriate when a mitigation measure may not function as intended or when broad-scale environmental change is possible. Adaptive management plans are precautionary in nature, and provide a level of security in long term environmental planning. Adaptive management plans also allow for the inclusion of improved science into mitigation measures as they are continually revised.

Adaptive management has been evolving since its emergence in the 1970s. Adaptive approaches include an ability to incorporate knowledge into the management plan as the knowledge is gleaned and circumstances change. Eberhard et al. (Eberhard, et al., 2009) described the categories of knowledge that may trigger changes to water quality management plans; system understanding, measuring progress and anticipating changes. These categories allow for the inclusion of knowledge and adaptation of management to changed conditions. Embedding adaptation into environmental plans involves thinking about how the results of monitoring will change management actions. Adaptive management plans are a way to accept uncertainties and build a structured framework to respond to changing conditions.

Adaptive management creates a flexible path with actions to take when specific triggers occur. AMPs are a formalization of a plan for performance monitoring and project re-evaluation in the future. The general structure of adaptive management can be described by the following steps:

1. Identify risk triggers associated with vulnerabilities or uncertainties;
2. Quantify impacts and uncertainties;
3. Evaluate strategies and define implementation path that allows for multiple options at specific triggers;
4. Monitor the performance and critical variables in the system; and
5. Implement or re-evaluate strategies when triggers are reached.

Within AMPs, triggers provide decision points in a stepwise decision-making framework that identifies how and when management action should be taken. A key characteristic of adaptive management is monitoring, which is used to advance scientific understanding and to adjust management policies in an iterative process. Adaptive management is a rigorous method for addressing uncertainties in ecosystem management.

Finally, an AMP is a management tool wherein a framework is provided to make quick and effective decisions to guide responses to unforeseen events. In order for an AMP to be effective, the consideration of contingencies and their inclusion into its design must be considered during the early stages of mine planning, and in that respect should be included in the EIS.

2.10 ALTERNATIVES TO THE PROJECT

2.11.3.1 Waste Rock Management

The EIS points out a number of considerations related to the alternative of pit backfilling:

- *In NL, it is required to make efforts to progressively rehabilitate the exposed waste rock pile. These efforts would be sacrificed and the area beneath the pile would need to be rehabilitated once the life of Project is complete*

The EIS should recognize that this alternative would result in at least partial *restoration* of the original surface contours and hydrology of the open pit area. The requirement for progressive rehabilitation should not be used as a rationale as there is no question if the proponents were to later propose on their own removal of a waste rock pile, they would be given consideration to do so.

- *A nearly equal number of years of equipment operation (fuel consumption, vehicle emissions, dust, and employment) to return the waste rock to the same open pit*

As the removal of waste rock back to the open pit would involve a downhill haul, versus an uphill haul when the pit was excavated, there would be a significant reduction in time, fuel consumption, and vehicle emissions as well as employment. This suggests the EIS is incorrect. In making statements throughout the EIS such as "a nearly equal number of years," the EIS should instead provide an actual estimate based on a scientific study rather than force the reviewer to rely on broad unsupported generalizations.

- *Approximately 70 to 80% of the waste rock material would fill the pit due to bulking; therefore, 20 to 30% of the waste rock would remain within the waste rock pile location and would need to be covered with overburden and revegetated*

The descriptions reliance on waste rock alone to support the consideration is incomplete. The EIS needs to explain, and provide a mass balance, showing how this would result including accounting for the material removed from the open pit as ore and after processing stored as tailings. We would have to assume that a bulking factor was used such that theoretically 60% of the material excavated from the pit could be returned to fill the same volume, and that the estimation of 70-80% is based on also accounting for the removal of ore which ends up as tailings.

- *Once the pit was filled, it would reduce the risk of slope failures on highwalls, as they would be better supported by the weight of the waste rock material.*

The EIS is understating the potential benefit of pit backfilling related to highwall stability. Simply put, if the backfilling is complete and results in no exposed highwalls, *there is no credible risk of highwall slope failures. Pit backfilling would serve to permanently and completely buttress the highwalls and prevent this from possibly happening.*

- *Backfill of 300 m vertical depth of the open pit will be slow; however, 'creep' settlement of the waste rock backfill in the pit will continue for some time after it is originally filled and will require long term maintenance to 'top up' the fill in the pit as it will also likely settle unevenly. This will also prevent the placement of a soil cover and subsequent revegetation of the pit area for some time.*

The EIS inaccurately describes the settlement due to differential consolidation of the waste materials as "creep" settlement. As noted in Fell et al[6] (2000) creep settlement takes place on slopes (e.g., waste rock pile slopes). But if the pit is backfilled such that the waste rock is not significantly sloped, creep will not occur. However, differential settlement of waste rock when not compacted is common, and will likely cause the surface of the pile to settle

[6] Fell, Robin & Hungr, Oldrich & Leroueil, Serge & Riemer, Wynfrith. (2000). Keynote lecture – Geotechnical engineering of the stability of natural slopes, and cuts and fills in soil. GeoEng 2000. 1. https://www.researchgate.net/publication/267403410_Keynote_lecture-Geotechnical_engineering_of_the_stability_of_natural_slopes_and_cuts_and_fills_in_soil

unevenly. However, we would note that this same process will occur on the waste rock piles themselves, as well as the TMF, and must be accounted for in all rehabilitation measures. In rehabilitation plans this is often addressed by mounding the materials so as to achieve positive drainage off the facility even after differential settlement occurs. Additionally, it must be accounted for in long-term monitoring and maintenance plans and if settlement occurs over the long-term that negatively impacts the environment or post-mining land use, repairs must be made.

- *In general terms, the cost associated with the activities outlined above would make the mining Project uneconomical.*

Instead of relying on this unsupported statement, the EIS should provide an estimated cost of backfilling, and include an evaluation that conduct a sensitivity analysis showing how the estimated cost would actually impact the project economics in terms of net present value and rate of return.

According to the EIS, *Placement of waste rock in an open pit is technically feasible if an exhausted open pit, or an exhausted area of an open pit, is available; however, in most cases, these opportunities do not exist. In Marathon's case, due to reasons of Project scale and economy as outlined in Section 2.5, both pits are mined simultaneously and are exhausted at approximately the same time, leaving little or no opportunity to place waste rock from one pit into the other.*

As previously described in the EIS, the Leprechaun open pit is to be exhausted in Year 9, at which time tailings will be deposited in the pit, and the tailings will not be expected to completely fill the pit during the remaining mine life. The EIS should address the alternative for the waste rock produced from the Marathon pit from Year 9 to Year 12 to be included as backfill in the Leprechaun open pit together with tailings. This would result in a more complete pit backfill of the Leprechaun open pit and the corresponding benefits.

2.11.6.4 Tailings Disposal Alternatives

Given the recommendations of the Mount Polley Independent Expert Review Panel for Best Available Technology (BAT) for new TSFs as filtered or "dry stack" tailings, it is customary for any credible analysis of tailings disposal alternatives to be based on a thorough stand-alone analysis. The requirements are provided in the Guidelines for the assessment of alternatives for mine waste disposal[7] which suggest:

> "The alternatives assessment should objectively and rigorously consider all available options for mine waste disposal. It should assess all aspects of each mine waste disposal alternative throughout the project life cycle (i.e., from construction through operation, closure and ultimately long-term monitoring and maintenance). The alternatives assessment should also include all aspects of the project, direct or indirect, that may contribute to the predicted impacts associated with each potential alternative. These may include the design of the mine and ore processing system to the extent that they would impact mine waste production, storage options, water management and water treatment. The assessment will consider the predicted quality and quantity of effluent that would be discharged from each alternative assessed, taking into account the effluent quality limits set in the MMER, and the predicted impacts (inclusive of mitigation measures) associated with the proposed TIA, if any, on surface and groundwater water quality and flow.
>
> The assessment should address environmental, technical and socio-economic aspects of all of the elements as described above for each alternative throughout the project life cycle. A comprehensive economic assessment of the alternatives is also required and should consider the full costs of each alternative throughout the project life cycle. This economic assessment should also consider all costs associated with any compensation agreements that are to be developed, including the habitat compensation plan associated with using the water body as a TIA."

[7] https://www.canada.ca/en/environment-climate-change/services/managing-pollution/publications/guidelines-alternatives-mine-waste-disposal.html

The alternatives assessment guidelines include an alternatives assessment process that includes the following steps:

Step 1: Identify Candidate Alternatives
Step 2: Pre-Screening Assessment
Step 3: Alternative Characterization
Step 4: Multiple Accounts Ledger
Step 5: Value-Based Decision Process
Step 6: Sensitivity Analysis
Step 7: Document Results

Instead of relying on a stand-alone siting study and unsupported opinions as to the viability of tailings disposal alternatives, the EIS needs to be informed by an assessment of alternatives that conforms with the recommended guidelines.

2.11.13 Rehabilitation Methods

Rather than being mentioned in Section 2.6 Rehabilitation and Closure as might be expected, the EIS mentions financial assurance in the context of rehabilitation method alternatives stating, *Financial Assurance, which is expected to be in the range of $45M to $50M, is insurance held by the provincial government for the purpose of rehabilitating the site in the event that Marathon defaults on the Project (e.g., declares bankruptcy).*

Financial assurance is an essential element of a proposed mining project. The viability of the reclamation, closure, and post-closure management is a critical factor in evaluating potential long-term indirect, direct, and cumulative impacts and determining whether the proposed project can be considered fully protective of environmental resources. Furthermore, this information is essential for an adequate analysis of the proposed project, because it could make the difference between a project that is adequately managed over the long term by the site operator and an unfunded or under-funded contaminated site that becomes a public liability that must be addressed by the regulators.

Potential additional care and maintenance measures that should be considered and analyzed in the EIS to minimize long-term liability of reclamation uncertainties include long-term settlement of the waste rock piles and TSF, functionality of stormwater drainage channels and sediment ponds, stability of the TSF and other constructed river channels, and effects from climate change.

If a long-term trust fund will be established for the proposed project, the appropriate level of funding, types of financial instruments, and mechanics of the fund are critical to ensure that sufficient funds will be available when needed. In addition to the projected long-term engineering, maintenance, and monitoring costs of each activity, the EIS should discuss the financial assumptions used to estimate the funding levels, projected trust fund growth rate, and mechanics of the trust fund. The fund mechanics include: (a) requirements for timing of payments into the trust fund; (b) how the responsible agency ensures that the trust fund is bankruptcy remote; (c) acceptable financial instruments; (d) legal structure of the trust fund for tax purposes; (e) who will pay the taxes on trust fund earnings and trust fees and expenses; (f) how will taxes and fees be paid on the trust if the mining company goes out of business; (g) who will make investment decisions if the operator is no longer viable; (h) if the federal government controls the investment decisions, what legal and ethical issues arise from the responsible agency controlling investment decisions about investments in private companies, voting stock and similar issues if the trust owns stock; (i) the identity of the trust fund beneficiaries; and (j) the identity and corporate structure of the operator with responsibility and liability for financial assurance at this site.

As previously recommended, the EIS should be based on a more detailed RCP, and the RCP should also include a preliminary financial assurance cost estimate.

2.11.13.3 Tailings Management Facility Rehabilitation

The EIS suggests the reduction or elimination of the tailings ponds, and improvement to achieve 'landform" classification are "alternatives." As previously mentioned in these comments, the elimination of water from the surface of the TSF and stabilization to achieve a landform are best practices. As such they should be viewed as objectives if not requirements, and not as alternatives.

The statement in the EIS, *Landform classification for the TMF would be the preferred option; however, the technical feasibility of this alternative will require operational and even initial closure monitoring while the Project is still operating and sending tailings to the Leprechaun open pit)*. Achievement of a landform requires a decision at this stage of the project as it must be included in the TSF design. This outcome should not rely on as yet to be determined or decided circumstances or additional post-operational interventions.

Given the location and circumstances, if the project proponent cannot commit to a landform classification for the TSF post-closure, ensuring long-term stability without intervention, then additional consideration should be given to require all tailings to be stored in-pit or filtered.

2.11.13.9 Revegetation Alternatives

As noted in the EIS, *Many of the rehabilitation alternatives discussed above involve the eventual revegetation of the component or area*. However, as previously noted, none of those descriptions include any discussion of the actual revegetation that might be performed, or as might be expected to be described in an outline of an RCP. Instead, the EIS provides a minimal description of potential revegetation approaches and methods in the discussion of alternatives.

An example of an alternative approach to revegetation would be to incorporate geomorphic landform reclamation principles. Ayres et al (2006) proposes the following general approach and guidelines for waste rock landform reclamation that can also be applied to TSF reclamation.

"The following generalized approach is proposed for developing a sustainable final landform design for existing waste rock stockpiles:

1. Determine the final land use for the rehabilitated site through consultation with all stakeholders, and an assessment of potential geologic or structural control elements for the landform;
2. Observe and collect data on a nearby natural landscape (a natural analogue) to determine hillslope forms and gradients, soil and vegetation types, drainage density, and watershed characteristics;
3. Determine the long-term eroded profile for the various slopes of the existing stockpile through erosion and landform evolution numerical modelling;
4. Based on the maximum slope length and gradient as determined from Steps 2 and 3, design a methodology for reshaping the existing stockpile to conform to these requirements (a horseshoe-shaped landform, which creates a small well-defined catchment, can be effective in reducing slope length and gradients without changing the footprint of an existing stockpile)
5. Design a surface water management system to safely convey meteoric water off the final landform, and ensure runoff reaches final discharge points in volumes and at velocities that will not cause unacceptable erosion or sedimentation;
6. Develop a final landform design following completion of Steps 2 to 5 inclusive, taking into consideration the long-term safe storage of reactive or hazardous materials.
7. Develop a revegetation plan suitable for the swales and ridges in the final landform based on data collected in Step 2; and
8. Review the final landform design with key stakeholders for general acceptance prior to implementation."

"The following guidelines are proposed to aid in the development of a sustainable final landform design for waste rock stockpiles.

- Design the final landform using natural analogues as described in Keys et al. (1995). The reclaimed landscape can be no more stable than the adjacent undisturbed landscape; therefore, the designer can assume that the reclaimed area will be less stable and design accordingly, with gentler slopes, higher density drainage and smaller drainage basins.
- Maintain the final landform height and slope angles for stockpiles in areas of low relief as low as possible. Where slopes compatible with the surrounding landscape cannot be achieved, an attempt should be made to visually soften steeper areas by avoiding straight "engineered" ridges and sharp changes of angle, and by careful planting of trees to break up views of the horizon (Environment Australia, 1998).
- The preferred reclaimed slope design is a "spur-end" slope plan with a concave or complex (convex-concave) profile. The use of terraces or contour banks should be avoided. It is very difficult in practice, particularly for stockpiles with long slopes, to construct concave slopes with continual curvature on a waste rock stockpile. However, hillslope curvature can be obtained using a series of linear slopes or slope facets as shown in Fig. 3. Hancock et al. (2003) demonstrated through simulations with a landform evolution model that there is minimal difference in sediment loss between a hillslope constructed of linear facets and that constructed from continual curvature.
- Erosion and subsequent evolution of the proposed final landform design(s) should be predicted over a period of at least 100 years using state-of-the-art software packages.
- The thickness of earthen covers designed to minimize the entry of atmospheric oxygen and/or meteoric water to reactive or hazardous material should not only be based on soil-atmosphere numeric simulations, but should also take into consideration the predicted long-term erosion from the final landform (e.g., see Ayres et al. (2005)).
- The design of surface water drainage courses should be based on the discharge and sediment load of the receiving stream(s). Drainage channels used to convey surface water off the top of the landform should follow the slope gradient of the final landform as much as possible. The use of imported substrate as well as man-made materials such as pipes, gabions, and concrete should be avoided whenever possible.
- Design conservatively to account for excessive erosion resulting from extreme climatic events and differential settlement in the reclaimed landform.
- Reclamation of large waste storage facilities should include the construction of small lakes and wetlands upstream of final surface water discharge points, provided they are geomorphically compatible and stable. Such features will attenuate surface runoff to reduce peak flows and increase sedimentation prior to reaching receiving streams (Sawatsky, 2004)."[8]

6.0 GROUNDWATER RESOURCES

6.3.5.1 Assumptions and the Conservative Approach

[8] B. Ayres, B. Dobchuk, D. Christensen, M. O'Kane and M. Fawcett. 2006. Incorporation of Natural Slope Features into the Design of Final Landforms for Waste Rock Stockpiles, Paper presented at the 7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006, St. Louis MO;

Hancock, G.R., K.G. Evans, G.R. Willgoose, D.R. Moliere, M.J. Saynor, and R.J. Loch. 2000. Medium-term erosion simulation of an abandoned mine site using the SIBERIA landscape evolution model. Aust. J. Soil Res., v. 38, p. 249-263;

Martin-Duque, J.F., M.A. Sanz, J.M. Bodoque, A. Luda and C. Martln-Moreno. 2010. Restoring earth surface processes through landform design. A 13-year monitoring of a geomorphic reclamation model for quarries on slopes, John Wiley & Sons, Ltd.;

Michael, Peter R. , Michael J. Superfesky, and Lois J. Uranowski. Challenges to Applying Geomorphic and Stream Reclamation Methodologies to Mountaintop Mining and Excess Spoil Fill Construction in Steep-Slope Topography (E.G. Central Appalachia). Paper presented at the 2010 National Meeting of the American Society of Mining and Reclamation, Pittsburgh, PA Bridging Reclamation, Science and the Community June 5 - 11, 2010. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502;

Sawatsky, L., G.T. McKenna, and M-J. Keys. 2000. Towards minimizing the long-term liability of reclaimed mine sites. p. 21-36. In M.J. Haigh (ed.). Reclaimed Land: Erosion Control, Soils and Ecology. Rotterdam: A.A. Balkema;

Schor, Horst J., Gray, Donald H. 2007. Landforming: An Environmental Approach to Hillside Development, Mine Reclamation and Watershed Restoration, John Wiley & Sons.

According to the EIS, *This model approach imposes the highest vertical groundwater gradient from the tailings pond and results in a conservatively high prediction of seepage rates from the TMF over the operation phase of the Project*.

While the methods used are an improvement over previous industry practice of suggestion zero-leakage, and acknowledge that liner do have the potential for fail, the methodology itself is not conservative and tends to underpredict liner leakage. Most often this is due to the presence of a more significant failure than used to estimate leakage, such as a seam failure or liner rip, or pipe coupling failure. It can also be due to the presence of multiple failures rather than a single failure. Based on our professional experience, when liners do leak, the discharge rates are typically one to two orders of magnitude (10-100X) more than typically estimated. It should also be noted that when liner leakage is detected, the range of subsequent mitigation can result in complete repair to no significant improvement depending on the nature of the source of leakage. The level of mitigation is largely based on access to the seepage. For these reasons, we strongly recommend that the TMF utilize a liner system to minimize seepage, but the system should include a leak detection and evacuation provision given the inevitability of liner leakage.

According to the EIS, *This model approach results in a conservatively high prediction of seepage rates from the waste rock piles over the operation phase of the Project.* And*, As a result, the loadings represent a conservative estimate under steady-state conditions during operation.*

The suggestion of conservatism in the estimates during operations, without mention of post-closure, suggests that the same methods are not conservative in estimating post-closure water quality or quantity. The EIS should clarify, and as mentioned elsewhere in our comments, the EIS should address post-closure with equal emphasis as closure through the discussion.

According to the EIS, *This approach provides a conservative estimate of groundwater quality discharging to surface water and does not consider physical or chemical attenuation processes along the groundwater flow path.*

In our experience the actual contribution of physical or chemical attenuation processes in groundwater is highly speculative and typically of minimal consequence. Therefore, the approach used for the EIS is not conservative because it does not consider physical or chemical attenuation processes, but simply scientifically credible. The inclusion of unproven or unmeasurable processes in a model would be unscientific, and not less conservative.

According to the EIS, *Based on geochemical testing it has been demonstrated that loading rates will decline over time. As a result, by not including further decreases in loading rates, long-term water quality predictions and loading to the environment are overestimated and provides a conservative approach for the assessment.*

The ability of geochemical testing to accurately predict long-term water quality or quantity is highly uncertain, as are all water predictions. Geochemical testing is carried out under highly idealized conditions and while it is considered useful, it is not conclusive. See further comments re Section 6.7, Prediction Confidence.

6.3.5.3 Acid Rock Drainage and Metal Leaching

Leprechaun Complex
According to the EIS, *Overall, the waste rock pile is not expected to generate ARD due to the small amount of PAG material and significant excess of NP. Therefore, it is not anticipated that specific ARD management of waste rock will be required.* However, also according to the EIS, *Waste rock lithologies show moderate ML potential for aluminum, phosphorous, copper, selenium, and zinc*.

This suggests specific ML management of waste rock will be required, or at least should be considered from a contingency and adaptive management standpoint. The EIS should explain why only “high leaching potential” is being addressed and why concentrations that exceed Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CWQG-FAL) between the CWQG-FAL and ten times the CWQG-FAL value, *were arbitrarily* *assigned to moderate leaching potential*. Further, the EIS should explain why moderate leaching potential is being treated in the EIS as having no impacts or consequences.

Marathon Complex
According to the EIS, *Approximately 14% of the 60 Mm3 of waste rock is conservatively estimated to be PAG. Blending PAG and non-PAG rock with excess of neutralization potential and/or encapsulation of PAG waste by non-PAG rock will be conducted to neutralize acidity potentially generated in PAG pockets and as a result, the final drainage from waste rock is not expected to be acidic. The waste rock pile will be covered by growth medium / overburden during rehabilitation, further reducing the risk of ARD/ML. There are no exceedances of MDMER limits observed in leachates from the waste rock humidity cells. Overall, waste rock lithologies show moderate ML potential for aluminum, mercury, selenium, and zinc.*

Blending and encapsulation of PAG can be effective; however, actual implementation has been shown to require planning and diligence. The EIS should be supported by a conceptual waste rock management plan (WRMP). The primary objective of a WRMP is to provide the geochemical testing and characterization program that will be implemented to guide the use, storage, and management of waste rock for the Project. Specifically, a conceptual WRMP identifies:

- ARD/ML criteria to guide the management of waste rock, including the identification of waste rock appropriate for construction purposes;
- procedures to be implemented during operation to classify and manage various waste rock lithologies based on ARD potential; and
- methods to manage ARD from waste rock storage areas (WRSAs) based on the geochemical properties of the material.

The conceptual WRMP should be developed based on the geochemical characterization program that has been completed to-date. This conceptual WRMP should be closely integrated with other management plans that have, or will be, developed as part of the Project. The EIS should note that geochemical characterization will continue during the life of mine (LOM) and the results will be used to inform adaptive management and update the WRMP.

Processing Plant and Tailings Management Facility Complex

According to the EIS,

- *Approximately 13% and 67% of ore samples from Leprechaun and Marathon pits, respectively are conservatively classified as PAG.*
- *Approximately 41 Mt of tailings will be produced from both high-grade ore and low-grade ore with about 38% of the material originating from the Leprechaun pit and the remainder from the Marathon pit.*
- *Composite samples of tailings from both deposits are classified as non-PAG and are not expected to generate ARD.*

The information provided in the EIS with respect to acid drainage accounting is confusing and requires additional analysis by the reviewer, as well as additional information, to be comprehensible or meaningful. As shown in the below table, the information provided can be used to calculate the total % and quantity of PAG versus non-PAG.

Tailings PAG Mass Balance

Source	Mass		PAG		Non-PAG	
	%	Mt	%	MT	%	MT
Leprechaun Pit	38%	16	13%	2	87%	14
Marathon Pit	62%	25	67%	17	33%	8
Total	100%	41	46%	19	54%	22

Based on the information in the EIS, an estimated 46% of the tailings would be PAG, and 54% would be non-PAG. It is unclear in the EIS if the basis of "composite samples" is from a similar mass balance, or from actual composite samples of tailings. Regardless, the relatively small difference between the quantity of PAG and non-PAG in this instance does not demonstrate or suggest that the tailings overall will be not be acid drainage generating. The EIS should provide additional information for the tailings that demonstrates if neutralization potential (NP) is in excess of acid potential (AP). Additionally, the EIS should discuss and address the potential for lenses of acid-generating material to occur in the TMF. Finally, the EIS should address as a potential mitigation measure the isolation of acid-generating flotation concentrate material in the tailings stream and location within the TMF. The EIS should also address the possibility of using the mined-out Leprechaun Pit as a submerged repository for flotation concentrate, albeit requiring re-handling of the first 9 years of concentrate stored separately for later deposition.

6.5.2.1 Project Pathways

According to the EIS, *The main potential effect to groundwater quality during decommissioning, rehabilitation and closure is the continued seepage from the waste rock piles and TMF through overburden and bedrock. Revegetation of the waste rock piles and TMF during progressive and closure rehabilitation will reduce seepage from operational levels*.

While revegetation will reduce seepage from un-revegetated conditions, such as during operations, the amount of reduction may or may not be significant in reducing seepage overall from the waste rock piles or TMF. In a climate like that of the project site the overall benefit in terms of reducing seepage is likely to be minimal in terms of addressing potential water quality impacts. Where impacts are likely to occur, a more sophisticated approach such as an engineered cover might be necessary. The actual amount of reduction is based on numerous factors including precipitation, evaporation, plant evapotranspiration and other climate conditions. The EIS should have included an evaluation of the amount of infiltration that would be expected to occur after revegetation and the estimated benefit overall of revegetation to address seepage should be estimated and stated, including any uncertainties in the estimate.

6.7 PREDICTION CONFIDENCE

According to the EIS, *predictions made using the model are based on several conservative assumptions to reduce the influence of uncertainty in the predictions, including the assumption of saturated waste rock piles, no attenuation of water quality along the flow paths, and that all mass of leached parameters from the piles will arrive simultaneously at the receptor. These assumptions result in a conservative prediction of the mass loading in the early phases of the Project (i.e., operation) and provide a better (while still conservative) representation of long-term water quality through closure.*

Comments also apply to **7.3.5.3 Assumptions and the Conservative Approach** *assumptions regarding the conservative approach and uncertainty.*

Predictions generated by groundwater and hydrologic flow models are associated with a degree of uncertainty, and can be limited in their predictive power. General sources of model uncertainty are attributed to a variety of factors, including:

- Insufficient data for characterizing hydraulic properties (over a large enough area), or the hydrologic system's response to changes or stressors on which the model predictions depend;
- Inaccurate conceptual models or model assumptions;
- Inadequate geometrical representation of a complex system and its heterogeneities;
- Random error resulting from spatial interpolations;
- Random errors in field measurements;

- Poor data collection designs and inadequate interpretation of the collected data;
- Not representing relevant processes that affect the hydrologic system;
- General limitations of the models and numerical methods used; and
- Unpredictable natural and human factors.

Uncertainties associated with model predictions can be evaluated and assessed using a variety of approaches, including:

- Sensitivity analysis;
- "Bayesian model averaging" applied to multiple conceptual models and multiple parameter estimation methods;
- Parallel testing of several viable conceptual models, combined with parametric uncertainty analysis carried out for each conceptual model;
- The use of "pilot points" in conjunction with nonlinear parameter estimation software that incorporates advanced regularization functionality;
- "Calibration-Constrained Monte-Carlo," also called "Null Space Monte Carlo"; and/or
- "Subspace Monte Carlo" that allows calibration-constrained random heterogeneity.

Sensitivity analysis is deemed an important part of model uncertainty analysis. Most often such analysis is limited to varying model parameters and noting how such changes affect the model calibration. However, sensitivity analysis alone is not always adequate if the altered model is used for making predictions. This is because varying the values of model parameters often results in a significant model "de-calibration," and de-calibrated models should not be used for predictive simulations.

ASTM International Standard Guide for Conducting Sensitivity Analysis for a Groundwater Flow Model Application (ASTM International 2008) provides the following clear instructions: "For each value of each group of inputs, rerun the calibration and prediction runs [emphasis added] of the model with the new value of the calibrated value" – this means that after varying the value of a given parameter, one needs to calibrate the altered model, before using it for making predictions. This is seldom accomplished with the models developed for industrial applications, as completing such systematic analysis would require large budgets and a significant level of effort that many projects cannot support.

The identification of the limitations that result in model predictive uncertainties with respect to this project are beyond the scope of this review. The EIS models should be independently reviewed, and with respect to the hydrologic model, the following determined:

- Was the number of hydraulically tested wells and boreholes adequate?
- Are there limitations of the data derived from the completed hydraulic testing related to the scale of the tests?
- Were any of the fault zones near the proposed pits hydraulically tested?
- Was the model evaluated to predictive sensitivity to various possible degrees of hydraulic transmissivity of fault zones?
- Is the spatial distribution of wells with measured groundwater level adequate?

The EIS needs to make clear that there is uncertainty inherent in the model predictions. Ideally, their use would be limited to comparison of alternatives, as there is uncertainty regarding whether current best practices are sufficient to provide confident predictions of actual water quantity or quality decades or centuries in the future

(Kempton et al. 2000; Kuipers, et al 2006; Maest et al. 2006; Eary et al. 2009; and NRC 1999).[9] While the predictive water quantity and quality models are useful to understand the general water quality that may be present decades or centuries in the future, they are only estimates, and the level of uncertainty in the model predictions cannot be fully quantified. The EIS needs to address whether predictions made by the models had a level of uncertainty that could bear on the significance of a predicted impact. Uncertainty with respect to long-term predictions in particular needs to be acknowledged and addressed by the EIS.

6.9.2 Monitoring Methods

According to the EIS, *During Project development, a detailed groundwater monitoring program will be implemented for main Project components, building on the baseline monitoring program, to confirm potential changes in groundwater associated with Project activities.*

At the very least a preliminary groundwater monitoring program showing proposed monitoring wells and procedures should have been developed for and described in the EIS. The preliminary groundwater monitoring program should have been provided to solicit public comment via the EIS that could be addressed and/or incorporated into the detailed groundwater monitoring program to be done in the future. The preliminary groundwater monitoring program would allow the reviewer to assess the likely effectiveness of the program.

21.0 ACCIDENTAL EVENTS
21.3 MARATHON'S APPROACH TO ACCIDENT PREVENTION AND EMERGENCY RESPONSE PLANNING

According to the EIS, *Marathon's environmental management policy is based on evolving best-practice standards for environmental performance in the mining industry*.

As noted by MAC (2019)[10] "Risk management strategies typically involve developing and implementing risk controls aimed to control or mitigate risks identified during risk assessment. Through application of risk management strategies, organizations take the necessary steps to reduce identified risks within acceptable levels that are As Low As Reasonably Practicable (ALARP). These strategies mitigate and control risks by one or a combination of the following:

- eliminating or avoiding specific risks to minimize overall risk to the extent practicable;
- minimizing the likelihood that the risk will occur by early identification and implementation of appropriate controls; and
- developing contingency and mitigation plans for the potential consequences of the identified risks."

The EIS does not appear to be supported or utilize a risk management strategy approach consistent with the recommendation of MAC. Recommend the permittee be required to perform a multi-stakeholder Failure Modes Effects Analysis (FMEA)[11] to identify the potential failure modes and effects as well as potential mitigation measures to address this section.

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[9] Kempton, J.H.; Locke, W.; Atkins, D.; and Nicholson, A. 2000. Probabilistic Quantification of Uncertainty in Predicting Mine Pit-Lake Water Quality, Mining Engineering, October 2000;

Kuipers, J.R.; Maest, A.S.; MacHardy, K.A.; and Lawson, G. 2006. Comparison of Predicted and Actual Water Quality at Hardrock Mines: The Reliability of Predictions in Environmental Impact Statements.;

Maest, A.; Kuipers, J.; MacHardy, K.; and Lawson, G. 2006. Predicted Versus Actual Water Quality at 22 Hardrock Mine Sites: Effect of Inherent Geochemical and Hydrologic Characteristics, 7th 23 International Conference on Acid Mine Drainage, American Society of Mining and Reclamation, 24 Lexington, KY;

Eary, L.E. and Schafer, W.M. 2009. Approaches for Evaluating the Predictive Reliability of Pit Lake Numerical Models, in Castedenyk, D.N., Eary, L.E, editors, Mine Pit Lakes, Characteristics, Predictive Modeling, and Sustainability, Society of Mining, Metallurgy and Exploration, Littleton, Colorado.

[10] *op. cit.*

[11] See A. Robertson, 2012, FMEA Risk Analysis: Failure Modes and Effects Analysis
http://www.infomine.com/library/publications/docs/Robertson2012b.pdf

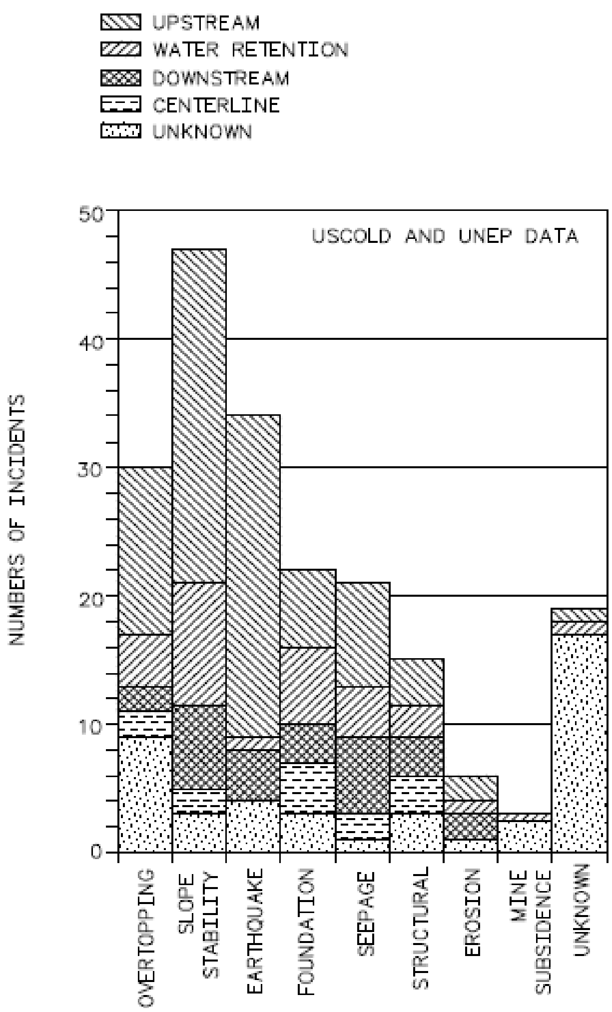
21.5.1 Tailings Management Facility Malfunction
21.5.1.1 Description of Scenario

The EIS acknowledges that multiple failure mechanisms have resulted in catastrophic dam failures, *including earthquakes, landslides, overtopping, internal erosion or piping, foundation failure, and slope failures*. However, without explanation other than to suggest they are "the most common causes of recorded dam failure" the EIS focuses the discussion of the description of the scenario on piping and dam overtopping.

UNEP's 2001 Tailings Dams Risk of Dangerous Occurrences, Bulletin 121, is frequently cited as a reference with respect to TSF failure modes. They identified slope stability as being the primary failure mode of TSFs, followed by earthquake (seismic) and overtopping (see TSF Failure Incidents by Failure Mode and Design Type (UNEP 2001)). They also identify foundation failures, seepage, structural, erosion and mine subsidence as failure modes.

As previously suggested in these comments, the basis for this section should be an FMEA together with a catastrophic failure scenario consistent with CDA guidance. The present approach of the EIS leaves the suggestion that the project proponent is both not well informed as to TMF management and safety and best practice.

TSF Failure Incidents by Failure Mode and Design Type (UNEP 2001)



The EIS fails to note that none of the three most recent catastrophic dam failures (e.g., Mt. Polley, Samarco, and Fundão) were due to overtopping, or that the Fundão failure was of a supposedly closed TSF. Ultimately, given the uncertainties and their potential as credible failure modes, a worst-case failure involving a foundation failure, resulting in an instantaneous release of a significant amount of the tailings and process water mass, should be identified and considered by the EIS, and the effects evaluated based on a breach inundation analysis and breach effects analysis consistent with CDA guidance.

21.5.3 Fuel and Hazardous Materials Spill
21.5.3.4 Environmental Effects Assessment

According to the EIS, *The average range of diesel fuel spills was estimated at 12,000 litres spilling into the river within an hour. It was also assumed that 47 kg of sodium cyanide and 108.70 kg of ammonium nitrate spilled into the river within an hour.*

The EIS should provide some type of basis for the assumptions used. The use of "the average range" followed by a specific number is not logical. Why wasn't the worst case of an entire truck load of diesel fuel spilled? Similarly, what is the basis for the relatively small amount of sodium cyanide spilled when shipments will be much larger? The quantities modelled are not consistent with a "worst case scenario."

21.5.3.2 Project Design and Safety Measures to Reduce Environmental Effects
and **21.5.6.2 Project Design and Safety Measures to Reduce Environmental Effects**

It is notable that in these sections, as well as elsewhere in the EIS, there is no mention of compliance with the International Cyanide Management Code (the Cyanide Code). The International Cyanide Management Institute (ICMI) has developed a program for the gold mining industry to improve the life-cycle management of cyanide used in gold and silver mining, to enhance the protection of human health, and to reduce the potential for environmental impacts. Gold and silver mining companies that are signatories to the Cyanide Code can get certified by meeting Cyanide Code requirements.[12] Audit reports and corrective action reports for ICMI certified gold mines are published on the ICMC website under the company name.[13]

Consistent with the recommendations of the Initiative for Responsible Mining Assurance[14], the proponent should indicate in the EIS that they are a signatory to the Cyanide Code and in addition agree to meet the following design criteria:

<u>Construction</u> – (a) Impermeable secondary containment for cyanide unloading, storage, mixing and process tanks shall be sized to hold a volume at least 110% of the largest tank within the containment and any piping draining back to the tank, and with additional capacity for the design storm event; and (b) Pipelines containing process solution shall utilize secondary containment in combination with audible alarms, interlock systems, and/or sumps, as spill control measures.

<u>Discharges</u> – Discharges to a surface water mixing zone shall not contain cyanide, either alone or in combination with other toxins, that will be lethal to resident aquatic life or interfere with the passage of migratory fish.

<u>Monitoring</u> – The operating company shall carry out baseline water quality sampling and monitor discharges to surface waters or groundwaters for weak acid dissociable (WAD) cyanide. If WAD cyanide is detected in discharges to surface waters, then the operating company shall also monitor total cyanide, free cyanide, and thiocyanate levels.

<u>Reporting</u> – Cyanide water quality monitoring data shall be published on at least a quarterly basis in tabular format, and graphical format if available, on the mine or the operating company website, or provided to stakeholders upon request.

[12] https://www.cyanidecode.org/about-cyanidecode/cyanide-code
[13] https://www.cyanidecode.org/signatorycompanies/directory-of-signatory-companies
[14] https://responsiblemining.net/resources/