May 31, 2019

Shane McCoy
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Subject: Pebble Mine Draft EIS Comments on Reclamation and Closure

Dear Mr. McCoy,

Despite the significant post-operational environmental impacts and risks at Pebble, no Reclamation and Closure Plan has been completed and the closure analysis within the Draft Environmental Impact Statement (DEIS) is clearly inadequate.

As noted in this comment letter there are a large number of strategic closure-related omissions, errors and uncertainties within the DEIS and its supporting documents. Closure strategies and commitments are key components of mining Environmental Impact Statements because significant post-operational impacts and risks may persist for centuries after a relatively brief mine life. For this reason, it is common practice for mining projects to complete a Reclamation and Closure Plan during the EIS process. A review of several mining Environmental Impact Statements completed over the past three years shows that five out of six had released closure plans before the EIS was completed. The Donlin Gold Project in particular completed a 458-page Reclamation and Closure Plan with a detailed cost estimate during its EIS process, which was led by the Army Corps of Engineers.

The lack of even a conceptual level Reclamation and Closure Plan is a particular concern because closure of the 20-year Pebble mine will be complex and very costly. The total closure costs are almost certain to exceed 1.5 billion dollars even after discounting later expenses to the first year of closure. This high closure cost poses an even more significant financial risk given that the DEIS 20-year mine plan is almost certainly not economically feasible (Borden DEIS comment letter dated March 28, 2019).

In order to address these major deficiencies in the DEIS, a Reclamation and Closure plan needs to be developed for the Pebble 20-year mine plan as part of the EIS process. To help ensure the integrity of the EIS process and in fairness to local communities, the State of Alaska and to shareholders, I also strongly urge the Pebble Limited Partnership to publish a rigorous closure cost estimate as part of the EIS process.

Professional Background

I am an environmental scientist and manager with over thirty years of experience in the mining and consulting industries. During my 23 years with the global mining company Rio Tinto I designed several successfully-completed closure projects, participated in closure steering committees and was a contributing author on closure standards and guidance notes. I have performed environmental, permitting and closure work at over fifty mines, projects and operations. This included over seven years as Head of Environment for Rio Tinto's Copper, Copper & Diamonds and Copper & Coal Product Groups. I have published numerous papers on mine environmental performance and management in peer reviewed scientific journals, conference proceedings and books. I am experienced in the management of environmental strategies, issues and costs associated with mine closure.

Mining EIS Reclamation and Closure Planning

Closure goals, strategies and commitments are key components of mining Environmental Impact Statements because significant post-operational environmental impacts and risks may persist for centuries after a relatively brief mine life. For this reason, it is common practice for mining projects to complete a Reclamation and Closure Plan during the EIS process. A review of several mining Environmental Impact Statements completed over the past three years shows that five out of six had released closure plans before the EIS was completed. The sixth EIS had a robust reclamation and closure description in Chapter 2 (Proposed Actions and Alternatives) with additional information in many of the supporting chapters. These EIS documents were completed in various States and with various lead agencies: Copper Flats Copper Mine Project (New Mexico, BLM) Rosemont Copper Mine Project (Arizona, USFS), Gold Rock Mine Project (Nevada, BLM), Gold Bar Project (Nevada, BLM), Northmet Project (Minnesota, State DNR) and most significantly the Donlin Gold Project (Alaska, Army Corps of Engineers). Donlin completed a 458-page Reclamation and Closure Plan with a detailed cost estimate during its EIS process. The lack of a Reclamation and Closure plan is also acknowledged as a significant data gap in Section 3.1.6 of the Pebble DEIS. Given how few substantive mine plan alternatives are actually being considered by the DEIS, production of a robust closure plan would certainly not be unduly burdensome at this stage.

Despite the significance of post-operational environmental impacts and risks at Pebble, no Reclamation and Closure Plan has been completed and the closure analysis within the DEIS is clearly inadequate. Furthermore, it appears that the Pebble Limited Partnership intends to wait to produce a closure plan until after the EIS is completed (Sections 2 and 4.22). There are significant closure omissions and errors in the DEIS which are described in the next section of this letter. Many strategic and complex closure components are only described in generalized terms with insufficient detail presented to determine if they are appropriate and practicable.

The DEIS and supporting documents do not provide preliminary engineering drawings for most key closure structures and landforms. Nor does the DEIS provide any materials balances for major earthworks, demolition or topsoil management.

The lack of even a conceptual level Reclamation and Closure Plan is a particular concern because closure of the 20-year Pebble mine will be complex and very costly. As described in Section 4.16, centuries of water treatment will be required for predicted flows in excess of 5000 gallons per minute. Geotechnical risks associated with pit walls and the permanent bulk tailings storage facility will persist in perpetuity in this seismically active area and could result in the catastrophic release of tailings and/or untreated water. As detailed later in this letter, the total closure costs are almost certain to exceed 1.5 billion dollars even after discounting later expenses to the first year of closure. This very high closure cost is a particular concern given that the DEIS 20-year mine plan is almost certainly not economically feasible (Borden DEIS comment letter dated March 28, 2019). The very high closure costs coupled with the marginal overall project economics mean that the 20-year mine plan is almost certainly not the "least environmentally damaging practicable alternative". Should mining be initiated, there will undoubtedly be intense financial pressure to defer these closure expenditures by continued mining as the uneconomic 20-year mine plan approaches its end. A future mine operator may also attempt to avoid backfilling the pit with chemically reactive waste rock and tailings (despite the absolute necessity for acid rock drainage control and to ensure permanent containment) because this could preclude any future resource development in the remaining shallow and more accessible portions of the ore body.

In order to address these major deficiencies in the DEIS, a Reclamation and Closure plan must be developed for the Pebble 20-year mine plan. At a minimum, this plan should provide additional detail and address all omissions, errors and uncertainties highlighted in this letter and other DEIS comments. To help ensure the integrity of the EIS process and in fairness to local communities, the State of Alaska and to shareholders, I also strongly urge the Pebble Limited Partnership to publish a rigorous closure cost estimate as part of the EIS process.

Pebble DEIS Significant Closure-Related Omissions, Errors and Uncertainties

The Pebble DEIS fails to discuss or provides insufficient detail for the following strategic closure issues which would be key components of a robust Reclamation and Closure plan. These issues must be addressed to 1) evaluate the long-term post-closure impacts and risks, some of which could persist for centuries; 2) determine if effective closure is even practicable under the actual environmental, operational and financial conditions of the project; 3) inform mine design so that Pebble can implement its stated "holistic, design-for-closure philosophy" (Section 2); and 4) eventually allow closure cost estimates for financial assurance.

Topsoil Management and Balance – Section 4.22 states that "topsoil and overburden would be salvaged during construction for use as growth media during reclamation" and mine plan figures do show some topsoil stockpiles. However, there are no estimates of topsoil volumes that will be salvaged during construction, no discussion of topsoil salvage or storage techniques at the mine or access corridor, and no estimates of topsoil requirements to successfully revegetate roughly 14 square miles of disturbance. These data are almost always included in a Reclamation and Closure plan.

Revegetation Strategies and Goals – Section 2 states that "sites would be seeded for revegetation" and Section 4.22 does provide a very generic discussion of wetlands re-establishment. However, there are no maps or tables showing what types of vegetation will be established where, and there is not any discussion of seed mixes, seeding techniques or revegetation goals. Successful revegetation of the roughly 14 square miles of disturbance is one of the key requirements to return the land to beneficial post-mining use.

Drainage Re-establishment and Revegetation of Quarries – Section 4.14 states that quarry sites (873 acres) "would not undergo reclamation". No justification is given for why over a square mile of heavily impacted land will not be reclaimed in this extremely sensitive environment. At a minimum a free draining and revegetated landform needs to be re-established. This may require refining the quarry designs to minimize the impounding of water and importation of growth media to allow vegetation establishment on the large low-angle surfaces that are created.

Infrastructure Demolition and Material Disposal – Section 2 of the DEIS states that "all mill and support facilities not required for post-closure…… would be fully reclaimed in accordance with State of Alaska requirements". A very large amount of infrastructure would need to be demolished including truck shops, warehouses, explosives storage, rock crushers, the concentrator, tailings pipelines, more than three square miles of HDPE liner, excess employee housing, excess water treatment capacity and excess power generation capacity. Given the remoteness of the site, almost none of the construction debris is likely to have salvage value and it would all need to be disposed of on site. Although Section 2 does state that the debris would be placed in a specially designated landfill or into the open pit, there are not estimates of debris volumes or conceptual level designs for how it would be safely disposed.

Bulk Tailings Storage Facility (TSF) Recontouring – As stated in Section 2.0 "the bulk TSF would be closed by regrading its surface so that all drainage would be directed off". This regrading is clearly required to minimize infiltration and help ensure long-term tailings containment. However, the DEIS provides no detail on how this large and complex engineering project will be accomplished. As committed in Table 4.16-1 the TSF must be able to contain the potential maximum precipitation event plus the 1 in a 100-year snowpack during operation. At least 2000 feet of beach must also be maintained between the reclamation pond and the embankments. The fine tailings underlying the decant pond will also settle much more than the sands underlying the beaches when they consolidate at closure. Recontouring will almost certainly require tens of millions of cubic yards of material movement to create a free draining convex surface. Just to fill the depression capable of holding the extreme rainfall design event will require backfill of 17 million cubic yards (Knight Piesold 2018g) and the actual volume will almost certainly be much higher.

Bulk TSF Runoff Discharge Structure(s) – Section 2 states that "a spillway will be constructed from the bulk TSF". This is a critical closure component, but no additional detail is provided. If the spillway failed during a large storm event or a series of events, subsequent erosion could destabilize the embankment and begin transporting tailings into the down-stream river systems. It will be challenging to create a stable, non-erosive spillway capable of transmitting even the 200-year 24-hour storm event with flows greater than 100,000 gallon per minute down a steep 20-degree embankment slope. Flows associated with the potential maximum precipitation event could be roughly five times larger.

Bulk TSF Cover Design and infiltration Modelling – Section 2 states that "the tailings surface would be covered with soil and/or rock and possibly a geomembrane or other synthetic material" and that "a low-permeability soil cover with the ability to support vegetation would be placed over the surface of the tailings". While the Project Description (Appendix N) states "a capillary break and growth media will be placed over the surface of the tailings". There are no conceptual level designs available for the proposed cover; no placeholder estimates of cover thickness and materials balances; and no estimates of how much they would (or should) reduce infiltration. Placement of a geomembrane liner over a 2475-acre area is likely to cost well in excess of $100 million. A soil cover is likely to be much less costly but is unlikely to cut infiltration to less than 20% of incident precipitation. Unless a very expensive and complex cover is constructed, seepage from the bulk tailings storage facility which requires treatment is likely to continue indefinitely at rates in excess of 1000 gpm. As stated in Section 2 "seepage water from the bulk TSF embankment SCPs would be collected and either treated in the WTPs or directed to the pit lake until determined to be suitable for discharge – anticipated after approximately year 50 post-closure". However, even the relative low sulfide bulk tailings are likely to contain in excess of one million tons of sulfur at closure (0.1% S in 1100 million tons of tailings) which will almost certainly take much longer than 50 years to oxidize and be transported out of the tailings mass. It is unclear if the DEIS adequately accounts for this continued water treatment liability after year 50.

Other Embankment Recontouring to Re-Establish Drainage – Section 2 states that the pyritic TSF, main Water Management Pond (WMP) and associated seepage ponds "would be reclaimed, and surface water runoff from the area discharged to the downstream environment" and "embankments associated with reclaimed facilities would be breached and flattened". Breaching of these embankments is a key closure requirement or they would remain water impounding structures forever and would cut off over three-square miles of surface runoff from the downstream river systems. Unfortunately, the tallest and widest portion of each embankment will lie directly over the existing natural drainage channels. The portion of the pyritic TSF embankment that would need to be removed will be 425 feet high, and the main WMP embankment would be 190 feet high. Preliminary estimates indicate that about 20% of the total embankment volume will need to be removed to establish a stable drainage pathway through the embankments. The steep 2:1 horizontal:vertical slopes of the WMP will also likely need to be reduced to at least 2.5:1 to ensure erosional stability and to allow topsoil placement and revegetation. In total roughly 40 million cubic yards of fill or more may need to be moved.

Management of Other Embankment Seepage – The WMP and pyritic TSF embankments will contain approximately 240 million tons of rock fill and cover roughly 900 acres. Laboratory testing confirms that the rock itself poses minimal risk of acidification. However, even at neutral pH some solutes in seepage water such as selenium, copper and sulfate are likely to exceed discharge criteria (SRK 2018; Geochemical Source Terms for Water Treatment Planning). Even more significantly, because the fill material will be composed of blasted bedrock, it is certain to contain residual blasting agent and to produce seepage water with nitrate concentrations one to two orders of magnitude above water quality requirements. This is particularly true of the significant portions of the embankment that will be covered by an HDPE liner during operation. Assuming a 20% infiltration rate for precipitation that falls on the reclaimed and revegetated embankments, roughly 500 gallons per minute of additional water are likely to require treatment for decades after physical reclamation is completed. This collection and treatment requirement does not appear to be included in the DEIS analysis.

Water Treatment Plant Practicability – The proposed closure water treatment plant design is very complex, still has significant uncertainties and is likely to have very high operating costs. Treatments steps include metals precipitation with lime, ferric chloride and other reagents, second-stage metals precipitation, clarification, ultrafiltration, nanofiltration, followed by multistage gypsum precipitation via lime addition, ultrafiltration and reverse osmosis. I am not aware of a treatment flowsheet of this complexity being applied to such high flows anywhere else in the world. By necessity the entire water treatment strategy is at best conceptual in nature and no laboratory or pilot scale tests have been completed. During an internal review of the proposed treatment processes conducted in October, 2018 (AECOM 2018i) it was stated that "it is difficult to fully assess the treatment process in a meaningful way without confidence in reliability of the design of the treatment process". Given the current uncertainties and inconsistencies in the treatment strategy, and the lack of even preliminary engineering drawings, designs and specifications, the ability of the proposed post-closure water treatment plant to meet required throughputs and discharge water quality requirements has not been demonstrated. These same deficiencies also exist for the operational water treatment plants which are, if anything, more complex than the proposed closure facilities.

Water Treatment Plant Replacement – It is likely that even with good preventative maintenance, the water treatment plant will need to be replaced several times within the first one hundred years of operation. This would be a complex and costly operation at the remote, closed site and needs to be considered in the Reclamation and Closure Plan.

Pipeline and Pump Layout for Perpetual Water Management– Pipelines and pumping infrastructure will be required to transport contaminated water from the open pit, and bulk TSF, pyritic TSF embankment and main water management pond embankment to the water treatment plant. As stated in Chapter 2 "The design of this system would need to be completed as part of the closure [plan]." Given the importance of this closure infrastructure, the Reclamation and Closure Plan will certainly need to have preliminary designs for post-closure seepage collection, pipe and pump station locations and requirements.

Support Infrastructure for Perpetual Water Treatment – In order to maintain and operate all water collection, transport and treatment infrastructure for the first one hundred years, a large number of support facilities will also be required. These will include a power plant, employee housing, workshops, more than 60 miles of road, ports and a ferry. Although mentioned in Chapter 2 no detail is provided as to how this infrastructure will be maintained and how frequently it will need to be replaced. Post-closure power demand is likely to be an order of magnitude lower than during operation and it is not clear that the large gas-fired power plant will be a practicable power source at closure.

Long-Term Environmental Monitoring and Maintenance – After closure there are certain to be ongoing long-term monitoring requirements for surface and groundwater quality, flow and water levels, water treatment plant performance, revegetation success, aquatic ecosystem health and landform erosion performance at many locations both within and down gradient from the disturbed footprint. There will also almost certainly be follow-up reclamation requirements for failed vegetation, erosion mitigation and potentially for water quality issues in some locations. However, no detail on this large body of work is provided in the DEIS, though it is acknowledged in Chapter 2 that "further detail would be developed in support of State permitting and the Reclamation Plan Approval requirements".

Monitoring and Extraction Well Abandonment – There are likely to be hundreds of dewatering wells, water supply wells, monitoring wells and old exploration boreholes which will no longer be needed at closure. Although not mentioned in the DEIS, all of these boreholes will need to be properly sealed and abandoned.

Contaminated Sites Management – After several years of construction and twenty years of operation even a well-managed mine may create contaminated soil and groundwater sites via spills or leakage of reagents, hydrocarbons or contaminated mine contact waters from TSFs and water management ponds.

<u>Pebble Mine Closure Costs</u>

This section provides a preliminary conceptual-level estimate of closure costs for the 20-year mine plan described in the Pebble DEIS. It is based upon the assumptions and commitments made in the DEIS or, where these are lacking to address a strategic environmental risk or impact, upon mining industry standard closure practice. Closure costs are largely driven by the exceedingly large perpetual water treatment liability created by the 20-year mine plan. These are predicted to average more than 22,000 gallons per minute in early closure declining to more than 5000 gpm in perpetuity (50^{th} percentile treatment requirements, Table 4.16-3). For the conceptual cost estimate water treatment is only considered for the first one hundred years, but in reality, it would likely be required for many centuries should the mine be developed. Cost estimates for individual closure components are summarized in the table below.

Total undiscounted physical closure costs which will be incurred in the first 20 years of closure are estimated to be approximately $500 Million. Total undiscounted water treatment costs which will be incurred in the first 100 years of closure are estimated to be approximately $4 Billion. When these costs are discounted to the year of closure using standard industry accounting practices (a generous risk-free discount rate of 3.5%) the total closure cost almost certainly exceeds $1.5 Billion and will likely exceed $2.0 Billion.

Table 1 – Preliminary Conceptual Level Closure Costs for the Pebble 20-Year Mine Case

Closure Activity	Estimated Cost	Notes
Move pyrite tailings to open pit	$110 Million	155 Mt at 1.35 t/yd^3 at $1.00/yd^3 for dredging (1)
Establish drainage through Pyrite TSF and main WMP	$60 Million	20% of embankment fill moved (40 M yd^3) at $1.53/yd^3
Move PAG waste rock to open pit	$50 Million	50 Mt at 1.66 t/yd^3 at $1.53/yd^3 for truck hauling
Bulk TSF recontouring to promote runoff	$30 Million	17 M yd^3 at $1.53/yd^3
Cover placement over bulk TSF interior	$20 Million	Three ft soil cover over 2475 acres at $1.53/yd^3
Infrastructure Demolition	$20 Million	Demolition cost from Donlin Gold Mine 2017 Reclamation and Closure Plan (2)
Topsoil placement, surface preparation and seeding	$10 Million	6 inches of topsoil on 7500 acres plus $365/acre for surface prep and seeding (3)
Modification of pit water treatment plant	$10 Million	Mean capital cost from MEND 2013 for membrane separation plants (4)
Environmental monitoring and maintenance	$60 Million	20% of the annual operating environmental budget from Wardrop (2011) for 20 years (5)
Access Road Maintenance and Operation	$40 Million	50% of Wardrop (2011) annual operational road maintenance budget per mile for 77 miles and 20 years
Direct Physical Closure Cost	$410 Million	

Total Physical Closure Cost	**$520 Million**	**Direct costs plus 28% indirect costs for 20 years of physical closure works (6)**
Direct Water Treatment Cost	$3200 Million	DEIS estimated flows from each phase of closure with mean water treatment costs from MEND 2013 (7)
Total Water Treatment Cost	**$4100 Million**	**Direct costs plus 28% indirect costs for 100 years of water treatment**

(1) Recent average unit costs for bulk earth movement in closure and reclamation plans at the Donlin Mine and Pogo Mine (both SRK, 2017) generally exceeded $2/m^3, sometimes by a factor of two. $2/m^3 equates to $1.53/yd^3 which is the value used for earthmoving cost estimates involving truck hauling. For dredging of pyritic tailings this was reduce to $1.00 /yd^3 to account for the generally greater cost efficiencies of this method. (2) The Donlin Gold Mine Reclamation and Closure plan had a cost estimate of $22 million for demolition of all infrastructure. This was used as a proxy for demolition costs at Pebble. Actual costs at Pebble are likely to be significantly higher than at Donlin given the larger scale of the required infrastructure. (3) The estimated topsoil/growth media placement thickness of six inches is likely a bare minimum required for successful vegetation establishment and some areas such as the rock quarries will almost certainly require more. Unit costs per acre for ripping/scarifying and seeding are taken from the Pogo Mine Reclamation and Closure plan. (4) Canadian Mine Environmental Neutral Drainage Program (MEND) 2013 report "Review of Mine Drainage Treatment and Sludge Management Operations". (5) Wardrop, 2011, Preliminary Assessment of the Pebble Project, prepared for Northern Dynasty Minerals Ltd. (6) Indirect costs include contract administration, engineering design, insurance, contractor overhead and contingency. Indirect costs assumed in recently completed reclamation and closure plans average more than 30% of the direct costs (28.5% at Donlin, 30% at Chino, 37% at Rosemont, 38.5% at Pogo). (7) Water treatment cost are based upon the 50th percentile flows in DEIS table 4.16-3 for each of the four closure phases and average water treatment costs per thousand liters from a study of more than 100 water treatment plants which were predominantly located in the United States and Canada (MEND 2013 – see footnote 4). The average operation cost in the study was $1.54 per 1000 liters ($5.82 per 1000 gallons). In reality the Pebble water treatment strategy is much more complex than the average treatment plant in the review and so its costs are likely to be higher.

This closure cost estimate is almost certainly an underestimate of the actual closure costs for the proposed 20-year Pebble mine plan because of the conservative assumptions that were made and the many near-certain closure requirements that were not included. Potentially significant closure cost items which are not addressed in this estimate include:

- Employee severance costs when the mine initially closes and when major physical closure works are completed.

- General administration costs to staff, supply and oversee operations in a remote location for the first one hundred years.
- Water treatment and management costs that will be required after one hundred years. In reality water treatment will almost certainly be required for several centuries.
- Power plant operating costs and logistical costs to support a mine camp in a remote location for the first one hundred years.
- Infrastructure replacement costs to periodically build new water treatment plants, employee housing, power plants and other facilities to maintain water treatment for the first one hundred years.
- All environmental monitoring and maintenance activities after year-twenty.
- Costs to operate and maintain the access corridor after year-twenty including ports, ferries and more than 60 miles of roads.
- Initial capital costs for construction and subsequent operational pumping costs to transport water from the open pit, bulk TSF and reclaimed embankments to the water treatment plant.
- Spillway construction costs to safely transmit large storm events off of the bulk TSF in a non-erosive manner.
- Contaminated sites remediation costs.
- Closure costs to seal all monitoring, dewatering and water production wells.
- Major earthworks costs to ensure adequate drainage from, and vegetation establishment on, the 873 acres impacted by rock quarrying.
- Any costs required to stabilize the post-flooding pit walls and ensure they are not prone to failure and seiche wave generation during large seismic events.

Sincerely,

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