Concerns of the Draft EIS for the Proposed Pebble Mine

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Here I provide a list of my primary concerns about the technical quality of the Draft Environmental Impact Statement (DEIS) released by the US Army Corps of Engineers to assess the environmental risks of the proposed Pebble Mine in Bristol Bay, Alaska. While there are many inconsistencies and inadequacies in the DEIS, I have focused on my primary points of concern here.

I am a professor in the School of Aquatic and Fishery Sciences at the University of Washington in Seattle. I am a Principal Investigator of the UW Alaska Salmon Program, which has studied the ecology of salmon and their watersheds in western Alaska since 1946. I have worked in these ecosystems since 1997 and spend over 3 months of the year in the field in Bristol Bay, performing research on the habitat and ecology of salmon and the species with which they interact. My concerns described here draw on this 75 years of institutional experience and almost 30 years of personal scientific experience working on the ecology of salmon ecosystems along the west coast of North America.

To summarize, the DEIS is not a rigorous scientific assessment of the risks of the Pebble project to the water quality, fisheries, and people of the Nushagak and Kvichak watersheds. Through a series of faulty assumptions and assessment approaches, the DEIS has arrived at the premature conclusion that there are no long-term substantial risks of this project to Bristol Bay ecosystems and the region's human communities. This conclusion is not supported by the science that should be under consideration. It is undeniable, based on the data and information available, that the long-term risks of the Pebble project to the Nushagak and Kvichak watersheds are substantially higher than the DEIS has concluded.

The Pebble DEIS falls distinctly short of the intended rigor of the NEPA assessment process. If this assessment was submitted to the standard scientific peer review process, I believe it would be soundly rejected and found to be unpublishable in the scientific literature.

I believe the DEIS for Pebble Mine should be rejected based on the complete lack of rigor of the science in this assessment. There is too much at stake for Alaska for such a careless assessment to be used in the decision-making process. I believe the DEIS should be re-written, using a more defensible set of starting assumptions and more rigorous assessment about the risks of this proposed project.

My ten primary concerns about the DEIS are listed below.

1. The DEIS assumes too short a time frame over which to evaluate risks

In assessing the risks of the Pebble Mine, the DEIS assumes that the mine can be constructed, the ore removed, and the site decommissioned in about 50 years. The DEIS further assumes that all important risks associated with this project will occur only during this time period. For several reasons, this is the most glaring problem with the DEIS. While boundary conditions need to be established in any risk assessment (e.g., for how long, and over what spatial area the project may have effects), the unrealistically

short time frame assumed in the Pebble DEIS leads inevitably to a conclusion of negligible risk. This is a serious oversight and simply ignores what the existing data on the nature of the mineral deposit, and the ecology of the area, tell us about the risks. Most risks from this mine will not become evident for several decades, or even centuries, after the proposed mine has closed.

Several issues make the assumed time frame a gross underestimate of the time frame that should be considered in a legitimate EIS. First, much of the waste rock material that will be produced from this mine, including both the pyritic and bulk tailings, will generate acid mine drainage (AMD) – a toxic cocktail of sulfuric acid and heavy metals such as residual copper, selenium, and cadmium. The ore to be mined is rich in sulfides which, when exposed to oxygen and water, will produce sulfuric acid which will both make waters acidic and also dissolve residual toxic heavy metals that pose distinct risks to water quality and fish. This is known with almost 100% certainty. But how the wastes will be contained and maintained, over geochemically-relevant time scales (i.e. centuries), is glossed over in the DEIS.

While Pebble Limited Partnership's own data on the composition of the ore deposit show with near certainty that much of the waste will produce AMD, it will likely take more than 2 decades to start doing so. Thus, in the short-term while the Pebble project is initially constructed and actively mined, there may be little indication of the severity of the toxic AMD that will eventually be produced, and will continue to be produced for centuries. A legitimate EIS would explicitly account for the need for perpetual storage and maintenance of these tailings. Risks associated with retaining and maintaining these tailings will extend over centuries – not the 50-year time period assumed by the DEIS. <u>The DEIS should be rejected based on this simple fact alone.</u>

Many of the impacts of the mine and its extended infrastructure (i.e, roads, pipeline, ferry terminal) on fish habitat will also take decades to fully develop. For example, roads will impact the movement of rivers and streams on their floodplains, and will change surface and ground water flows. The impacts of infrastructure on aquatic habitats will likely take decades to fully develop. Thus, the EIS must consider a substantially longer time frame to fully account for effects on fish habitat. The assumed 50-year time frame is distinctly too short, probably by at least an order of magnitude, given what we know about the ecology of this region.

2. The Pebble Mine should be considered a 'gateway mine' in terms of long-term impacts

The current mine plan under consideration for permitting would target a small fraction of the entire Pebble ore deposit. Expansion of this mine into the deeper, more valuable, components of the deposit is highly likely, which means that the most toxic wastes (i.e., those that will produce AMD) cannot be stored in the mine pit as is described in the current mine plan. For the mine to be expanded into the deeper ore deposit, the pit will need to remain open which means that the toxic acid-generating material must be stored above ground, probably behind earthen dams. This puts this waste material at higher likelihood for producing AMD, and further increases the risk that AMD will leak into surface- and groundwater sources.

All EIS under the National Environmental Protection Act (NEPA) must explicitly treat "Reasonably Foreseeable Future Actions" (RFFA) of any project to account for long-term potential effects and their associated risks. While it is true that the current mine plan is the project under consideration for permitting, it is clear that if this plan is permitted, it will enable further mining development of the Pebble deposit and of other deposits in the region. Thus, when accounting for RFFA it is only responsible

to consider the Pebble Mine as a 'gateway mine' whose long-term consequences include 1) expansion of the initial mine to extract the entire Pebble deposit and its associated increase in the time that critical components of its infrastructure (e.g., Pyritic TSF) threaten the ecosystem and downstream human communities, and 2) the opening up of this region to much broader mining activities that would be enabled by construction of the infrastructure serving the initial mine (i.e., roads, pipelines, electricity, etc). The risks of these inevitable additional activities that will be enabled by the initial permitting of the Pebble Mine must be considered in the DEIS as part of the RFFA. The DEIS currently pays little attention to these long-term, but very likely, future developments in the region that will be catalyzed by the initial permitting of the Pebble project. By ignoring these RFFA, the DEIS distinctly and grossly underestimates long-term risks to the ecosystem.

3. The DEIS assumes that there are no interactions among stressors

It is broadly understood in environmental sciences that most development activities produce many possible stressors to ecosystems. In the case of Pebble Mine, this includes dewatering streams, draining wetlands, leakage of toxic materials into water sources, roads preventing streams from moving across floodplains, in addition to the potential for more catastrophic events such as failures of tailings dams. What has become widely appreciated is that these multiple stressors typically amplify the effects of each other when generating risks to the environment, i.e., stressors interact and compound each other's effects (Hodgson et al. 2019). The current DEIS assumes that all stresses associated with the Pebble project occur independently, and do not amplify each other's effects on ecosystems. This assumption ignores decades of research and assessment of the effects of similar projects that show clearly that the effects of mines involve multiple stressors that typically interact with one another and amplify the risks that each individual stressor creates on its own. This oversight of the Pebble DEIS also leads to a serious underestimate of the potential environmental risks of this project. A properly conducted EIS would account for interactions among stressors and how these translate into risks to the ecosystem, which would inevitably be much higher than the Pebble DEIS currently concludes. The current treatment of 'cumulative risks' in the DEIS focused narrowly on the accumulation of stressors through time. It does not include interactions among stressors, and it should.

4. The DEIS relies on inadequate assessment of fish habitat

A major component of the DEIS focusses on estimating the amount of fish habitat that is vulnerable to the development of Pebble Mine. The DEIS concludes that a small fraction of a percent of fish habitat in the Kvichak and Nushagak river watersheds is vulnerable to mining activities. To arrive at this conclusion, the DEIS compares the recent number of fish observed in nearby streams to the aggregate number that returned to the entire watershed. This approach leads inevitably to underestimating the value of habitat that could be impacted by the mining activities.

The reason for this underestimation is that we know from decades of monitoring of salmon, that population abundance varies tremendously through time in any individual component of habitat (Schindler et al. 2010). However, all populations do not boom and bust at the same time, so that the abundance lows in one habitat are offset by abundance highs in other habitats. What this means is that different pieces of habitat are important for producing fish at different points in time. Thus, just because certain habitat currently produces a small number of fish (e.g., as determined from the 2-3 years of monitoring within the DEIS), does not mean it does not have the potential to support higher abundances in the future. In fact, long-term data on Bristol Bay rivers shows that local abundances can vary 100x over

decade-long time scales. Thus, properly functioning watersheds should be viewed as habitat portfolios, whereby the sustainability of the regional resource depends on the diversity of habitats across a river basin (Schindler et al. 2010, Brennan et al. 2019). The DEIS currently does not view the system in this dynamic way, thereby distinctly underestimating the importance of small components of habitat to the long-term sustainability of the ecosystem. The DEIS should be rewritten to account for the dynamic nature of salmon habitat, the fact that intact watersheds operate as shifting habitat mosaics (Brennan et al. 2019), and that the long-term future potential of habitat is assessed (rather than current abundance of fish which assumes a static ecosystem).

5. Groundwater Exchange

The area where the Pebble deposit is located has extremely complex groundwater dynamics that will be fundamentally disturbed by a project the size of Pebble Mine. The area is covered in a thick layer of gravels that was deposited during the last glaciation, producing complex surface and sub-surface water flows across the landscape. The data collected by Pebble LP demonstrate this, illustrating complexities such as the fact that several interacting aquifers are connected via the gravels that will be impacted by the Pebble Mine. For example, one third of the under flow from the South Fork of the Koktuli Flats Area flows into the Upper Talarik (DEIS 3.17, pg. 20).

The existing mine plan acknowledges that water from the mine pit will need to be pumped out continuously to allow the deposit to be workable. Further, it will be necessary to maintain low water levels in the tailings pond to maintain negative hydrologic head to prevent AMD from spreading across the landscape. This negative hydrologic head will be maintained by pumping water out of the tailings pond, treating it, and then releasing it to downstream surface waters. However, there is essentially no comprehensive assessment of the risks of being able to maintain this negative head while simultaneously treating the effluent water to the point where it does not pose risks to habitats downstream, for time periods much longer than the active mine life. This capacity will need to be maintained forever, not just during the mine life as is currently assumed in the DEIS.

What is also missing from the DEIS is any acknowledgement of the uncertainties associated with understanding how these groundwater connections work under different precipitation regimes (e.g., under climate change) and under different mining excavation scenarios. The DEIS assumes that we know how groundwater exchanges will respond to these disturbances, and that retaining mining wastes can be done effectively to prevent contamination of ground water sources. The DEIS does acknowledge that some contamination is possible, but if detected, the groundwater will be removed and treated and then discharged back to the environment. The DEIS does not sufficiently describe how this will be done, and whether it is even possible to monitor, detect and then treat effluent, in an area as hydrologically complex as where the Pebble deposit is located. We are asked to trust that such post-mining monitoring and treatment will be done effectively, with no empirical evidence provided to back up such assertions. A proper, quantitative analysis of such risks would undoubtedly produce estimates of risks to the environment that are much higher than the DEIS has concluded.

6. Tectonic risks and tailings dam failure are underestimated

The Pebble deposit is located in a region that is tectonically active though the DEIS deems that the risks to the long-term waste storage facilities and related infrastructure are negligible. This conclusion derives from at least two poorly supported assumptions. First, the time frame over which risks to infrastructure

are considered is much too short (see concern #1). Bulk tailings will need to be stored behind an earthen dam on the site forever and therefore risks should be calculated for a more reasonably long time frame. While it is reasonable to assume that the probability of a large tectonic event is very small in any given year, the cumulative probability through time obviously depends on how long a time frame is considered. The current DEIS assumes that the relevant time frame is about 50 years, even though mining wastes will need to be stored safely for centuries. It is not clear what the appropriate time frame to integrate these risks over is, but it is certainly substantially longer than the assumed 50 years, and should probably be assumed to be at least 500 years. This is particularly important given the high likelihood of further expansion of this mine, and development of other mines that would be enabled by an initial permit – a scenario that must be considered a RFFA.

Second, it is not clear that the return intervals for large tectonic events are estimated appropriately. My initial assessment suggests that the probably of a large event was calculated for the immediate vicinity of the proposed mine. However, large tectonic events, particularly in the region associated with megathrust earthquakes are likely to impose ground-shaking even at sites far distant from their epicenter. The assumed recurrence intervals in the DEIS appear to be substantially longer than what is reasonable for the geologic formation and known tectonic activity of this region (Plafker et al. 1992, Mann et al. 1998). Thus, the risks to the earthen dams that would hold back mine wastes appear to be distinctly underestimated.

The DEIS should refer to technical report by Dr. C. Wobus for a full explanation of the inadequacy of this component of the risk assessment, and numerical simulations that demonstrate what the likely downstream impacts on the Nushagak River would be. The EIS should be updated to account for more defensible earthquake scenarios (in terms of magnitude, return interval, and the time horizon over which risks are associated). The current set of parameters considered result in an unrealistically low estimate of risk to infrastructure from tectonic activity.

7. Loss of wetlands and headwater streams are assumed to have no downstream impacts

The DEIS acknowledges that many acres of wetlands and miles of headwater streams will be drained or destroyed in the process of developing and working the Pebble deposit. Loss of these wetlands and streams are acknowledged to have direct effects on aquatic habitats in the area of the Pebble mine (but assumed to be either negligible or that they can be restored). However, the DEIS assumes that there are no downstream effects on water quality and habitat. Wetlands are widely known to have a variety of important effects on downstream ecosystems through processes such as moderating temperatures and flows, intercepting silt, and modifying water chemistry. The American Fisheries Society recently published a review of such widely known effects in the scientific literature (Colvin et al. 2019). The DEIS ignores nearly all of these effects and assumes that the loss of wetlands and headwater streams will result in only trivial impacts to the ecosystems of this region, largely because they don't acknowledge the effects on downstream aquatic habitats. This conclusion is completely incorrect. A proper EIS would account for the landscape scale effects of losses of wetlands and headwater streams on downstream water quality and fish habitat. The current assumptions used in assessing the risks of draining headwater wetlands and streams are fully inappropriate.

8. The DEIS assumes that climate change is not happening

Despite the widespread evidence of warming climate in Alaska and the associated environmental disturbances associated with it, the Pebble DEIS assumes that the effects of climate on mining risks are negligible. Over the last 50 years Alaska has experienced increasingly warmer climates and associated effects on ecosystems, such as shifts in ice break-up dates, less snow and more rain during the winter, and melting permafrost in northern regions of the state. Plausible scenarios for the next 100 years all include further warming, intensifying precipitation, and increasingly less winter snow and ice. These changes in climate pose distinct risks to aquatic ecosystems and to infrastructure. Of particular relevance to the Pebble Mine EIS is that changes in precipitation patterns, particularly during the winter when rain-on-snow events will become more common, pose additional risks to flooding and erosion. Thus, risks of infrastructure failures must include the expected disturbance frequencies and intensities that will occur with changing climate. The DEIS assumes that these will be no different than the historical disturbance patterns observed in Alaska. This assumption is in distinct contrast to the science documenting ongoing climate change effects on Alaska's ecosystems, and leads to reduced estimates of risk of the Pebble project.

Further, estimates of fish habitat loss will likely be exacerbated by climate change. More intense summer droughts, heat waves, and flooding events are expected with climate change. We know that maintaining a diversity of habitat conditions in watersheds is what provides fish and wildlife the 'options' for coping with extreme climate events. By reducing the variety of habitat conditions in these watersheds (i.e., by draining wetlands, dewatering streams, etc.), the Pebble project will undeniably reduce the resilience of these watersheds to future climate change. The current DEIS does not even consider these issues in its assessment of the risks of the Pebble project. Related to discussion point #3 (interacting stressors, above), climate change should be considered one additional and inevitable stressor with which mining-related stresses will interact and be amplified. Assuming climate change is not occurring, as the DEIS does, also leads to conservative estimates of risk to the environment.

9. No concrete plan for long-term monitoring and treatment of the site

The Pebble DEIS acknowledges that there are tangible risks associated with the long-term storage and retention of mining wastes at this site. However, the risks of toxins associated with AMD being released into natural waterways are concluded to be either negligible, or that they can be detected and properly treated before release to the environment. Given that we know with virtually 100% certainty that the mining wastes will produce AMD for many centuries after the mine has closed, it is irresponsible that the DEIS does not propose a defensible plan for the long-term monitoring of the site, identify who will pay for it, how will clean-up of contaminated surface and groundwater be accomplished, and who will pay for the clean-up if an accident or leak occurs. Alaskans will undoubtedly be saddled with these costs, just like taxpayers have in every other place in the world where this type of mine has operated. The states of Maine, New Mexico, Michigan, and Colorado no longer permit new mines that will require perpetual storage and treatment of mining wastes (as Pebble will) because they have realized that they can no longer afford the costs of monitoring and treating the toxic legacies of their existing mines. Pebble Mine would require the same, though substantially larger and more complex, effort to manage and maintain the waste material for centuries after the mine has been decommissioned.

The Pebble DEIS should develop a set of concrete monitoring, treatment, and clean-up scenarios for the wastes and infrastructure that will be left behind, that extends over relevant time scales (i.e., centuries), and estimate the risks to the environment over those time frames. The NEPA process requires that

Reasonably Foreseeable Future Actions (RFFA) be considered as part of the risk assessment of projects under consideration by an EIS. This is yet another RFFA that has been swept under the rug in the Pebble DEIS. A more thorough assessment should be a requirement of a legitimate EIS. Experience from nearly all sulfide-rich deposits demonstrates that problems with contamination mostly arise long after mines have been decommissioned.

10. Assumption that mitigation and restoration are effective and possible

While the DEIS concludes that there are some small-scale risks associated with the Pebble Mine, it assumes that any effects will be effectively detected, and countered by effective mitigation and restoration. However, the DEIS does not explain what will be fixed and how it will be fixed. Again, the DEIS is asking for a lot of trust that all will go well. Experience has shown that habitat restoration and mitigation in other parts of the world are remarkably difficult and expensive, and are often ineffective, because many unanticipated harmful effects of mines eventually express themselves in the ecosystem. The DEIS assumes that effective restoration and mitigation of habitat destroyed or contaminated by Pebble activities is possible and will be 100% effective. However, no details of how this will be accomplished are given. The DEIS should include more detailed and realistic scenarios for what types of environmental damage could be incurred from this project, how and when these effects might be detected, how mitigation and restoration will be implemented, and the likelihood of success is for any restoration or mitigation effort. This analysis should draw on the experience of attempts to restore habitat, water quality, and fisheries in other ecosystems where AMD and extensive infrastructure have impacted large expanses of habitat. This analysis will be sobering, and will highlight yet another reason why the Pebble DEIS has reached a hasty and unsupported set of conclusions regarding the risks to ecosystems and people from the proposed Pebble Mine.

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