State of Alaska Technical Comments

Environmental Protection Agency May 2012

External Review Draft

"An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska"

Docket # EPA-HQ-ORD-2012-0276

Submitted July 23, 2012

(with a summary letter dated July 23, 2012 also submitted)

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Report Section Identification: Abstract – and Elsewhere in the Document
Report Page Number: *i*
Comment: The document states that the hypothetical scenarios used would "result in the direct loss of 87.5 km to 141.4 km of streams and 10.3 and 17.3 km2 of wetlands." This does not adequately put the projected impact in perspective because there is no attempt to relate this to a percentage of the entire watershed. An abstract should be an overview or big picture and in this case the big picture is the entire Bristol Bay Watershed.
Recommended Change: Express the hypothetical stream and wetlands loss as a percentage of the entire Watershed.

Report Section Identification: General
Report Page Number: Tables and Figures
Draft Comment: Not all acronyms are defined that are used tables and figures. Nontechnical readers will not be familiar with the chemical symbols used for the metals. Sources of information contained within tables and figures are not provided in the footnotes.
Draft Recommended Change: Define all acronyms used in tables and figures. Include names of metals rather than their chemical symbols. Provide sources of information presented in tables and figures.

Report Section Identification: General comment on risk estimates.
Report Page Number: General
Draft Comment: Given the uncertainty in the mine plan, numerous data gaps in the assessment of current conditions, use of conservative risk screening criteria, uncertainty in measured concentrations or parameters, and consideration of potential risk mitigation measures, risk might be better discussed in a more qualitative manner or using probabilistic risk assessment techniques. Using probabilistic risk assessment the uncertainty and variability in the risk assessment estimates might be used to better predict the magnitude of expected impacts.

Report Section Identification: Executive Summary - Scope of Assessment – and Elsewhere in the Document
Report Page Number: ES-1
Comment: The document states that impacts to Alaska Native cultures are one of the endpoints. The document tends to view any impacts as negative and does not adequately address the potential positive impacts. It is not clear where the EPA has the authority to determine potential impacts to only one group of people while excluding the potential impacts and benefits to a larger group such as all residents of Alaska. Even local non-Native subsistence users are excluded from this assessment.
Recommended Change: The EPA should clarify its authority to limit its scope to only one group

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of people and describe its reasoning for excluding the potential beneficial impacts.

Report Section Identification: All
Report Page Number: All
Comment: There is not a definition for "freshwater habitat" in the text or maps (e.g., Figure ES-5 on page ES-12). I am assuming this is the waterbody plus the wetlands, but I could not find any reference to this.
Recommended Change: Define what is meant by "freshwater habitat."
Draft Comment Reference: N/A

Report Section Identification: Executive Summary
Report Page Number: Throughout the report
Comment: Although the report authors frequently state that the mine under analysis is hypothetical, the report has virtually no discussion on the local and regional geology and hydrogeology. However, the report often mentions field investigations and testing that have been performed as part of exploration programs. So, some data exist on the key aspects of the subsurface environment as they pertain to some of the major issues for this mine, namely, the direct hydrologic impacts and the related fish and habitat impacts. The report does not include discussion of ambient groundwater quality.
Recommended Change: The report should include new sections dedicated to describing the local and regional geologic and hydrogeologic conditions, and providing a framework for quantifying the primary subsurface conditions such as soil and rock types, hydraulic properties, degree of fracturing and fracture interconnectivity. The report should include hydrogeologic sections, soil and rock descriptions, summary of properties, groundwater levels and flow directions and gradients, and groundwater chemistry.

Report Section Identification: Executive Summary through Section 7
Report Page Number: Many
Comment: There are hundreds of references to groundwater in the report and it is repeatedly listed as a key factor in fish habitat and other wildlife habitat functions. Specific text is repeated many times throughout Sections 5 and 6 reporting the value of groundwater to fish. In Figure 4-9, a groundwater diagram is presented including a very large cone of depression that is repeatedly referred to as likely to severely impact stream recharge. In Appendix H, the geology of porphyry copper deposits is presented and reference is made to nearly 1200 borings being made in the Pebble deposit. Yet, hydrogeology within the pit and Tailings Storage Facilities (TSFs) is not described in the Bristol Bay Watershed Assessment report. If the underlying geology is bedrock, then there is no large reservoir of groundwater as shown in Figure 4-9. Rather, there would only be shallow groundwater in the glacial deposits overlying the bedrock. Degree of fracturing in any bedrock would be critical to how much downward movement of groundwater there is and how much groundwater is actually present in the mine pit and TSF area.

This lack of any presentation of actual or likely groundwater conditions within the hypothetical mine scenario is a critical omission because of the repeatedly stated importance of groundwater.
Recommended Change: A thorough hydrogeological description needs to be incorporated into the risk assessment to determine the actual or selected hypothetical conditions incorporated into the risk assessment. This needs to be incorporated into a detailed water balance and consideration of how much water is available for discharge to streams throughout the year.

Report Section Identification: Executive Summary and Throughout
Report Page Number: Throughout
Comment: The Bristol Bay Watershed Assessment is has repeated influential statements that are not well linked with actual conditions. The repetition suggests a preferred conclusion.
Recommended Change: Provide data, describe the analysis of the data and summarize the conclusions in a scientifically neutral manner.

Report Section Identification: Executive Summary and Throughout Entire Document
Report Page Number: Many, including Appendices
Comment: Broad generalizations are made throughout the documents. Related to this are items such as Appendix A, Figure 2 that shows nearly the entire Nushagak River as spawning habitat for Sockeye, when it is likely there are portions of the river that are used considerably more than others. This may be due to a lack of documented evidence, but if it isn't really the entire river, then it should not be marked as such.
Recommended Change: Text needs to be made more specific or better acknowledge lack of site-specific evidence/information and how it may affect conclusions.

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: In regard to the impacts of the proposed mine on streams and fish, the Bristol Bay Watershed Assessment is too general to determine actual impacts of the proposed mine.
Recommended Change: A detailed and site-specific EPA review of the Pebble Limited Partnership (Pebble Limited Partnership) Environmental Baseline Document (Pebble Limited Partnership Environmental Baseline Data) and application of their considerable data to the issues raised by EPA in the Bristol Bay Watershed Assessment would have gone much further to understanding the actual impact.

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: While there is an economic assessment of the current conditions in the Bristol Bay area (Bristol Bay Watershed Assessment Vol. 3), there is no economic analysis related to the potential fish impacts of the mine, nor of the potential recreational opportunities that develop due to the road,

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and other economic issues. While such an evaluation may not be possible with the level of analysis provided by the EPA in the Bristol Bay Watershed Assessment, it would seem possible that a minimal mine-related economic impact on the fisheries could be off-set by mine-related economic benefit of greater proportion.
Recommended Change: Do an economic cost-benefit analysis.

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: Overall, it is uncertain and unquantified what the actual impacts of the mine are likely to be. No reasonable maximum or average impact to fish and wildlife are provided. While it can be stated with certainty that the mine pit, waste rock piles, and tailing storage facilities (TSF)+ will cover fish and wildlife habitat, the percentage of that impact on localized and regional fish and wildlife populations and the economic impact it may have, are never quantified. TSF dam construction and failure is the single most significant issue related to fish and wildlife impacts. Much more detailed information is needed on groundwater flow and its relation to overall water balance
Recommended Change:

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: The Bristol Bay Watershed Assessment should have incorporated the vast amount of information that is available in the Pebble Limited Partnership Environmental Baseline Data. The lack of site-specific data limits the Bristol Bay Watershed Assessment to conclusions based on assumptions that may be inaccurate to the site-specific conditions provided by the baseline data.
Recommended Change: Use site specific data as available, identify data gaps, fill data gaps, and do further analysis.

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: Biological impacts of the proposed mine should be examined closely. But much of the decision making on this project will be socio-political decisions such as: should we disturb the current wilderness of the mine area, even if it is determined there is no "significant" ecological impact. For example, much of the EPA Bristol Bay Watershed Assessment emanates an underlying ecological philosophy that any impact in the "pristine" Bristol Bay watershed is bad because, in and of itself, the impact reduces the "pristine" nature. That is, The Bristol Bay Watershed Assessment portrays a philosophy that there is no threshold for acceptable impacts, so any impact is unacceptable. This philosophy is contrary to the past ecological and toxicological "threshold" management approaches applied in this country through its existing political and legal structure.
Recommended Change:

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Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: Many of the potential issues/impacts brought up within the Bristol Bay Watershed Assessment are important and should be considered in an evaluation of project permits and plans. But the results of the Bristol Bay Watershed Assessment are inadequate to determine the actual impacts. For example, culverts can be a problem for stream function and fish passage. This is raised as an issue in the Bristol Bay Watershed Assessment. So, any project/roadway designs must assure culverts are properly designed and maintained, or bridges are used that span the active channel area. But stream crossings do not necessarily cause significant impacts to fish or stream function if managed and permitted correctly.
Recommended Change:

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: No one can refute that some level of impacts to fish, wildlife, and their habitat(s) will result if the mine is built and operated for many years. The question is "what are the risks". The Bristol Bay Watershed Assessment repeatedly emphasizes the "possible" effects, but other than the simple risk based screening of average leachate concentrations to water quality criteria, there is essentially no other site-specific assessment of the impacts to species and the quantification of lost habitat. The conclusions are oversimplified to the extent that it is not applicable to individual species or their populations. Pre-emptive action by the EPA in an area designated by a state as a potential mining area is unprecedented.
Recommended Change: Pebble Limited Partnership has collected a massive amount of relevant site-specific data, made public in their Pebble Limited Partnership Environmental Baseline Data, that has not been incorporated into any ecological risk assessment of the potential mine impacts. Unless there is a pre-emptive political decision to disallow development of the mine because of the "pristine" nature of the Bristol Bay Watershed, then Pebble Limited Partnership should be allowed to use their data to develop a mine development and management plan, and a risk assessment/mitigation plan for the proposed mine. Then, agencies responsible for environmental impact and permitting review can better assess the degree of impact and either request further mitigation/assurances or deny the permit. Or, if the EPA wants to continue engagement in this process, then they could do the site-specific study, but it would seem that any EPA work would then have to be subject to interaction and review by the permittee.

Report Section Identification: Executive Summary and Throughout
Report Page Number: All

Comment: The Pebble Limited Partnership Environmental Baseline Data provides a substantial amount of site-specific data and detail, but the data have not been incorporated into a risk assessment type of document, as likely would be done through the permitting process. On the other hand, the Bristol Bay Watershed Assessment does a risk assessment with essentially no site-specific data. Neither the Pebble Limited Partnership Environmental Baseline Data nor the Bristol Bay Watershed Assessment allows a clear understanding of the potential risks to the environment, fish, wildlife, or Alaska Natives.
Recommended Change: The details provided in the Pebble Limited Partnership Environmental Baseline Data and other site-specific documents must be used to more accurately and more elaborately evaluate and predict risks.

Report Section Identification: Figures
Report Page Number: Figures
Comment: None of the Figures in the Bristol Bay Watershed Assessment show any of the existing roads. Nor is it provided in the Bristol Bay Watershed Assessment that 15% to 20% of the proposed road already exists, primarily between Cook Inlet and Iliamna Lake, and improvements likely could be made to the existing road. The lack of information on existing roads imparts some level of bias in that the environmental impact of potential mine development is greater than what already exists.
Recommended Change: Provide the reader with the existing miles of roadway in the proposed road corridor and discuss how these roads have impacted fish and subsistence life, and what improvements may be made to reduce the negative impacts.

Report Section Identification: Executive Summary and Throughout
Report Page Number: All
Comment: Throughout much of the document, the normal approach to technical reporting is reversed. Rather than starting a section or subsection with an understanding/discussion of the issues to be addressed then addressing/evaluating the issues before reporting results of the evaluation, the Bristol Bay Watershed Assessment provides conclusive statements in the introduction to many, if not all sections and subsections. In some cases these conclusions are completely unsubstantiated in the following subsections. In other cases, there are some simple to extremely incomplete analyses that appear designed solely to support the conclusions stated in the introductory paragraphs. It is as if the report is written to convince people of the opinions of the authors, without the level of detail or evaluation necessary to support the conclusions. It is disconcerting to see this in a Technical Document from the USEPA.
Recommended Change: Do not rely on the Bristol Bay Watershed Assessment as a technical document. Rather, allow technical documentation to be developed by the applicants with good data and detailed analysis. Use the detailed analysis and evaluation to evaluate the likely impacts of the Pebble Mine.

Report Section Identification: Executive Summary

Report Page Number: Pages ES 1 – ES 4 Scope of the Assessment
Comment: The scope of the assessment and methods for evaluating impacts on fisheries, considering the various scales of the impacted watersheds are not clearly defined. For instance, in the executive summary, the following three statements are made: *"This assessment reviews, analyzes, and synthesizes available information on the potential impacts of large-scale mining development on Bristol Bay fisheries and subsequent effects on the wildlife and Alaska Native cultures of the region".* and *"The geographic scope of the assessment is the Nushagak River and Kvichak River watersheds (Figure ES-1). These are the largest of the Bristol Bay watershed's six major river basins and compose about 50% of the total watershed area."* and *"The headwaters of three biologically productive tributaries originate in this region: the North Fork Koktuli River, located to the northwest of the Pebble deposit, which flows into the Nushagak River via the Mulchatna River; the South Fork Koktuli River, which drains the Pebble deposit area and converges with the North Fork west of the Pebble deposit; and Upper Talarik Creek, which drains the eastern portion of the Pebble deposit and flows into the Kvichak River via Iliamna Lake, the largest undeveloped lake in the United States (Figure ES-2)."*
Recommended Change: Include an expanded discussion of methods and techniques used to evaluate the impacts of the project considering the various landscape scales involved in the project and the linkages between a site scale impact up to a watershed scale impact. These scales are generally: 1) site scale – direct impacts from mine development, 2) sub-basin scale impacts on streams directly downstream (and upstream) of the mine development such as the Koktuli and Talarik Creek systems, 3) basin scale impacts on the next order of streams, rivers, wetland systems such as the Nushagak and Kvichak Rivers, and 4) the watershed scale Bristol Bay watersheds. The methods should also refer to the conceptual models and how linkages between various site, sub-basin, basin and watershed scales are evaluated.

Report Page Number: ES-5
Comment: The text indicates that about half of the Bristol Bay sockeye salmon production is from the Nushagak – Kvichak and references Figure ES-4. The Kvichak commercial harvest reported in Figure ES-4 includes sockeye destined for the Naknek River watershed. Because of commercial fishery management and reporting, Kvichak and Naknek harvest data are not separated. Inclusion of Naknek River production overstates the amount of production from the "area of focus for this assessment."
Recommended Change: Wherever commercial harvest data are referenced, EPA needs to identify that the Naknek River is not part of the assessment area and including these numbers may overstate the importance of production from the assessment area.

Report Section Identification: Executive Summary – Scope of Assessment and Elsewhere in the Document

Report Page Number: ES-5
Comment: The document states that other deposits in the region would present risks similar to those outlined in the assessment. It is presumptuous for the EPA to assume other deposits in the area would have similar risks as Pebble. Later in the document, a comparison of the chosen scenario for Pebble, would make it the largest mine in North America. As hypothetical and unlikely as that assumption is, it is even more unlikely that other deposits in the region would be of the same scale and present similar risks. The document does state elsewhere that the other deposits are not likely to be as large as Pebble but it is contradictory to state that they would have "similar impacts" in the executive summary.
Recommended Change: The executive summary should not state that other deposits will have similar impacts.

Report Section Identification: Executive Summary, Ecological Resources
Report Page Number: ES-5, paragraph 4, 2nd sentence
Comment: The Nushagak River Chinook run is referenced; use of the word "run" is unclear.
Recommended Change: Suggest using language that clearly describes what level of run is being discussed (i.e., total run, escapement, etc.)

Report Section Identification: Executive Summary, Ecological Resources, Figure ES-3
Report Page Number: ES-6
Comment: Information depicted in map is confusing (e.g., what is the difference between "no field evidence" and "undocumented"
Recommended Change: Define categories and terms more clearly.
Draft Comment Reference: None

Report Section Identification: Executive Summary, Ecological Resources, Figure ES-4
Report Page Number: ES-7
Comment: Subtle contrast in pie chart colors makes figure difficult to read.
Recommended Change: Use more contrasting colors and/or arrange in order of size.
Draft Comment Reference: None

Report Section Identification: Executive Summary, Ecological Resources
Report Page Number: ES-8 (paragraph 1, last sentence)
Comment: Estimate cited is average annual catch, not the total estimated catch over five years 2003-2007. Estimates should use more recent data.
Recommended Change: ". . . ~~between 2003 and 2007~~ for 2003 through 2007 an estimated annual average of 196,825 rainbow trout . . ."; in addition use catch estimates from 2008-2010 reported in recent Jennings et al. Statewide Harvest Survey reports available on the department webpage.

Report Section Identification: Executive Summary

Report Page Number: ES-9

Comment:
An important clarification involves the claim that 80% of all protein in the region comes from subsistence foods. The Alaska Traditional Diet Project has a section on this topic that is dedicated to Bristol Bay. Salmon, moose, caribou, and other species accounted for 52% of food sources of protein in a nutritional survey of 132 participants for Bristol Bay Area Health Corporation (Table 9c. page 72). Salmon is at the top of this list (32%) and it is healthier than other sources of protein listed, but 52% is based on a survey of 132 people regarding food intake. ADF&G generally surveys harvest and may ask some consumption questions as additional information only and not part of a dietary survey.

Draft Comment Reference: Final report on the Alaska Traditional Diet Project Survey, March, 2004, prepared by Alaska Native Epidemiology Center et al.
http://www.anthc.org/chs/epicenter/upload/traditional_diet.pdf

Report Section Identification: Volume 1 Economics of Ecological Resources

Report Page Number: ES-9

Comment: There's no effort made to quantify how many of the workers and how much of earnings are made by non-residents. According to Alaska Department of Labor and Workforce Development Research and Analysis Bristol Bay Region Fishing and Seafood Industry Data in 2009, 58.8% of total gross earnings earned by non-resident permit holders and 87.1% of wages were earned by non residents. The characterization of the Bristol Bay Commercial Fishery is incomplete without a reflection of the profits gained from Alaska's fisheries resources by non residents and how much of the gross earnings leave the state, is not spent in Alaska, or in the Bristol Bay region.

Similar data presented for the general public is also published the November 2009 issue of Alaska Economic Trends published by the Alaska Department of Labor and Workforce Development, including that in 2008:

- 46% of Alaska's crew members lived outside the state
- 73% of seafood processing employees lived outside the state and they earned $187 million that year
- Seafood processing since at least the mid-1980s8 has been the sector with the highest percentage
  of nonresidents, both within the fishing industry and in all wage and salary employment in the state.

Warren, J. and Hadland, J. Employment in Alaska's Seafood Industry in *Alaska Economic Trends November 2009*. State of Alaska Department of Labor and Workforce Development, Research and Analysis Section.. pp. 4-10. p. 6-7 and Exhibit 7.

Alaska Department of Labor and Workforce Development Research and Analysis. Fishing and Seafood Industry in Alaska Current Data. Fishing and Seafood industry in Alaska Overall Seafood Industry Data Tables. Fish Harvesting and Processing Workers and Wages. Bristol Bay Region Seafood Industry, 2003-2009.

Report Section Identification: Executive Summary
Report Page Number: Page ES-9, Indigenous Cultures
Comment: The Executive Summary comments on the twenty-five indigenous cultures, and that fourteen are within the Nushagak and Kvichak watersheds.
Recommended Change: Include a map (or provide reference to map later in report) showing the Alaska Native village locations, or regions/territories that they generally occupy and use for subsistence living. The Native village may be those shown in Figure ES-1, but need to be labeled in the legend.

Report Section Identification: Volume 1 Geological Resources and Mine Scenario
Report Page Number: ES-10
Comment: While the assessment lays out a potential mine it does not make an attempt to assess the economic impact or number of workers employed by such a mine. While the assessment notes public sources for data used to determine the so called plausible mine scenario presented. The same attempt is not made concerning economic impacts or workforce, despite there being the publically available information posted by the Pebble Limited Partnership. Pebble Limited Partnership, http://www.pebblepartnership.com/opportunity.php

Report Section Identification: Executive Summary and elsewhere in the document
Report Page Number: ES-12,ES-17, 4-20, 5-15
Comment: It is not clear what "Freshwater Habitat" is on the map. These maps that appear in multiple location of the document are misleading and appear to show lakes and water bodies that don't exist. The blue color generally denotes water bodies.
Recommended Change: Clarify what "Freshwater Habitat" is and use a different color or hatch pattern to not imply that they are lakes.

Report Section Identification: Executive Summary, Overall Risks to Salmon and Other Fish
Report Page Number: ES-14
Comment: The stated scope of the assessment identified on p. ES-1 is: "This assessment reviews, analyzes, and synthesizes available information on the potential impacts of large-scale mining development on Bristol Bay fisheries and subsequent effects on the wildlife and Alaska Native cultures of the region."It is not clear on this page or throughout the report how loss of length of streams or area of habitat was estimated, and relating these losses directly to effects on fish production (i.e., the stated scope of this assessment).
Recommended Change: Better describe how stream/habitat losses are estimated and specifically make the connections to the resulting potential impacts on fish production.

Report Section Identification: Executive Summary
Report Page Number: ES-14—ES-22
Comment: Although EPA attempts to describe the mine in terms of no-failure, they do not mention

this in terms of the probability that no failure will occur. Instead, EPA describes the impacts of a no failure operation, as well as the probabilities of failure and subsequent impacts from a catastrophic failure. EPA implies that failure is certain because tailings dams are "in place for hundreds to thousands of years." EPA does not describe the probability of the mine operating and closing without a major failure. If there is a probability of the occurrence of an event, P_e, then the probability of the event not occurring is $1-P_e$. Consequently, for any low probability event, there is a complementary high probability that the event will not occur. For example, if the probability of a "failure" is 0.0001 per year, the probability for "success" (no failure) is 0.9999 per year; in other words, each year there is a 99.99% chance that no failure will occur.

Report Section Identification: Main Report, Executive Summary, Overall Risks to Salmon and Other Fish
Report Page Number: ES-15 (Bullet 5)
Comment: Specifying that sockeye are "particularly at risk to impacts from the road" understates the impacts to all fish that utilize streams that would be crossed by a potential road. Most of the east side Lake Iliamna drainages support spawning coho salmon and the Iliamna River supports five species of Pacific salmon. Further, many other important anadromous and resident fish are found in area streams that would be crossed by a potential road. While the assessment focus appears to be on sockeye salmon, impacts to other fish from a potential road could be significant.
Recommended Change: EPA needs to clarify that possible roadway effects would apply to all fish species present.

Report Section Identification: Vol 1 Executive summary
Report Page Number: Page ES-15 (Pg 37 of 339)
Comment: The third bullet says: "Water treatment and reduced passage through groundwater flow paths could increase summer water temperatures and decrease winter water temperatures, making streams less suitable for salmon, trout, and char." The opposite could also occur, i.e. cooler dewatering ground water could reduce summer temperatures; it would also be warmer than surface waters in the winter so may increase winter river temperatures.

Report Section Identification: Vol 1 Executive summary
Report Page Number: Page ES-21 (Pg 43 of 339)
Comment: Says: "Pre-Tertiary waste rocks, which would be excavated to expose the ore body, are acid-forming with high copper concentrations in test leachates and would require 2,900 to 52,000-fold dilution to achieve water quality criteria." These values need to be verified, see comment on page 5-49 through 5-55. For the biotic ligand model Pre-Tertiary waste rock leachates would require from 2,900- to 52,000-fold dilution. To meet State chronic water quality criterion the leachates would require from 280- to 580-fold dilution. The State has not conducted an evaluation as to whether the biotic ligand model is necessary to protect aquatic life nor has any state fully adopted this method for setting federally-required water quality standard statewide for copper. The biotic ligand model is particularly sensitive to low pH and low dissolved organic carbon values. Basing downstream risk solely on pre-Tertiary leachate does not consider the kinetics of acid generation and does not take into consideration the changes in pH and dissolved organic carbon that

occur with downstream mixing or scouring (i.e., during a catastrophic dam failure) in the creek and in the lake. These relationships are non-linear. The use of the biotic ligand model results may well overly exaggerate the calculation of needed dilution for copper.
Recommended Change: Verify accuracy of values based on comment for pages 5-49 through 5-55. This statement should identify the physical and chemical mechanism assumptions and should, at a minimum, reflect State of Alaska Water Quality Standards for copper. Reference to the biotic ligand model for copper should be disclosed along with its sensitivity to low pH and low dissolved organic carbon.

Report Section Identification: Vol 1 Executive summary
Report Page Number: Page ES-21 (Pg 43 of 339)
Comment: Says: "a potentially large mixing zone in the lake…" "Mixing zone" has a specific regulatory connotation that varies depending on whether it is permitted or unpermitted. As cited in the assessment on page 5-48, "Based on Alaskan Water Quality Standards (18 Alaska Administrative Code [AAC] 70), no mixing zones would be authorized for anadromous streams or spawning habitat for most game or subsistence fish species, so it is expected that effluents would be required to meet criteria (i.e., no exemptions would be granted)."
Recommended Change: To avoid having different readers reach different conclusions, suggest greater specificity as follows: "a potentially large, unpermitted mixing zone in the lake" or "a potentially large affected area ~~mixing zone~~ in the lake."

Report Section Identification: Executive Summary
Report Page Number: Page ES-23, Fish-Mediated Risk to Indigenous Culture
Comment: The impacts to fisheries resources that consequently impact indigenous cultures, does not include assessment of secondary mine development and infrastructure (towns, roads, utilities, social-political impacts). These secondary mine development and infrastructure could have the potential to be as significant an impact on indigenous cultures as the mine-to-fish impacts on indigenous cultures.
Recommended Change: An expanded mine scenario should be included to include secondary mine development and infrastructure and associated impacts to understand the full scope of cumulative effects.

Report Section Identification: Executive Summary Fish-Mediated Risk to Wildlife
Report Page Number:ES-23
Draft Comment: Aside from fish mediated risks to wildlife, it might also be pertinent to discuss other issues impacting wildlife including elimination or change in habitat due to avoidance or attractive nuisances of the mine.
Draft Recommended Change: Discuss elimination or change in wildlife habitat due to avoidance or attractive nuisances of the mine.

Report Section Identification: Executive Summary
Report Page Number: Page ES-26, Summaries of Uncertainties in the Assessment

Comment: A significant amount of uncertainty in the study is the lack of baseline data to perform the required studies.
Recommended Change: The study should outline data and study methods, available data and data needs required to fully understand the impacts of the single and multiple mine proposals in the Bristol Bay watershed(s).

Report Section Identification: Executive Summary, Summary of Uncertainties and Limitations in the Assessment
Report Page Number: ES-26, bullet 3, last sentence
Comment: Overly simplistic to believe that "Estimated effects of mining on habitat become the available surrogate for estimated effects on fish populations." There are many examples showing fish habitat is not a good measure of fish abundance or population dynamics.
Recommended Change: Consider including ways to assess and/or gather insights into fish abundance and population dynamics that are less cumbersome than those stated in the report and better than habitat surrogate.

Report Section Identification: Volume 1 Chapter 1 Introduction
Report Page Number: 1-2
Comment: Given that it is reported in the assessment that revenues from the Pebble mine have been estimated at between $300 billion and $500 billion over the life of the mine, it is feasible to include additional economics regarding the impacts this type of development has already had in the region. The Alaska Mineral Industry Report includes the amount of money reportedly spent annually by the Pebble Limited Partnership (PLP) on the Pebble project for 2006 –2010. (Information regarding the exploration began to be reported starting in the report for 2001, reporting for 2004 included the expenditures related to a contract awarded to an Alaskan company, and the 2005 report notes the amount spent on environmental studies and community outreach.) The following information should be included in quantifying the ongoing financial, economic and other contributions made through the project in your economic assessment as your have done for the fishing industry. It should be noted that the money spent by PLP for 2009 and 2010 is not a 1:1 of what will be spent annually throughout the life of the mine. That detail has not been clarified in the economics presented for the fishery. In 2010, "The Pebble copper–gold–molybdenum project remained the largest exploration project in Alaska. Northern Dynasty Minerals Ltd. reported that the Pebble Partnership spent $73 million on the Pebble project in 2010, with $21 million spent on engineering studies, $28 million on drilling, and $24 million on environmental and socioeconomic studies." (Szumigala, 2011) In 2009, "The Pebble copper–gold–molybdenum project remained the largest exploration project in Alaska, with an announced 2009 budget of $70 million. The budget, approximately 50 percent of the project's 2008 budget, included $20 million for drilling, $14 million for environmental studies, and $36 million for engineering, cultural, community outreach, and other prefeasibility studies. Approximately $452 million has been spent on exploration at the Pebble project by Northern Dynasty Minerals Ltd., Anglo American Exploration (USA) Inc., and Pebble Limited Partnership

from 2000 through 2009." (Szumigala, 2010) Additionally, the Alaska Department of Labor and Workforce Development reported that nearly three-quarters of all wage and salary earnings from mining stay within the state due to Alaska residents making up about three quarters of all workers in the mining industry in their October 2010 issue of Alaska Economic Trends.
Draft Comment Reference: Szumigala, D.J., Harbo, L.A., and Adleman, J.N., 2011, Alaska's mineral industry 2010, 83 p., p. 29. Szumigala, D.J., Harbo, L.A., and Hughes, R.A., 2010, Alaska's mineral industry 2009, 81 p. p. 18 Shanks, A., Abrahamson, M. and L. Baron. Alaska's Mining Industry in *Alaska Economic Trends October 2010*. State of Alaska Department of Labor and Workforce Development, Research and Analysis Section.. pp. 4-11. p. 6.

Report Section Identification: 1.0
Report Page Number: 1-2
Comment: Leaving out an economic cost/benefit analysis omits significant decision criteria.
Recommended Change: Conduct or take into account economic costs/benefits.

Report Section Identification: 1.0
Report Page Number: 1-2
Comment: The page states that the revenues from the mine have been estimated to be between $300 billion to $500 billion over the life of the mine. This text should be included in the Executive Summary to provide contrast to the economics of the Bristol Bay watershed.
Recommended Change: Incorporate this text into the Economics section of the Executive Summary.

Report Section Identification: 2.1 Introduction to Bristol Bay Region, Figure 2-1
Report Page Number: 2-2
Comment: "Their" in figure caption should not be capitalized.

Report Section Identification: 2.0 and Throughout
Report Page Number: Multiple
Comment: No reference to, or consideration of, winter freezing or permafrost is provided in the risk assessment. Winter ice and permafrost both have potentially dramatic implications in seasonal groundwater flow, particularly shallow groundwater.

Recommended Change: Provide section of the report, or include in a new groundwater section, the potential/likely influence of winter freeze and/or permafrost on groundwater volume, flow, and stream recharge potential. Incorporate this information into estimations of stream recharge and groundwater flow into and through mining pit and Tailings Storage Facilities.
Comment Reference: http://pubs.usgs.gov/fs/2011/3133/

Report Section Identification: 2.0, 4.0, and Executive Summary
Report Page Number: Multiple
Comment: The report is lacking information on regional hydrogeology, local hydrogeology, groundwater and surface water interaction. A mine of this size could greatly impact the water balance in the area. A more detailed understanding of the above area is needed.
Recommended Change: Provide a hydrogeological analysis on the watershed. The report should include regional and local geology and hydrogeology, and surface water and groundwater interaction as well. Provide cross-section, logs, lithologies, groundwater levels, and hydrographs of the aquifers. Provide estimation of hydraulic parameters for the aquifers.

Report Section Identification: 2.0 and 4.3.7
Report Page Number: Multiple
Comment: High seasonal fluctuations exist in the mine area as shown in Figure 2-7, page 2-23. However, the seasonal effects were not adequately considered in the water balance estimation. Frozen conditions would have a major impact on flows in creeks and runoff. Peak seasonal precipitation and snow melt would also have a major impact on the water balance. Water balance estimated with averaged precipitation (as in Box 4-2, page 4-28) will not represent the seasonal field conditions.
Recommended Change: Provide temporal and seasonal fluctuation of rainfall, stream flow, and groundwater level. Evaluate the mining impact on water balance under long term average condition and high seasonal flow condition.

Report Section Identification: 2.0
Report Page Number: 2-1 through 2-26
Comment: While some description of the regional conditions is warranted, much of Chapter 2 is irrelevant to assessing impacts of a mine at the Pebble deposit.

Report Section Identification: Chapter 2
Report Page Number:2-1 through 2-26
Draft Comment: This chapter is lacking sufficient detail expectant of a discussion of current conditions, more appropriately referred to as background or baseline conditions. The area's biodiversity instead is generalized in tables and figures. There is no discussion of current water quality for each of the 17 hydrogeologic areas nor any habitat mapping, biological survey information, and threatened or endangered information.

A more in-depth evaluation of wildlife is provided by U.S. Fish and Wildlife in Appendix C and should be referenced more prominently in this chapter.
Draft Recommended Change: Include additional information describing current (baseline) conditions and reference Appendix C more prominently.

Report Section Identification: Chapter 2.
Report Page Number: 2-1
Draft Comment: In the context of risk assessment terminology, characterization of current condition is typically referred to as background or baseline conditions.
Draft Recommended Change: Change in chapter title

Report Section Identification: 2.1
Report Page Number: Page 2-2
Comment: This page shows that the Togiak, Naknek, Egegik and Ugashik watersheds are completely isolated from any of the mine drainages and could not be affected by the mine in any way yet nowhere in the text is this mentioned, especially when discussing the value of the fisheries, Native cultures, and direct impact to neighboring villages.
Recommended Change: The text in the executive Summary and in Chapter 2 should point out that these watersheds could not be affected by the mine and that they represent approximately xx% of the population of the Bristol Bay region and xx% of the economy.

Report Section Identification: 2.1 to 2.2.1
Report Page Number: 2-2, 2-4, 2-5 and 2-12
Comment: The Figures on these pages exaggerate the area of the Pebble Deposit. The legend states that the area in red is the approximate area of the Pebble Deposit. A more accurate way to present this is the "Likely Maximum Disturbed Area of the Pebble Mine". Using Figure 2-2 as an example of all of these figures. It could be argued that this scale is too small to accurately show the area, but perception of these figures is easily swayed and it is important as people form their opinions of the impacts. The maximum mine disturbance from the map of Page ES-17 is approximately 30.8 square miles, while the map of Figure 2-2 shows 116.4 square miles, based on the scale of the map.
Recommended Change: The figures above should be revised to show Likely Maximum Disturbed Area of the Pebble Mine, reflecting the smaller area. The actual area should be shown on each figure.

Report Section Identification: 2.1 Introduction to the Bristol Bay Region
Report Page Number: 2-3
Comment: The document states that "the great majority obtain most of their food resources from subsistence, fishing, hunting, and gathering". There are several studies that show this is not the

case. One report published by the International Journal of Circumpolar Health Titled: The Dietary Intake of Alaska Native People, concluded 21 % of calories, 46 % of protein, and 3 % of carbohydrates came from traditional Alaska Native foods. This study was limited to only two regions of rural Alaska but there are other studies that could be referenced that came to similar conclusions.
Recommended Change: The document should include scientific peer reviewed facts for this statement.

Report Section Identification: Sections 2.2 and 6.6
Report Page Number: All pages within the identified sections
Comment: Sections 2.2 and 6.6 discuss Alaska Native Cultures and the Effects on Human Welfare and Alaska Native Cultures. According to the report "because the cultures are subsistence-based and reliant on salmon in particular, any negative impact on salmon quality and/or quantity resulting from failures or accidents should be assumed to cause a negative impact on human health and welfare, both directly from loss or change in food resources, and indirectly from disruption to an integral part of the culture." The report goes on to discuss how subsistence is important for Alaska Natives, especially salmon. According to the Alaska Department of Fish and Game Division of Subsistence update of subsistence economies in Alaska 2010, which is available to the public on the Department's website, just over half of the harvest of wild foods in Bristol Bay is salmon. This important resource is used by the region's diverse population (Alaska Natives and others). Although communities in Bristol Bay are dominantly Alaska Native, these communities do have a more complex demographic and all residents rely on wild resources, especially salmon. According to the U.S. Census in Dillingham, the region's largest community, 68% of the population is Alaska Native.
Recommended Change: This report should take into account how subsistence, especially salmon is important for all residents of the region. Many non-Alaska Native peoples in Bristol Bay have lived in the area for multiple generations.

Report Section Identification: Sections 2.2 and 6.6; Appendix D
Report Page Number: All pages within the identified sections
Comment: The watershed assessment report further says that "It is not possible to quantify the magnitude of subsistence resources that would be lost." The ADF&G, Division of Subsistence has conducted extensive research in the Bristol Bay Watershed, and has conducted research specifically at quantifying the harvest of wild resources. Appendix D of this report does reference some of these reports including the Alaska Subsistence Salmon Fisheries 2005 Annual report (Fall, Caylor et al. 2007), An Overview of Subsistence Fisheries in the Bristol Bay Management Area (Fall, Krieg et al. 2009), the Kvichak Watershed Subsistence Salmon Fishery: An Ethnographic Study (Fall, Holen et al. 2010), and 2 of the 5 baseline studies that were conducted specifically for the Pebble Project (Fall, Holen et al. 2006; Krieg, Holen et al. 2009). Although the data from these studies were used in compiling Appendix D, staff at the Division of Subsistence were not consulted for this assessment; it appears as a result that the authors failed to consult several important recent publications including both technical papers and articles that are also necessary for understanding the complexity of subsistence and the intersection of subsistence and culture in the Bristol Bay region (Holen, Krieg et al. 2005; Krieg, Chythlook et al. 2005; Fall, Brown et al. 2009; Fall, Brown

et al. 2009; Holen 2009; Holen 2009; Holen and Lemons 2010; Fall, Brown et al. 2011; Holen 2011; Holen 2011; Fall, Braem et al. 2012; Holen 2012). Consultation with Division of Subsistence staff would also have alerted the authors to a key source of local and traditional knowledge (LTK) about salmon in the Bristol Bay Area: From Neqa to Tepa, Łuq'a to Chuqilin: A Database with Traditional Knowledge about the Fish of Bristol Bay and the Northern Alaska Peninsula, which is available on CD from the division.

Recommended Change: Authors of these sections of the watershed assessment should consult with the ADF&G, Division of Subsistence to ensure an accurate and complete depiction of the complexity of subsistence and the intersection of subsistence and culture in the Bristol Bay region.

Draft Comment Reference: Fall, J. A., N. Braem, et al. (2012). Alaska subsistence salmon fisheries 2009 annual report. Technical Paper No. 373. Anchorage, Alaska Department of Fish and Game, Division of Subsistence.

Fall, J. A., C. Brown, et al. (2011). Alaska subsistence salmon fisheries 2008 annual report. Technical Paper No. 359. Anchorage, Alaska Department of Fish and Game, Division of Subsistence.

Fall, J. A., C. Brown, et al. (2009). Alaska subsistence salmon fisheries 2006 annual report. Anchorage, Alaska Department of Fish and Game Division of Subsistence Technical Paper No. 344.

Fall, J. A., C. Brown, et al. (2009). Alaska subsistence salmon fisheries 2007 annual report. Anchorage, Alaska Department of Fish and Game Division of Subsistence Technical Paper No. 346.

Fall, J. A., D. Caylor, et al. (2007). Alaska subsistence salmon fisheries 2005 annual report. Juneau., Alaska Department of Fish and Game, Division of Subsistence Technical Data Report No. 318.

Fall, J. A., D. Holen, et al. (2010). The Kvichak watershed subsistence salmon fishery: An ethnographic study. Technical Paper No. 352. . Anchorage, Division of Subsistence, Alaska Department of Fish and Game.

Fall, J. A., D. L. Holen, et al. (2006). Subsistence harvests and uses of wild resources in Iliamna, Newhalen, Nondalton, Pedro Bay, and Port Alsworth, Alaska, 2004. Juneau., Alaska Department of Fish and Game, Division of Subsistence Technical Data Report No. 302.

Fall, J. A., T. Krieg, et al. (2009). An overview of subsistence fisheries of the Bristol Bay management area. Anchorage, Alaska Department of Fish and Game.

Holen, D. (2009). "The dynamic context of cultural and social sustainability of communities in Southwest Alaska." Journal of Enterprising Communities 3(3): 306-316.

Holen, D. (2009). "A resilient subsistence salmon fishery in Southwest Alaska." Journal of Northern Studies 2: 99-113.

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Holen, D. (2011). "We all drink this water:" The contemporary context of salmon fishing in Southwest Alaska. Humanizing security in the Arctic. D. Michelle, F. Levesque and J. Ferguson. Edmonton, Canadian Circumpolar Institute: 191-208.

Holen, D. and T. Lemons (2010). Subsistence harvests and uses of wild resources in Lime Village, Alaska, 2007. Division of Subsistence Technical Paper No. 355. Anchorage, Division of Subsistence, Alaska Department of Fish and Game.

Holen, D., Theodore Krieg, Jory Stariwat, and Terri Lemons (2012). Subsistence harvests and uses of wild resources in Aleknagik, Clark's Point, and Manokotak, Alaska, 2008. Technical Paper No. 368. Anchorage, Division of Subsistence, Alaska Department of Fish and Game.

Holen, D., Theodore Krieg, Terri Lemons (2011). Subsistence harvests and uses of wild resources in King Salmon, Naknek, and South Naknek, Alaska, 2007. Technical Paper No. 360. Anchorage, Division of Subsistence, Alaska Department of Fish and Game.

Holen, D. L., T. Krieg, et al. (2005). Harvests and uses of caribou, moose, bears, and Dall sheep by communities of Game Management Units 9B and 17, Western Bristol Bay, Alaska 2001-2002. Juneau., Alaska Department of Fish and Game, Division of Subsistence Technical Data Report No. 283.

Krieg, T., M. Chythlook, et al. (2005). Freshwater fish harvest and use in communities of the Kvichak watershed, 2003. Juneau., Alaska Department of Fish and Game, Division of Subsistence Technical Data Report No. 297.

Krieg, T., D. Holen, et al. (2009). Subsistence harvests and uses of wild resources in Igiugig, Kokhanok, Koliganek, Levelock, and New Stuyahok, Alaska, 2005. Dillingham, Alaska Department of Fish and Game, Division of Subsistence Technical Paper No. 322.

Report Section Identification: Table 2-2
Report Page Number: 2-7
Comment: The table title "…as a Percentage of Entire Watershed Area" is misleading, as the rows (which sum to 100 percent) are for sub-areas of the two watersheds (Nushagak and Kvichak). .
Recommended Change: Recommend revising the table title.

Report Section Identification: 2.2
Report Page Number: 2-8
Comment: The Figure shows pictures of various rivers and lakes in the Bristol Bay region, many of which would not be affected by the mine in any way according to the maps provided throughout the Bristol Bay Watershed Assessment however, the actual stream sections that would be blocked or eliminated are not included.
Recommended Change: The figure above should be revised (or a new figure added) to show the actual stream sections that would be blocked or eliminated by the mine.

Report Page Number: 2-9
Comment: Only resident, non-anadromous Dolly Varden are considered in the assessment but there are significant anadromous Dolly Varden populations in the Kvichak and Nushagak watersheds.
Recommended Change: Consider incorporating anadromous Dolly Varden of the Kvichak and Nushagak watersheds in the assessment.

Report Section Identification: 2.2
Report Page Number: 2-10
Comment: The Table 2-3 on this page shows the surveyed stream lengths occupied by each major fish species. Nothing is mentioned about the lengths that would be blocked or eliminated by the two mine scenarios.
Recommended Change: The Table should be revised to include additional columns of the actual stream lengths occupied that would be affected by the two mine scenarios, and the % of the total.

Report Section Identification: 2.2.1 Pacific Salmon Populations
Report Page Number: Page 2-12, Figure 2-5 (and ES-3, Figure ES-1) The Nushagak and Kvichak Watersheds of Bristol Bay
Comment: The black dots represented as Native villages are not shown in legend.
Recommended Change: The figure should include in the legend the black dots representing the villages (Native communities).

Report Section Identification: 2.2.1 Pacific Salmon Populations
Report Page Number: Pages 2-13, Figure 2-6 - Average Annual Relative Fish Abundance
Comment: The figure 2-6b (and ES-4b) shows relative average annual fish abundance in the Bristol Bay Watershed. The figure does not show each of the six separate watersheds, and combines Nushagak, Kvichak, Naknek watersheds.
Recommended Change: Show each of the six Bristol Bay watersheds including the Togiak, (splitting out the Nushagak, Kvichak, Naknek), Egegik, and Ugashik Rivers. Also, highlight which watersheds (Nushagak, Kvichak) will be directly impacted by the mine scenario.

Report Section Identification: Sections 2.2.2 and 2.2.3
Report Page Number:2-15 through 2-17
Draft Comment: Consideration of threatened or endangered species is an important aspect of the ecological risk assessment, but yet they are not are not discussed in these sections.
Draft Recommended Change: List known of suspected threatened species within the study area.

Report Section Identification: 2.2.2 Resident Fish Populations, Table 2-5
Report Page Number: 2-15
Comment: Table 2-5 needs to be updated with the latest published information. The table characterizes sport catch and harvest from 2003-2007, but there are more recent published data that should be used (through 2010).
Recommended Change: Update Table 2-5 to most recent catch and harvest data per the reference below.
Draft Comment Reference: Updated data are available from Jennings, G. R., K. Sundet, and A.E. Bingham. 2011. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2010. Alaska Department of Fish and Game, Fishery Data Series No. 11-60, Anchorage.

Report Section Identification: 2.2.3 Wildlife Populations
Report Page Number: 2-15
Comment: Wildlife populations are described as generally "large." ADF&G does not know what that is supposed to mean. Moose densities are often low, and caribou numbers are low compared to the 1990s.
Recommended Change: Describe what is meant by "large"

Report Section Identification: 2.2.3 Wildlife Populations
Report Page Number: 2-16
Comment: The 2008 caribou estimate is listed as 30,000. It should be 30,000-40,000.
Recommended Change: Include the estimate range.

Report Section Identification: Section 2.2.3
Report Page Number: 2-16
Draft Comment: Text states that the Mulchatna caribou herd spends a considerable amount of time in other watersheds. Approximately how much time does the Mulchatna caribou herd spend in the Nushagak and Kvichak River watersheds?
Draft Recommended Change: Specify how much time the Mulchatna caribou herd spends in the Nushagak and Kvichak River watersheds as compared to other watersheds in the Bristol Bay watershed. This information might be presented as a fractional use estimate.

Report Section Identification: 2.2.4
Report Page Number: 2-17
Comment: If the total estimated annual salmon ecosystem direct expenditures is $479.6 million that should be put in context with the value of the mineral resources in the same area.

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Report Section Identification: 2.3.1
Report Page Number: 2-20
Comment: If Bristol Bay has 90,000 km of streams and Nushagak and Kivichak have 58,000 km of streams, those numbers should be compared with the km of streams that would be impacted by the mine to give perspective on the percentage of the area that could be impacted by mining. Table 5-3 in chapter 5 lists 61.4 km streams eliminated by footprint for minimum mine size, and 125.1 km for maximum mine size. 125.1/90,000 = 0.1 percent.

Report Section Identification: Main Report, Section 2.3.2, Groundwater Exchange and Flow Stability, 1st paragraph
Report Page Number: 2-21
Comment: While the statement "Densities of salmon-supporting streams tend to be lower in regions with lower permeability and less extensive exchange between groundwater and surface water" may be true, the references used (Johnson and Blanche 2011, ADFG, 2012) don't support that assertion.
Recommended Change: EPA needs to use appropriate references to support the assertion.

Report Section Identification: 2.3.2 Groundwater Exchange and Flow Stability
Report Page Number: 2-21
Comment: The second part of the first sentence in the second paragraph is not supported in the document by any hydrogeologic data or information. As it stands, the reader must accept the premise that these glacial soils actually exist and have high permeabilities.
Recommended Change: The report should contain at least a minimal amount of hydrogeologic data to support this statement. These could include geologic and hydrogeologic cross-sections, and hydraulic conductivity results.

Report Section Identification: 2.3.2 Groundwater Exchange and Flow Stability
Report Page Number: 2-21
Comment: The use of the word "tight" in paragraph 2 of this section is potentially misleading, and is not technically used for describing the hydraulic connection between surface and ground waters. In hydrogeology, the word "tight" is more commonly used to describe the permeability (hydraulic conductivity) of a soil or rock. A "tight" soil would not normally result in a good hydraulic connection between a river and aquifer, which is the apparent intent of the sentence.
Recommended Change: Recommend replacing the word with an appropriate hydrogeologic descriptive term.

Report Section Identification: 2.3.2 Groundwater Exchange and Flow Stability
Report Page Number: 2-21; 2-23 (Figure 2-7)
Comment: The third paragraph discusses the relative stability of the Pebble area streams and baseflow, and Figure 2-7 charts data for several rivers and streams using gage data. The chart y-axes show "runoff in mm". The relationship between this metric and groundwater contribution to

the river/stream is not adequately described, and the baseflow component (versus other sources) of the hydrographs is not defined. Also, "high baseflows" is a relative term that can only be put in context if compared to flows in other similar systems.
Recommended Change: Recommend revising the figures to more clearly illustrate the relationship between the gage data and the baseflow component. Also, some discussion of the time periods used and any statistical bias between data sets of different durations is warranted.

Report Section Identification: 2.3.5 Ecosystem Integrity
Report Page Number: 2-25
Comment: The document states " the primary human manipulation of the Bristol Bay ecosystem is the marine harvest of approximately 70 % of salmon returning to spawn" This level of harvest of a salmon resource suggests there is substantial opportunity to mitigate minor or temporary impacts from other human activities. The document goes into lengthy details of a perceived impact from a hypothetical mine using numerous assumptions but ignores the current impact to the salmon resource from the excessive by-catch by the marine commercial fishing industry. The document fails to adequately address the already significant impact to the salmon resource by human activities and that the marine harvest could be manipulated to increase uses for subsistence users.
Recommended Change: The document could address the substantial opportunity to manage and mitigate minor or temporary losses in salmon resources by actively managing the marine harvest to increase the availability of the resources to subsistence users as is already being done to account for excessive by-catch and other impacts.

Report Section Identification: 2.4 Bristol Bay and Salmon Stocks at a Global Scale
Report Page Number: Page 2-25
Comment: Last paragraph states "The status of Pacific salmon throughout the United States highlights the value of the Bristol Bay watershed as a salmon sanctuary or refuge." Use of the term sanctuary or refuge infers a designated legally protected status of the watershed and bay.
Recommended Change: This comment likely warrants additional consideration, investigation, and reporting on legalities and/or financially feasible option for a conservation area or refuge for the region.

Report Section Identification: 3.3
Report Page Number: 3-2
Comment: The endpoints 2, 3, and 4 are essentially glossed over, while endpoint 1 is not well related or scaled to represent the likely site-specific impacts of the Pebble mine. The conclusions of this document is used to directly assess impacts of the mine without an in depth consideration and quantification of site-specific actions and impacts.

Report Section Identification: 3.0
Report Page Number: 3-2
Comment: Omitting mine worker housing and other related mine operation infrastructure is significant. This could be the biggest city in the entire Bristol Bay region with 2000 or more

residents.
Recommended Change: Incorporate the development of a mine personnel living quarters should be considered into the risk assessment

Report Section Identification: 3.0
Report Page Number: Entire section, including the conceptual model
Comment: This section does not serve the normal purpose of a typical problem formulation. The primary purpose of problem formulation is to focus the risk assessment. This lack of focus is exemplified by the conceptual models on pages 3-7 through 3-11 that seem to present every conceivable issue, rather than just what is to be the focus of the risk assessment.
Recommended Change: Problem formulation should start with a discussion of the array of issues, and then through site-specific knowledge provide logical winnowing of issues to those that are most important. It would be okay to put the existing conceptual models at the beginning of the section as the universe of issues. Then through problem formulation discuss what is important and will be addressed in the risk assessment. The conceptual models at the end of the section should then reflect the most important issues and aspects of each issue. This elimination of some issues is particularly important for the Bristol Bay Watershed Assessment, which actually glosses over many smaller issues to focus on those that are most significant. Yet the provided conceptual model is not representative what could or should be investigated.

Report Section Identification: 3.1 Type of Development and 7.4.5 Effects of Secondary Development
Report Page Number: Page 3-1; Page 3-8, Figure 3-2b; and Page 7-15
Comment: Report Section 3.1, mine type of development states *"Certain activities associated with mining, but not directly related to mine operations, are not considered in this assessment. These include support activities such as housing workers and disposing of their wastes, power generation and transmission, construction and operation of a deepwater port at Cook Inlet, and secondary development (i.e., development that is not part of the mine project, but for which the mine project provides the impetus or opportunity, such as rural recreation or residential and commercial growth resulting from improved access). Exclusion of an activity from this assessment does not imply that it would be benign or have no effect on the environment, and many of these activities could have significant repercussions for the Bristol Bay ecosystem. The assessment focuses on activities directly associated with mine development, operation, and maintenance, which are most likely to have significant effects on the region's fish populations (Section 3.3)."* Report Section 3.6, Conceptual Models (Figure 3-2b) shows secondary development, housing and construction activities. Report Section 7.4.5 Effects of Secondary Development discusses the less significant effects of secondary development (on fish resources). The report study approach focuses on impact potential to the regions fisheries, and inferring impacts to the Native and indigenous cultures. The approach likely understates or underestimates the social-political and Native community effects secondary development may have beyond the

direct fish to cultural impacts on Native and indigenous cultures.
Recommended Change: In order to evaluate cumulative impacts, a detailed analysis and cumulative effects analysis of additional proposed mine claims, as well as secondary mine development for mine towns, energy, utilities, road/transportation, ports and ore transport route risks, will need to be addressed to understand watershed and fisheries impacts and indigenous culture impacts. Secondary mine development impacts, especially social-political and economic impacts on Native, and indigenous, subsistence living cultures could be significant. For example, while grants and loans can be obtained to support building local infrastructure projects, the economic health of the community to maintain the infrastructure is often the limiting factor in many Alaska Native and rural communities. An overall improvement in the local economy would allow for drinking water and sanitation projects that are currently uneconomic for local communities to maintain. Need to understand the entirety of long term mine development proposals and their cumulative effects.

Report Section Identification: 3.1 Type of Development
Report Page Number: Pages 3-1 and 3-2
Comment: The report states that the study focuses on mine operation activities only, as they pose the greatest potential for impacting salmon habitat. Multiple mines and secondary developments (including residential/commercial development, power, water/wastewater, roads, goods and services) likely have significant potential to impact both salmon habitat and Native indigenous cultures than is assumed in the report, especially in a near "pristine" watershed.
Recommended Change: Mine scenario should include evaluation of watershed development as a result of mine construction for all likely proposed mines to adequately address cumulative impacts to salmon fisheries and Native indigenous cultures.

Report Section Identification: 3.3 Endpoints
Report Page Number: Pages 3-4
Comment: This page states that the study limits the scope of the watershed assessment to the Nushagak and Kvichak River watersheds. This approach is acceptable in limiting the extents of the study, and then relating the impacts to the overall Bristol Bay Watershed. The report should refer to Bristol Bay watershed impacts, but not attempt to evaluate the baseline and impacts to the entire watershed.
Recommended Change: This discussion should be highlighted and brought forward in the introduction and executive summary. The sheer size/scale of the watershed cannot be fully studied. Therefore an expanded discussion of how a study would be performed by evaluating critical basins, namely focusing on the Nushagak and Kvichak River watersheds, and then relating the linkages and impacts to the larger Bristol Bay Watershed.

Report Section Identification: 3.5 Types of Evidence and Inference
Report Page Number: Page 3-5
Comment: The risk assessment approach using types of evidence and inference, conceptual modeling and characterization of risks by the lines (or multiple lines) of evidence is appropriate for generally understanding and scoping the watershed risk assessment. Higher risk (probability)

failure or impact effects will likely require additional studies and numerical modeling to refine and better understand and quantify project risks and uncertainties.
Recommended Change: The study should outline what additional data, studies and numerical models would be appropriate to evaluate higher risk mine elements (i.e. tailings facilities failures), that would be appropriate to support a comprehensive watershed assessment and risk analysis, and will prepare agencies and lay the groundwork for future mine permit studies.

Report Section Identification: Main Report, Section 3.5, Types of Evidence and Inference
Report Page Number: 3-5
Comment: In the first paragraph, EPA suggests "potential mitigation measures" were considered. Aside from the efficacy of mitigation discussion in Appendix G, we found little evidence of mitigation measures being considered and incorporated into the assessment.
Recommended Change: EPA needs to be clear how potential mitigation measures were considered in the watershed assessment.

Report Section Identification: 3.6 Conceptual Models
Report Page Number: Page(s) 3-6 through 3-11, Figures 3-2A through 3-2E
Comment: The conceptual models attempt to evaluate the entirety of potential mine impacts on fisheries habitat by phase (mine development and operation, and then during closure). The models are complex and difficult to interpret, and they do not demonstrate the potential scales of risks (i.e. high probability and small impact area or high probability and large impact area) nor the spatial aspects of the risks, or scale of impacts, all of which are related to fish habitat impacts.
Recommended Change: Recommend breaking out the conceptual models by major impact types as described in the No-Failure and Failure scenarios, and evaluating spatial distribution of impacts on fisheries habitat by showing the impacted stream habitat using GIS maps and spatial analyst techniques. Breaking these out will help understand the risks, and allow for overlaying the various risks and impacts in a spatial context. This type of presentation will allow for meaningful communication of the potential impacts to both a broad public audience, as well as a highly technical audience and reviewers.

Report Section Identification: Vol 1 Section 3.6
Report Page Number: Page 3-7
Comment: There should be a box for waste rock under the Underground Mining and Open Pit Mining boxes.

Report Section Identification: Figure 3-2A: Conceptual Model Illustrating Potential Habitat Effects Associated with Mine Construction and Operation; Figure 3-2B and 3-2C.
Report Page Number: 3-7, 3-8, 3-9
Comment: Every possible impact is provided, but no relative judgment is provided as to what is most important, and to be assessed in the Bristol Bay Watershed Assessment. Authors are suggesting everything is just "bad" and it is all going to occur regardless of the degree of potential impact, frequency and possible mitigation methods.

Recommended Change: Provide more specific conceptual models that show how/why certain items are more important than others and are to be included for assessment in the Bristol Bay Watershed Assessment.

Report Section Identification: Vol 1 Section 3.6
Report Page Number: Page 3-9
Comment: There should be a box in the figure that depicts filling the pit with water and the lack of dewatering water to maintain river flows.

Report Section Identification: Vol 1 Section 3.6
Report Page Number: Page 3-10 (Pg 88 of 339)
Comment: Change "slurry transport" to "slurry and return water transport"

Report Section Identification: Vol 1 Section 3.6
Report Page Number: Page 3-10
Comment: Maybe add a box in figure for "waste rock" which could leach metals and change other parameters, becoming more acid generating than predicted.

Report Section Identification: Volume 1 Chapter 4 Mining Background and Scenario and 4.3.3 Mine Operations, and 4.3.9.1 Transportation Corridor Roads
Report Page Number: 4-1, 4-19 and 4-34, respectively
Comment: "Described mining practices and our mine scenario reflect the current practice for porphyry copper mining around the world, and represent current good, but not necessarily best, mining practices. " "Based on standard mining practices, we assume that drill and blast methods would be used to excavate the rock, at a processing rate of approximately 200,000 metric tons/day for both the minimum and maximum mine sizes (Table 4-3)." "Material sources for road embankment fill, road topping, and riprap would be available at regular intervals along the road route, and we assume standard practices for design, construction, and operation of the road infrastructure, including design of bridges and culverts for fish passage." Why are standard but not best practices assumed in the scenario? It is reasonable to assert that practices better than current best practices will be in place for any mine development in the region given the advances in technology and engineering that are likely between now and the date of construction and actual mining.

Report Section Identification: Chapter 4
Report Page Number: 4-1
Comment: EPA uses basic concepts of engineering features in general descriptions of a broad

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assortment of technical issues related to tailings dams and mining. For example, tailings dams are described as being upstream, centerline, or downstream fill. Such elementary level descriptions defy technical review because of the lack of specific information. There are no conceptual designs, site investigation reports, engineering plans or specifications. EPA then describes impacts of such features in terms of their physical presence (e.g. footprint) and in terms of hypothetical, catastrophic failures. In fact, there is a probability that any engineering feature will fail, including buildings, bridges, jet engines, etc.; however, the simple probability of failure does not ensure its failure, and the benefits of those features provide incentive to take the risk that the failure does not occur because of mitigation measures engineered into the design. For example, Figure 5 in Silva, et al., 2008 shows tolerable risk based on annual probably of failure compared to people and dollars lost for various industrial features including mine pit slopes, dams, commercial aviation, and super tankers. This paper also includes an in depth review of risk management at an actual operating mine with tailings dams.

Silva, F. T., T. W. Lambe, W. A. Marr. 2008. Probability and risk of slope failure. *Journal of Geotechnical and Geoenvironmental Engineering* 134(12):1691-1699.

Report Section Identification: 4

Report Page Number: p. 4-1

Comment: EPA states that the mine scenarios described in the Assessment reflect "current good, but not necessarily best, mining practices" for porphyry copper mining. Therefore, the assumptions made by the EPA based on "good practice" may not reflect the "best practices" that may be used by an actual mining company. This approach seems unfair and unrealistic considering the amount of scrutiny expected from the public and the regulatory agencies issuing permits and approvals for mines in Alaska.

Report Section Identification: Chapter 4

Report Page Number:

Comment: EPA mine scenarios consider minimum and maximum sized mines. In terms of mined ore/tailings disposal volumes those boundaries are 2 billion metric tons (tonnes) and 6.5 billion tonnes, respectively. At 2 billion tonnes, the minimum mine scenario would be considered a very large mine on a global scale, and exaggerates the respective potential impacts under normal operations and failure scenarios. There are probably less than 10 mines in the world with estimates of 2 billion tonnes or more of tailings. The Andina Mine in Chile is the only mine known to be studying the concept of storing 5.8 billion tonnes of tailings. There are currently no metal mines with tailings storage facilities of this magnitude.

Report Section Identification: Chapter 4

Report Page Number: 4-1

Comment: EPA mentions the Pebble Limited Partnership (PLP) and states, "Although the Pebble deposit is used as an example of mining in the region, the assessment does not predict what the PLP may eventually propose." In Section 4.3, EPA states "Although we borrow details from Ghaffari, et.al (2011), our mine scenario is not based on a specific mine permit application..." In Section 4.3.5, EPA mentions the 2006 water rights application to ADNR by Northern Dynasty, but that application, and the Initial Application Report submitted to ADNR Dam Safety and Construction

Unit which included the tailings dam concepts, are not included in Chapter 9, *Cited References*. The Tailings Storage Facility (TSF) 1 and other features in the EPA mine scenario are virtually identical to the conceptual location of Tailings Impoundment G and other features in the Northern Dynasty application. The dam illustrated in Figure 4-8 is based on Northern Dynasty's concept for dams at Tailings Impoundment A. It is notable that the 2006 water rights application was submitted prior to the significant volume of baseline information released by the Pebble proponents in 2011. The Assessment relies heavily on concepts developed by Northern Dynasty who are party to the Pebble Limited Partnership but do not necessary represent PLP, the prospective Pebble proponent.

Report Section Identification: Chapter 4
Report Page Number:
Comment: It is difficult to make technical observations regarding the mine development model used in the Assessment because the basis of the model is comprised of a number of assumptions and not real data. While the proposed mine and scenarios that were assumed by the EPA may appear to be realistic in a sense, based on a given set of conditions, they by no means represent the only options and outcomes that could apply to a mine located in the Bristol Bay area, or any mine that is in the planning, development, operational or closure stages.

Report Section Identification: 4
Report Page Number: 4-2
Comment: Table 4-1 shows significantly lower grades of ore than that reported in the 2011 Report done for Dynasty Minerals by Wardrop. For example, copper % grade is reported as 0.34% in the Bristol Bay Watershed Assessment while the Waldrop states it is from 0.38% for the small mine and 0.46% for the full mine. This is significant since it relates to the economics of the project. Gold is also reported in the Bristol Bay Watershed Assessment as 0.31 grams per ton while the Waldrop report has it as 0.36 grams per ton.
Recommended Change: The potential range of grades for the deposit should be reported in this table.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, pages 10 and 11.

Report Section Identification: Chapter 4.1.2
Report Page Number: 4-4
Comment: EPA states, "...there are limitations in our ability to make predictions with a high level of certainty because of the inherent complexity of natural materials and their environment." EPA then goes on to compare the Pebble deposit to the Bingham Canyon deposit in Utah, and unilaterally make significant and substantial assumptions and predictions about physical settings, features and impacts of mining in the Bristol Bay region.

Report Section Identification: 4.1.2 Environmental Chemistry
Report Page Number: 4.4
Comment: It is inappropriate to start the Environmental Chemistry section with a statement that mining can pose a risk. This approach is repeated throughout the document, putting a conclusive statement in the introduction to a section, and then only discussing generally how the stated impact occurs. Because of this, the Bristol Bay Watershed Assessment seems to be trying to influence readers without any substantiation. The limitations on the ability to quantify releases to the environment should be discussed in detail in the Uncertainty Assessment if not elsewhere.
Recommended Change: Change structure of sections with an introduction to the issues, present data that is available and that is not, conclude what can be surmised from the data, and describe what the data gaps exist and what can and can't be concluded.

Report Section Identification: 4
Report Page Number: 4-4 through 4-7
Comment: Considerable narrative is presented on the hypothetical chemistry of the porphyry copper deposits, discussing how the acid generation potential (AP), the net neutralization potential (NP) and the neutralizing potential ratio (NPP) are calculated and what they mean. On page 4-5, it is stated that "In general, the rocks associated with porphyry copper deposits tend to straddle the boundary between being net acidic and net alkaline, as illustrated by Borden (2003) for the Bingham Canyon, Utah porphyry copper deposit (Figures 4-2 and 4-3). This is good information but the specific AP, NP and NPP of the Pebble Deposit are <u>not</u> discussed here. This is crucial information since it has bearing on potential environmental impacts during the mine and after the mine life in perpetuity. Good information on the humidity cell tests of the Tertiary and Pre-Tertiary waste rocks are included in Table 4 on page 15 of Appendix H. This information is more valuable than the extensive hypothetical discussion and should be incorporated into pages 4-4 through 4-7.
Recommended Change: Place the information from Appendix H (in summary form) on pages 4-4 through 4-7.

Report Section Identification: Chapter 4.2
Report Page Number: 4-5
Comment: EPA states that the Bristol Bay watershed encompasses 23,539 square miles, and loosely describes existing infrastructure in the region. EPA fails to compare the area of the mine scenarios as a percentage of the total area. Based on the surface areas for the minimum and maximum mine scenarios listed in Table 4-3 (and assuming the total transportation corridor is 0.25 kilometers wide), the areas of development are approximately 0.1% and 0.2% of the total area of the watershed, respectively. Note that the minimum mine size would be a very large mine on a global scale.

Report Section Identification: 4.3 Mine Scenario: No Failure
Report Page Number: 4-6; Table 4-4

Comment: To help place these data in context, the authors should add a column that shows the equivalent information for the hypothetical Pebble mine. Also, the table does not provide information on the local/regional geology or hydrogeology that would also help the comparison.

Report Section Identification: 4

Report Page Number: 4-8 through 4-11.

Comment: The following comment is an example of how possible mitigation methods could reduce the level of environmental concern and significantly alter the conclusions of impact if the mine plan used in the assessment had been vetted through the environmental and permitting review processes.

The referenced pages discuss the processing operation, but only in brief detail. The Northern Dynasty Minerals, Ltd. Report of 2011 was used to supplement this information. The accuracy of this report in representing PLP current plans is unknown, but this report does provide details and specifics that would be expected from a submitted mining project proposal.

From pages 4-8 through 4-11 and pages 164 through 174 in the Northern Dynasty Minerals, Ltd. Report of 2011, a prospective plan is to grind the ore to 80% passing 200 μmeters and produce rougher tailings which are basically inert and are approximately 85% of the total ore feed. The remaining 15% goes to another grinding circuit where the material will be ground to 80% passing 30 μmeters. There will then be various recovery flotation units for copper, molybdenum, etc. Gold will also be recovered. Of the 15% that is reground, 14% will be pyritic tailings that will be over 50% to 80% pure pyrite. This material will be encapsulated in the TSFs to prevent (or retard) oxidation and thus the production of sulfuric acid and dissolution of metals.

As a potential mitigation measure, PLP should consider modifying the processing mill to get full recovery of the pyrite and place none of it in the TSFs. It is fully recognized that this major change would require a full evaluation but it is based on the following reasons: 1) Page 173 of the Northern Dynasty Minerals, Ltd. report shows that considerable gold is locked up in solid solution with the pyrite and additional grinding of the pyrite produces significantly better recoveries of gold; 2) the pyrite could potentially be oxidized by bio-leaching, roasting and other methods; 3) if the site produces nearly 1 billion tons of pyritic tailings over the life of the mine, a reasonable estimate of iron content of these tailings is 25%. This is 250 million tons of iron. When this project was first evaluated, iron's value was $50 per ton. It is now $160 per ton and has no sign of easing, due to the growth in China and India. This value is $4 billion and although the cost of this recovery is expensive, this value would help offset it; 4) substantial savings in the design of liners in the TSFs could be realized since all of the material in the TSFs would be inert and there is no compelling reason to spend large sums in stopping seepage for water quality reasons; 5) large sums could also be saved in water treatment for decades and possibly centuries since treatment may not be needed of the seepage water. Pumping costs from seepage ponds could also be saved; 6) since the iron would be sold, the overall size of the TSFs could be reduced by approximately 10-12%, saving additional sums of money in dam construction; and 7) offering this change could help in easing permitting costs and addressing a major concern of water quality from the TSFs would be eliminated.

This is not to say that this must be done; it may not be economically possible in spite of the benefits cited above. However, it is certainly worth some evaluation and discussion. Included is a reference paper done by the University of Capetown in South Africa on "Mitigating the Generation of Acid

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Mine Drainage from Copper Sulfide tailings impoundments in perpetuity: "A Case Study for an Integrated Management Strategy" by Hesketh, Broadhurst and Harrison in 2009. This study showed successful separation of nearly 100% of the pyrite from a copper porphyry tailing.
Recommended Change: Evaluate this item in more detail in conjunction with the Pebble Limited Partnership. Make changes to the document in many places.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, pages 164-174. "Mitigating the Generation of Acid Mine Drainage from Copper Sulfide tailings impoundment Northern Dynasty Minerals, Ltd.ents in perpetuity: "A Case Study for an Integrated Management Strategy" by Hesketh, Broadhurst and Harrison in 2009.

Report Section Identification: 4
Report Page Number: 4-9
Comment: The following comment is an example of how possible mitigation methods could reduce the level of environmental concern and significantly alter the conclusions of impact if the mine plan used in the assessment had been vetted through the environmental and permitting review processes. The Simplified Schematic of Mined Material Processing does not separate the waste rock into PAG waste rock and NAG waste rock. This is important since the PAG waste rock can have impacts on the environment if not placed properly and if considerable acid formation occurs. The Northern Dynasty Minerals, Ltd. 2011 report states that the PAG waste rock will be piled on the west side of the pit and will be processed at the end of the mining operations and the tailings will be placed in the mine pit. If the price of copper drops, it may not be economically feasible to run this material through the mill at that time (it is low grade ore). This possibility must be addressed for long term post-closure, particularly with regard to water capture and treatment. If the material is strongly PAG, it should not be allowed to place this material in the mine pit since it will potentially affect groundwater in the area for a very long time if not treated. Also, full capture and treatment could be difficult in the long term. Table 4 of Appendix H shows that the Pebble East Pre-Tertiary waste rock humidity cell tests result is an average pH of 4.8.
Recommended Change: Revise the Schematic to include PAG and NAG waste rock. According to Northern Dynasty Minerals, Ltd., the 25 year plan would produce 2.4 billion tons of NAG and 0.6 billion tons of PAG. Include more discussion on possible impacts of leaving the PAG waste in permanent piles and in the mine pit, assuming that no future processing is undertaken.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, page 49.

Report Section Identification: Chapter 4.2.2
Report Page Number: 4-10
Comment: EPA points out that mill processes can affect tailings properties and reduce the acid-generating potential of tailings by producing pyrite concentrate. Cyanide processes for gold recovery are briefly described. Mitigation measures are discounted because of secondary handling requirements.

Report Section Identification: 4
Report Page Number: 4-11 and 4-12
Comment: The following comment is an example of how possible mitigation methods could reduce the level of environmental concern and significantly alter the conclusions of impact if the mine plan used in the assessment had been vetted through the environmental and permitting review processes. The illustration and narrative on these pages is identical to the narrative in the Northern Dynasty Minerals, Ltd. report with regard to the type of dam construction (i.e., initial dam will be the downstream type which is the most stable, which will be approximately 50% of the total dam height). The upper 50% will be centerline construction. Given the magnitude of this dam and the potential for serious earthquakes, this design must be evaluated in minute detail for stability. The long term strength parameters of the tailings behind the dam must be evaluated since this could affect the stability of the upstream portion of the dam, in particular, the upper portion.
Recommended Change: Use a seasoned dam expert with experience in extremely cold conditions and high risk of earthquake to provide a full evaluation of the dam design with respect to slope stability.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, pages 356 through 359.

Report Section Identification: 4
Report Page Number: 4-11 and 4-21
Comment: The following comment is an example of how possible mitigation methods could reduce the level of environmental concern and significantly alter the conclusions of impact if the mine plan used in the assessment had been vetted through the environmental and permitting review processes. The narrative on Page 4-11 discusses some general dam design criteria and page 4-21 has a very brief discussion about the lining of the dam. The Northern Dynasty Minerals, Ltd. Report of 2011 has a detailed cross section in Figure 18.3.1 on Page 355. This design shows a 100 mil HPDE liner over a geosynthetic clay liner, surrounded by some fine material above and below to protect the liner. The Northern Dynasty Minerals, Ltd. report also states that the lack of fine material has required the use of these linings. In other words, the rest of the dam will be built out of waste rock from the mine that may be permeable. For most situations, this design would be perfectly suitable, however, given the possibility of earthquakes, the sheer volume of the tailings and the sensitivity of the fisheries downstream, the risk is very high and additional layers of protection on the dams should be evaluated, such as a secondary HDPE liner with a second GCL layer.
Recommended Change: Use a dam expert with experience in extremely cold conditions and high risk of earthquake to provide a full evaluation of the dam design and lining requirements.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, page 355.

Report Section Identification: Chapter 4.2.3
Report Page Number: 4-12
Comment: EPA describes basic concepts of tailings dams as shown in Figure 4-5. This is an elementary level drawing with no technical merit.

Report Section Identification: Chapter 4.2.3
Report Page Number: 4-11
Comment: EPA states, "…geomembrane technology has not been available long enough to know their service life…" and generally discounts the potential mitigation value of the product. In fact, the advent of geomembranes began in 1839 when Charles Goodyear vulcanized natural rubber with sulfur which led to the development of thermoset polymers. Polyvinyl chloride resin production began in 1939 and mass production of polyethylene compounds began in 1943. The U. S. Bureau of Reclamation began using geomembranes in the 1960s. The geosynthetics industry broadly shifted to thermoplastic polymers in the 1980s. HDPE and other formulations of polyethylene are routinely approved by EPA and other international regulatory agencies for use in solid and hazardous waste landfills around the world (which have indefinite design lives, also). (Reference: *Designing with Geosynthetics*, 5th Edition. Koerner, 2005 **ISBN-10:** 0131454153)

Report Section Identification: Chapter 4.2.3
Report Page Number: 4-11
Comment: The EPA states, "…geomembranes are generally estimated by manufacturers to last 20 to 30 years when covered by tailings (North pers. comm.) [sic]". The statement appears to be referenced based on personal communication. While this may be the approximate service life of some geomembranes exposed to ultraviolet rays (sun), it is more typical of product warranties issued by manufacturers. The lifetime of buried geomembranes has been estimated as much as 400 years or more for a high density polyethylene (HDPE) by noted experts such as Robert M. Koerner.(see citation in comment above).

Report Section Identification: Chapter 4.3
Report Page Number: 4-13
Comment: The mine scenarios assessed by the EPA are representative of a very, large scale mining with a particular set of mine development elements that are not representative of a large percentage of porphyry copper deposit mines. For example, an open pit mine is selected while there are a number of large scale mines of such deposits that mine by bulk underground methods such as block caving, sub-level caving vertical crater retreat and other underground methods. The volume of waste rock created by such underground mining methods is several orders of magnitude less than that assumed in the EPA mine scenarios.

Report Section Identification: Chapter 4.3
Report Page Number: 4-13
Comment: The tailings disposal method by hydraulically placed, slurry tailings is one of a number

of methods that can be considered. While it is the most favored of the disposal methods for cost, there is an increasing tendency to adopt alternative methods such as paste and filtered, dry stacked tailings that effectively address water management issues and environmental protection. Paste tailings technology is being applied at large scale porphyry copper mines such as the Esperanza mine in Chile. These alternative tailings disposal methods permit greater freedom for the selection of disposal facilities and can be used to address specific environmental concerns. For example, with a smaller footprint, the need to build a cross valley dam can be eliminated, along with impacts to stream flow and salmon habitat. By selecting a tailings disposal method that requires the tailings storage facility in a location where the stream impact is maximized, the Assessment results in environmental impacts greater than can be achieved by alternative methods.

Report Section Identification: Chapter 4.3

Report Page Number: 4-16

Comment: In Table 4-4, EPA lists other mines and prospects in Alaska using Levit and Chambers, 2012 as the source. Fort Knox and Red Dog are the largest operating mines listed with tailings volumes of 200 and 100 million tonnes, respectively. The Donlin prospect is also included at 472 million tonnes. No mines outside of Alaska are listed. The basis for the ore volumes is not mentioned.

Report Section Identification: Chapter 4.3.2

Report Page Number: 4-17

Comment: EPA mentions two other mines outside of Alaska: "the largest porphyry copper mine in the United States (based on 2008 data) is the Safford Mine in Arizona, at 7.3 billion metric tons of ore [and] the largest in the world (based on 2008 data) is the Chuquicamata Mine in Chile, at 21.3 billion metric tons of ore." However, the source of the data is not clear. The 2011 annual report for Freeport-McMoRan Copper & Gold Inc. lists 206 million metric tons of ore at the Safford Mine. The basis for the discrepancy is not clear. EPA lists the potential mined ore at Pebble at 11 billion metric tons but fails to indicate the terms of these estimates (e.g. measured, indicated and inferred; proven and probable, etc.).

Report Section Identification: 4.3.1 Mine Location

Report Page Number: 4-17

Comment: While many of the hypothetical mine features may be transferable to other part of the region, the geologic and hydrogeologic conditions at the Pebble site area are likely to be unique. For example, the flow and seepage of groundwater into an 800 meter deep pit would very likely differ between site locations within the region due to different surficial soils and bedrock/aquifer permeability and connection with surface water bodies. This is a significant issue for the mine design.

Recommended Change: Recommend revising this paragraph/sentence to acknowledge that the geologic and hydrogeologic conditions are not as readily transferable as other features.

Report Section Identification: 4.3 Mine Failure Scenario

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Report Page Number: Page 4-17
Comment: The No Failure impact and effects scenario is likely overly conservative. Full containment and failure-free mining are not likely mine scenarios. Also, combining cumulative risks from the Failure scenario is not likely either. The risk analysis method used in the assessment describes the conceptual model framework identifying an envelope of potential risks, but does not quantify the risks to any degree of certainty. The risk assessment should seek to evaluate risks (and quantify where feasible) and identify the mostly likely mine development and failure scenarios to understand likely impacts, while stating the range of knowable risks.
Recommended Change: Risk should be quantified, and estimated, where feasible (i.e. mine site footprint impacts, hydrologic impacts, dam failure) on elements of the study where this is feasible, and for items where calculation of risks and effects are unfeasible, scale of risk should be assigned (i.e. high probability and small area or low impact). A probabilistic risk based analysis of a likely mine operation and failure scenario would reduce uncertainties leading to underestimates and overestimates of stated risks and impacts.

Report Section Identification: 4.3 Mine Scenario, No Failure
Report Page Number: Page 4-17
Comment: The report in the first paragraph on this page states "Our mine scenario represents current good, **but not necessarily best**, mining practices". This is stated differently in the Executive Summary Pages ES-14 where the report states "No failure, or routine operation, is a mode of operation defined as **using the highest design standards** and day-to-day practices, with all equipment and management systems operated in accordance with applicable specifications and requirements practices.
Recommended Change: Reconcile the statements.

Report Section Identification: 4.3.2 Mine Size
Report Page Number: Pages 4-17 and 4-19
Comment: On page 4-17, the report states that "If fully mined, the Pebble deposit may exceed 11 billion metric tons of ore…" On page 4-19, the report states that "In our mine scenario, we have defined a minimum and a maximum mine size of 2 billion metric tons and 6.5 billion metric tons of ore, respectively."
Recommended Change: Include justification for why the 6.5 billion metric tons of ore scenario is the "most likely" mine size versus the estimated maximum potential of 11 billion metric tons of ore.

Report Section Identification: 2.3.2 Groundwater Exchange and Flow Stability
Report Page Number: 4-20; Figure 4-7
Comment: Whereas the maximum mine size figure appears to show a dam for the TSF1, there is no indication of the dam location for TSF2 or TSF3.
Recommended Change: Recommend adding the dams to this figure.

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Report Section Identification: Chapter 4.3.5
Report Page Number: 4-21
Comment: The dam size, location and retaining volume are estimated and described, but there is no discussion as to how the quantities were estimated.

Report Section Identification: 4.3.5 Tailings Storage Facilities
Report Page Number: 4-21
Comment: In the first sentence in the first paragraph, the report discusses a 2006 water right application submitted by Northern Dynasty Mine. These quantities should be compared to the volumes/rates discussed later in the water balance part of Section 4.

Report Section Identification: 4
Report Page Number: 4-21
Comment: The following comment is an example of how possible mitigation methods could reduce the level of environmental concern and significantly alter the conclusions of impact if the mine plan used in the assessment had been vetted through the environmental and permitting review processes. The narrative is identical to the narrative in the Northern Dynasty Minerals, Ltd report with regard to the percent of pyritic tailings versus bulk tailings. The Northern Dynasty Minerals, Ltd. report defines these tailings as inert or non-acid producing. They are the rougher tails from the first flotation circuit. The Bristol Bay Watershed Assessment says that the pyritic tailings would be discharged below the water surface of the tailings pond and encapsulated in NAG tailings to retard the rate of pyrite oxidation. Given the fact that nearly 1 billion tons of pyritic tailings would be produced for the full mine, it is important to evaluate in greater detail the potential for this material to oxidize. Variables that are not immediately clear are a) what will be the percolation rate of water through the tails?; b) there is approximately 65 feet of gravel in many areas of the TSFs and they will not be lined. What will be done to prevent seepage in these gravels?; c) how will the TSF dams be constructed to greatly reduce seepage under the dam?; d) how will rainwater and snowmelt (which is relatively high in dissolved oxygen), affect the oxidation rate?; and e) how will normal seepage through the dam affect water movement and hence oxidation, through the pyritic tails?
Recommended Change: Get more detailed information on this topic and include it in Section 4.3.5 of the Bristol Bay Watershed Assessment.

Report Section Identification: Chapter 4.3.5
Report Page Number: 4-22
Comment: In Figure 4-8, EPA includes other landmarks such as the Washington Monument and the Transamerica Building in comparison to the conceptual height of the tailings dam. Such comparisons have no technical value.

Report Section Identification: Chapter 4.3.6
Report Page Number: 4-23

EPA-7609-0014527_00038

Comment: In Section 4.3.6, waste rock disposal areas are described without a specific description of the basis for the estimated size or footprint, apart from stating "these piles will be constructed with a geometry designed to reduce the amount of runoff requiring treatment."

Report Section Identification: 4.3.5 Tailings Storage Facilities
Report Page Number: 4-23
Comment: The second paragraph discusses a well field to monitor groundwater flowing down the valley. However, no specific details are provided for these wells.
Recommended Change: Recommend including estimates of the number of wells that might be needed to monitor groundwater quality and intercept seepage, well depths, spacings, diameters, construction materials and possible drilling challenges based on the local hydrogeology. Also recommend discussing the well maintenance program options that would ensure the wells are kept operational.

Report Section Identification: 4.3.6 Waste Rock
Report Page Number: 4-25; Figure 4-9
Comment: This schematic figure gives a misleading sense of the depth of the open pit relative to the groundwater conditions (as they appear to be understood). Although this figure is not to scale, if the intended pit depth is 800 meters, the base of the pit should be far deeper than shown. Also, one would expect a local groundwater mound to develop beneath the Waste Rock area in the lower figure (Post-Closure), with groundwater moving towards the pit and the stream.
Recommended Change: Revise the figure to better reflect the pit depth and groundwater flow pattern.

Report Section Identification: 4.3.6 Waste Rock
Report Page Number: Page 4-25, Figure 4-9
Comment: The figure shows a simplified schematic of the dewatering and water management system at the mine. What are the potential groundwater seepage and contaminant pathways? Pathways that come to mind are the shallow groundwater seepage through the bottom (unlined) portions of the TSF and fracture zones in the weathered bedrock layers.
Recommended Change: Recommend adding geology and soils information regarding the glacial deposits, with underlying weathered and competent bed-rock to the figure and discussion. Identify potential contaminant pathways on the schematic which should be consistent with the conceptual modeling schematics in Section 3.

Report Section Identification: Section 4.3.7
Report Page Number: 4-26
Comment: The river diversion plan assumes that the blocked creeks/rivers will eventually find a way to flow around the mine site and TSF, however, it might not be the case in many areas, particularly during the high flow season (either caused by heavy rainfall and snow melt). During the high flow season, surface water runoff might cause flooding, top the TSF, and/or move the potential contaminants into downstream water bodies if PAG waste rock is encountered.

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Recommended Change: Provide more detailed info on the river diversion plan, including the topographic information for the areas where the streams will be blocked by the mine pit or waste rock piles. Provide high seasonal flow information in the affected area and its impact on the mine site and safety of the TSF dam.

Report Section Identification: 4.3.7 Water Management
Report Page Number: 4-26
Comment: The document points out impacts that would "reduce or eliminate stream flows". While these statements may be correctly applied to the local streams near the potential mine site, the impact to the larger stream systems is negligible, especially to the Bristol Bay Watershed. The document fails to put this in proper perspective.
Recommended Change: The document should demonstrate the potential impact to a larger stream system and overall potential impact to the Bristol Bay Watershed.

Report Section Identification: 4.3.7 Water Management
Report Page Number: 4-27; Box 4-2
Comment: The report notes that a range of hydraulic conductivities have been measured in the area. However, the seepage calculation assumes a single value for each of the upper 200 meters and deeper materials. This range is not provided to enable the reader to put the selected values into context. Also, the selection of a relatively low hydraulic conductivity (10^{-8} m/s) for the deeper materials should be discussed in terms of primary or secondary porosity, and the likelihood that a mine of such dimensions would encounter water-bearing fracture zones and what the inflow contribution might be.
Recommended Change: Revise the seepage calculations and discussions to include a range of hydraulic conductivity values and the potential for water-bearing fracture flow contributions.

Report Section Identification: 4
Report Page Number: 4-27
Comment: This page states that the mining operation would always consume some water and there would always be less water available in streams during active mining than there was before the mine was present. This contradicts Section 5.3.1 which states that "During the start-up phase, all water from the site would be collected and used in operations. However, during the minimum and maximum mine operations, 5 million to 48 million cubic meters of water available on the site per annum would exceed operational needs, and treated water would be discharged. (Section 4.3.7)". This contradiction is important to rectify since it has implications to the health of the streams and fisheries below the mine.
Recommended Change: Evaluate this item in detail and provide narrative on it. Make any changes to the water balance.

Report Section Identification: 4.3.7 Waste Management
Report Page Number: 4-27
Comment: The report assumes that the mine would be located on a water divide; therefore, there

will be little groundwater contribution into the area defined by the cone of depression. This assumption is not well supported due to two reasons:

1. The surface water divide does not necessarily match the groundwater divide. Regional groundwater flow is not presented in the report to determine the location of groundwater divide.
2. Dewatering and mining activities in the mine site will change the local, and possibly the regional, groundwater flow field, which will change the water balance.

Recommended Change: Provide regional hydrogeological information such as cross-sections, logs, lithologies, groundwater levels, and groundwater contour maps.

Report Section Identification: 4.3.7 Water Management

Report Page Number: Page(s) 4-27 and 4-28

Comment: The water budget section of the report indicates how the estimation of water budgets was conducted by stating "Developing a water balance for these stages is important to the assessment, because it determines the amount of water available at the site that could still contribute to downstream flows (Box 4-2). However, water balance development is challenging and requires a number of assumptions. It depends upon the amount of water needed to support mining operations, the amount of water delivered to the site via precipitation, the amount of water lost due to evapotranspiration, and the net balance of water to and from groundwater sources. Information exists to estimate precipitation and evapotranspiration, and estimates of water needed for mining operations are available based on typical mining practices (Ghaffari et al. 2011). More challenging, and potentially the largest source of uncertainty, is determining the net balance of water from groundwater sources.". The water budget estimating methods described in Box 4-2 do not specify the type of calculation or model used to evaluate the water budget. It is assumed that a deterministic, spreadsheet, model was used to grossly estimate the mine water budgets for the various mine development and closure phases.

Recommended Change: Provide an expanded discussion of the type of water budget model used, assumptions made, data sources, uncertainties and limitations in modeling estimates. The use and application of a more robust modeling system that can integrate surface and groundwater hydrology and mining industrial water operations is needed to more accurately represent water management and water budget conditions.

Report Section Identification: 4

Report Page Number: 4-28

Comment: This page describes the water balance calculations expected for the mine. The mine inflow assumptions seem reasonable and are calculated to be 1.06 cubic meters per second for the maximum mine. However, this number has such an important bearing on the overall water balance that it must be checked in detail. If the number is actually much lower, then the mine may not discharge during the mine life, since considerable water will be consumed in the tailings deposition. This could affect fish habitat for some distance downstream. If it is much higher, the flows in the streams could be increased downstream of the mine, resulting in increased erosion of the banks for some distance downstream.

Recommended Change: Use a seasoned ground water expert with experience in evaluating mine

inflows from large pits to provide a full evaluation of the mine inflow predictions. Make any changes to the water balance, if necessary.

Report Section Identification: Box 4-2
Report Page Number: 4-28
Comment: The report assumes that groundwater is limited to the top 100 meters, only. Is there any evidence that a deeper aquifer does not exist at the mine site? As stated in Table 4-3, page 4-15, the mine pit will extend to 800 meters and 1,200 meters for the minimum and maximum mine, respectively. The potential to encounter a deeper aquifer under the mine will change the water balance significantly due to potential for a large amount of water from fracture flows in the deeper portion of the mine pit.
Recommended Change: A detailed hydrogeological description in the mining area is needed to determine if a deeper aquifer(s) exists to a depth of 1,200 meters.

Report Section Identification: Chapter 4.3.7
Report Page Number: 4-28
Comment: Box 4-2. Water Balance Calculations: The fundamental definition of a water balance is not adhered to in the discussion, thus making the results of the analysis worthless. Although the authors purportedly seem to be able to design AND comment on the negative effects of a yet to be designed and permitted facility, the water balance cannot be finalized until an understanding of water use *within* the facility itself is complete. The hypothetical inflows and outflows of a speculative design do not in itself, constitute a water balance.

Report Section Identification: 4.3.7 Water Management
Report Page Number: 4-30; Table 4-5
Comment: The geographical basis for the water balance provided in Table 4-5 excludes the area outside the immediate vicinity of the mine site. Typically, project-area water balances take into account flows for individual surface water bodies, water-bearing units/aquifers, and areal variability of precipitation and runoff components. In short, this water balance appears to lack acknowledgement of the key natural systems at and near the mine site. Also, water balances consider seasonality aspects (for example, monthly) and the effect of wetter- and drier-than-average years.
Recommended Change: The water balance should be fully reconsidered taking into account the comments above, and represented in a concise way with supporting figures, charts and tables.

Report Section Identification: Table 4-5
Report Page Number: 4-30
Comment: Table 4-5 indicates that water captured at the mine site is the same for the maximum mine condition and for the Post-Closure condition (both 41.2E6 cubic meter/year). The amount of water captured should not be the same under these two conditions due to the change in groundwater/surface water interaction. As mining progresses, the mine pit has the potential to intersect more groundwater from fracture flow. After the mine is closed, as the water level

increases in the mine pit, less groundwater could flow into the mine.
Recommended Change: Provide explanation for the same amount of water being captured for the maximum mine and post-closure conditions.

Report Section Identification: Table 4-5
Report Page Number: 4-30
Comment: Table 4-5 indicates that the "stored in TSFs as pore water" for the Start-up condition is 25.5E6 m3/year. The amount of the water as shown in the table indicates the same amount of water "stored in TSFs as pore water" for each year for minimum mine operation period. There should be a minimum amount of material in TSFs, if any, during the Start-Up phase.

Report Section Identification: 4
Report Page Number: 4-30
Comment: This page summarizes the water balance calculations expected for the mine. Although the water that will be captured by blocked streams is not actually part of the mine, it is an important part of the water balance and therefore, should be addressed. It is understood that diversions will be placed in the blocked drainages to divert what amount is feasible downstream through diversions, but there is no discussion of what blocked stream segment water will be backed up against the embankments that cannot be conveyed through diversions due to elevation. Pass through pipes underneath the TSFs will probably not work in perpetuity.
Recommended Change: Evaluate this item in detail and provide narrative on it. Make any changes to the water balance, if necessary.

Report Section Identification: 4
Report Page Number: 4-30
Comment: Using retention of 30% water by weight, calculations of the amount of pore water that will remain in the tailings each year after settlement and recapture of clean water using the floating barge in the TSFs can be estimated. The amount of 26.5 million cubic meters per year shown in the Table is reasonable. The post-closure column also correctly shows that no new water will be stored in the TSFs as pore water. What is not mentioned is that approximately 735 million cubic meters of permanent water will remain in the tailings as pore water over the life of the mine that will not be recaptured by the floating barge. This water would primarily come from precipitation and water inflow from the mine pit. This may be acceptable over 78 years time, but it is an extremely large amount of water that will essentially be taken from groundwater (in the mine pit) and placed in the TSFs. This should be discussed in the water balance. A more detailed evaluation of the water balance is needed.
Recommended Change: Describe the consumptive use of the pore water in the tailings over the life of the mine and its possible effects downstream on the groundwater and surface water systems.

Report Section Identification: 4 entire
Report Page Number: all pages in Chapter 4.
Comment: Much of what the Pebble Limited Partnership can do for environmental protection is based on the economics for the mine. This is not discussed in the Bristol Bay Watershed Assessment. It would be helpful to know the long term economics of the mine, which are described in detail in the Northern Dynasty Minerals, Ltd. Report of 2011, and whether they are based on conservative metal prices. The following list shows prices used in the economics calculated for the Northern Dynasty Minerals, Ltd. Report of 2011 compared to current prices. Copper $2.50/lb Current $3.33/lb Gold $1050/ounce Current $1610/ounce Molybdenum $13.50/lb Current $14.90/lb Silver $15.00/ounce Current $28.00/ounce Rhenium $3000/lb Current $2900/lb Palladium $490/ounce Current $618/ounce
Recommended Change: None
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, pages 12

Report Section Identification: 4.3.8 Post Closure Site Management
Report Page Number: 4-31
Comment: The document states an assumption that the mine would close " when all currently identified economically profitable ore is removed" . PLP has not demonstrated that there is any "economically profitable ore" at this time. Final feasibility studies, mine plans and numerous other studies would have to be complete before PLP could report a reserve or "profitable ore".
Recommended Change: Drop "currently identified" from the text

Report Section Identification: 4.3.8.3 Waste Rock
Report Page Number: 4-32
Comment: The document uses an assumption that a stable angle for waste rock slopes would be less than 15 %. There is no basis for this and our experience has shown that most reclaimed waste rock dumps are stable at 33 % and depending on the material, may be stable at steeper slopes. A steeper slope could reduce the overall footprint.
Recommended Change: Eliminate the 15 % reference.

Report Section Identification: 4.3.8.5 Premature Closure
Report Page Number: Page(s) 4-33
Comment: Premature mine closure is discussed. There are two sentences that need additional discussion. First "In one study of international mine closures between 1981 and 2009, 75% of the mines considered were closed before the mine plan was fully implemented (Laurence 2011)." Second, later in the section states "Because premature closure is an unanticipated event, water treatment systems would likely be insufficient to treat the excessive and persistent volume of low pH water containing high metal concentrations." If the premise of a high rate of premature closure

is true as presented in the assessment, it would be reasonable for the authors to assume premature closure as a likely scenario and the study should include this consideration in the No-Fail scenario or likely scenario analyses.
Recommended Change: Include an expanded discussion of premature closure, the uncertainty, and the potential impacts on fisheries and indigenous cultures as this condition is likely to occur.

Report Section Identification: 4
Report Page Number: 4-33 and 4-39
Comment: Page 4-33 states that the water from the leachate collection systems would be treated until necessary. Page 4-39 discusses water collection and treatment failure but focuses on a prediction of seepage flows through the TSFs, which would be untreated. This section goes on to state that if a treatment failure occurs, the expected discharge rate is 0.00115 m^3/sec. This is not a large flow and it is probably not the biggest risk with this type of failure. If a large treatment plant is in place, it may be possible that a large surge of untreated water would be discharged and this is not addressed in detail. The extreme weather conditions of this site combined with the fact that water treatment would go on for a very long time after closure, point to a significant possibility of "incidents" with the water treatment system which could produce much larger quantities than the expected seepage, albeit for a short time. Nevertheless, a surge like this could have a significant impact downstream. The treatment plant designs must have significant backup systems and safety factors to account for these possibilities.
Recommended Change: Describe the potential impacts of temporary failures of the water treatment system and the effects of possible surges of poor quality water on the downstream fish habitat.
Comment Reference:

Report Section Identification: 4
Report Page Number: 4-35 and Appendix G.
Comment: These pages show the road and pipeline corridor on maps. The maps fail to point out that a portion of the road is already built, which is from Williamsport to Pile Bay, as shown on Figure 18.2.5 of the Northern Dynasty Minerals, Ltd. Report of 2011. Another smaller section near Pedro Bay is also in place.
Recommended Change: Revise these pages and maps to show those sections of road that are already built and describe the widths and stream crossings that are in place and may need upgrading.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, page 9.

Report Section Identification: 4.4.1 Water Collection and Treatment Failure
Report Page Number: 4-39
Comment: In the first paragraph, the report discusses failure of the collection and treatment facility, and assumes a hydraulic conductivity for the permeable substrate for the upper 30 meters by using a value from the Pebble Limited Partnership's 2011 report. This value is two orders of

magnitude lower than the value used in the mine pit seepage calculation (Box 4-2) despite representing a shallower layer of material that one would expect to have a similar (or even higher) hydraulic conductivity.
Recommended Change: The report should provide some clarification regarding the selected parameter value, and even consider providing flows based on a range of values given the apparent uncertainty regarding the actual site location and specific hydrogeologic conditions.

Report Section Identification: Chapter 4.4.2
Report Page Number: 4-39
Comment: EPA states, "A tailings dam failures occurs when a tailings dam loses its structural integrity and releases tailings material from the impoundment. The released tailings flow under the force of gravity as a fast-moving flood containing a dense mixture of solids and liquids, often with catastrophic results." EPA lists examples of such catastrophic failures in Box 4-4. EPA then describes failure mechanisms such as overtopping and slope instability and then discusses failure statistics. However, EPA fails to point out that the failure statistics as presented do not distinguish catastrophic failures from relatively inconsequential incidents, thus implying that the failure probabilities are applicable to the uncontrolled release of tailings or otherwise catastrophic failures.

Report Section Identification: Chapter 4.4.2
Report Page Number: 4-40
Comment: EPA implies that because the tailings dam heights used in the mine scenario are very large, the impacts of a failure would be much greater than the historical failure record from much smaller dam failures. Box 4-4 lists four examples of tailings dam failures, including the 2008 flyash pond failure at the Kingston Power Plant in Tennessee. All of the dams described are less than 30 meters high, and all have questionable design and operational histories. EPA fails to acknowledge that tailings dam failure statistics are biased by the failure incidents of such small dams, because there have been no catastrophic failure of large dams approaching the scale of the mine scenarios used in the Assessment.

Report Section Identification: Chapter 4.4.2.1
Report Page Number: 4-40
Comment: EPA describes causes of tailings dams failure such as overtopping, slope instability, earthquakes and foundation failures. However, such failures are highly dependent on a number of site and project specific factors such as available construction materials, foundation type, (bedrock vs. depositional soil) and hydrology and hydraulics design.

Report Section Identification: Chapter 4.4.2.1
Report Page Number: 4-44
Comment: The Assessment indicates that overtopping is one of the leading causes of inactive tailings dam failures. However, this data is biased because the sample population includes a number of failures of dams with inadequate spillway designs. Any large or very large tailings dam in Alaska must be designed to accommodate the Probable Maximum Flood (PMF) during

operations, and safely pass the PMF through a properly designed spillway in closure. Note that the PMF is a misnomer, in that there is no specific probability associated with the event since it represents the result of the most severe meteorological and hydrologic event that is reasonably possible at a given site. The argument that a large or very large tailings dam built in Alaska would be particularly susceptible to failure due to overtopping based on historical evidence of international tailings dam failure incidents is systematically flawed.

Report Section Identification: Chapter 4.4.2.1

Report Page Number: 4-44

Comment: In Table 4-7, EPA lists examples of earthquakes in Alaska ranging from a magnitude 3.0, located 122 km from the project, to the Great Alaska Earthquake of 1964, a magnitude 9.2 located 469 km from the project. The nearest earthquake listed is a magnitude 4.3, located 30km from the project. A note on the table states, "...earthquakes in the range of magnitudes 2.5 to 3.6 occur regularly in the Lake Clark area...)". The earthquakes listed by EPA in relation to the Pebble deposit are technically insignificant. National guidelines for incident reporting for dams do not require reporting for earthquakes less than 5.0 within 24 km of the project site, or for earthquakes greater than 8.5 more than 102 km from the site.

Comment Reference: Section 9 of "Guidelines for Reporting the Performance of Dams", National Performance of Dams Program, Stanford University, 1994.

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-45

Comment: EPA references Chambers and Higman (2011) for tailings dam failure statistics. Reviewers question the use of this reference as it is a literature summary drawing conclusions that do not appear to have been peer reviewed and is written by a non-profit advocacy organization. See: http://www.csp2.org/reports/Long%20Term%20Risks%20of%20Tailings%20Dam%20Failure%20-%20Chambers%20&%20Higman%20Oct11.pdf

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-45

Comment: EPA states, "Low failure frequencies and incomplete datasets also make any meaningful correlations between the probability of failure and dam height or other characteristics questionable. Very few existing rockfill dams approach the size of the structures in our mine scenario, and none of these large dams have failed." Nevertheless, EPA continues in their conjecture to presume that the tailings dam fail during both the operation and post-closure phases of the mine.

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-45

Comment: The EPA presents statistics on dam failures and gives an upper bound of one failure per approximately 2,000 mine years. However, the EPA fails to describe whether the respective failures had any adverse impact on the environment. For example, a slope stability type dam failure may be reported, but not necessarily have resulted in any adverse impact on the environment downstream of the dam

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-46

Comment: EPA states, "This analysis considers the effects of earthquakes based on a site-specific evaluation of seismicity in the area. Box 4-6 describes the selection of earthquake characteristics for design criteria." In fact, Box 4-6 describes earthquake design criteria in general terms such as the Operating Basis Earthquake (OBE) and the Maximum Design Earthquake (MDE), but cites Northern Dynasty for specific, proposed ground motions (NDM, 2006). This reference is not included in Chapter 9, *Cited References*. While Figure 4-11 shows a seismic activity map for southwestern Alaska, EPA has not conducted a presented a technically defensible, probabilistic or deterministic seismic study for the region.

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-46

Comment: EPA cites ADNR *Guidelines for Cooperation with the Alaska Dam Safety Program* (June, 2005) (ADNR Dam Safety Guidelines) and references therein to U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Federal Energy Regulatory Commission guidelines for designing water retaining dams to safety factors of 1.5 (for slope stability). Box 4-6, *Selecting Earthquake Characteristics for Design Criteria*, includes general descriptions of earthquake design criteria, and criticizes the ADNR dam safety guidelines as 'inconsistent with the expected conditions for a large porphyry copper mine developed in the Bristol Bay…" Section 13.2.2, *Tailings Storage Facilities*, of the ADNR Dam Safety Guidelines specifically states, "Complete guidance on tailings dam design and closure is beyond the scope of this document…tailings dams represents certain challenges that require professionals with significant relevant experience." EPA leans heavily on the 1.5 safety factor for estimating failure probabilities and references (Silva, et al. , 2008). However, unlike the Assessment, Silva presents a balanced discussion on risk for a mine project, and other engineering features such as dams.

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-47

Comment: EPA uses curves from Figure 1 of Silva et al, 2008 to convert the factor of safety associated with the mine scenario tailings dam to an annual probability of failure. The scope of Silva's paper is broad and is intended for a wide range of potential geotechnical applications. The four categories of "Level of engineering" included in the Assessment are abbreviations of the more detailed Table 1 included in the referenced paper. A review of Table 1 indicates that the Class II (Above Average) category is reserved for "above average" geotechnical works in a general sense. For example, Class II structures do not require an investigation of site geologic history, design peer review, full time supervision by a qualified engineer during construction or implementation of a

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performance program during operation, all of which would be required of any new tailings dam constructed in Alaska. The EPA assumes that the mine scenario tailings dam will be between a Class II and Class I structure and chooses to use the annual probability of failure associated with Class II structures (10^{-4} with a FOS of 1.5) for comparison with high historical tailings dam failure rates. Based on Silva's definition, a new large or very large tailings dam constructed in Alaska would almost certainly fall into category 1 (Best). The corresponding annual probability of failure of a Class I structure with a FOS of 1.5 is 10^{-6}.

Report Section Identification: Chapter 4.4.2.2

Report Page Number: 4-47

Comment: The likelihood has been estimated, substantially, from the historic records of dam failures that have been recorded in the years 1960 to 2010. Many of the dams that are included in this failure record were constructed in periods prior to current engineering and oversight.

The ability to perform effective analyses must precede the practice of performing such analyses and if we look to when a) the capability and b) the practice of analyses of very important aspects of dam design were developed, we can see that many dams that have failed were not designed with adequate design methods. The flowing times are when the technology and practice became common for critical elements of tailings dam design in North America:

Slope stability analyses 1960's
Seepage and drainage analyses 1970's
Seismicity, foundation soils and tailings liquefaction, and dynamic analyses 1970's and 80's
Modeling tools for deformation (FLAC, PLAXIS) Post 1980's
Design for Closure and Closure management (not just abandonment) has only been a substantive requirement since the 1990's.

In areas other than North America, these technologies and the regulatory oversight and corporate governance that today control the security of dam construction were not applied till substantially later.

Thus many of the dams, indeed the vast majority, included in the failure statistics did not include the design, specifications and construction and operation supervision that would be required today for a major tailings dam constructed in Bristol Bay.

The site investigation, construction material characterization, design effort and construction supervision that is applied to smaller, lower hazard dams are vastly less than are applied to very large high hazard dams. The engineering man-hours that would be devoted to the investigation, design and construction supervision for the 'very large dam' that has been assumed for the MS would be many times (orders of magnitude) greater than that applied to the smaller dams of several decades ago.

The likelihood of failure of a large dam constructed with the current technology, regulatory control and corporate governance, that would be applicable at Bristol Bay, would be grossly overestimated by the likelihood ranges derived from historic failures.

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Report Section Identification: 4.4.2.2 Probability of Tailings Dams Failures
Report Page Number: Page(s) 4-47
Comment: Dam failure probabilities based on existing and anecdotal information shows a wide range (several orders of magnitude) difference in probability of failure.
Recommended Change: Considering the potential risks involved, the dam failure study should include a site specific dam failure analysis. A stochastic, risk based modeling approach is needed to address risk and uncertainty and incorporating sensitivity analyses of seismicity, soil strength and hydraulic conductivity properties, inflow hydrology, dam breach sizes, hydraulic and sediment transport downstream modeling. The analysis will refine probabilities and estimates of dam failure scenarios and reduce the uncertainty in dam failure orders of magnitude difference in estimated failure probabilities.

Report Section Identification: 4.4.2.2 Probability of Tailings Dams Failures
Report Page Number: Page(s) 4-47
Comment: Hydraulic modeling of downstream areas from dam failure and overtopping was performed as described in Box 4-8. The approach analyzes a probable maximum flood (PMF) inflow using Hydrologic Engineering Center's (HEC) -1for hydrologic modeling. Downstream rivers and streams were modeled using HEC-River Analysis System (HEC-RAS). The methods section does not describe specifically how dam breach size estimates were determined, and how the downstream sediment transport analyses were performed.
Recommended Change: The report should include information about what methods were used to analyze the dam breach size and flow conditions, and the associated sediment transport analyses. Empirical methods applied should be specified, such as those outlined in *Prediction of Dam Breach Parameters, USBR 1998,* and/or use of dam-break software to estimate breach sizes. This is important as the breach size; reservoir and tailings stages will highly influence the flood hydrograph. The sediment transport data collection and modeling work should be expanded in support of the study (both spatially and identifying / specifying the type of model being used). If not already being used, a mobile bed sediment transport and sediment routing model will likely be necessary to understand dam breach, sediment transport conditions and spatial extents of tailings deposition extents to any degree of certainty. Once the sediment deposition areas have been established, then downstream water quality impact assessments could be updated and refined. Dam break sedimentation impact areas could also be directly overlaid with existing fish habitat areas using GIS. The use of this type of model was likely beyond the scope and means of the initial assessment. However, it will be important to understand, characterize and quantify impacts (sediment and water quality), as well as to communicate risks and impacts to a broad audience regarding the potential catastrophic impacts to fisheries resources from a tailings dam break scenario.
Comment Reference: *Prediction of Dam Breach Parameters, USBR 1998*

Report Section Identification: Chapter 4.4.2.2
Report Page Number: 4-48
Comment: In Box 4-6, EPA suggests that an earthquake return period of 2500 years may be too

short for a tailings dam that could have a life expectancy of 10,000 years after operations cease. The design earthquakes that Northern Dynasty proposed seems reasonable, based on the information presented, but the accelerations used for design must be coupled with details for the structures setting. For earthquakes return periods greater than 2500 years, the design earthquake can be set so high that, should it occur, rivers and streams may be naturally destroyed while the dam itself would be unaffected.

Report Section Identification: 4
Report Page Number: 4-48
Comment: This page states that the maximum credible earthquake (MCE) of 7.8 was used to determine a maximum ground acceleration of 0.44g to 0.48g, which was used in the stability calculations of the dam. The Knight Piesold Report in 2006 titled "Pebble Project Tailings Impoundment A – Initial Application Report" shows an MCE of 7.8 producing a maximum bedrock acceleration of 0.30.
Recommended Change: Correct or explain the rationale for the discrepancy.
Comment Reference: Knight Piesold Report in 2006 titled "Pebble Project Tailings Impoundment Northern Dynasty Minerals, Ltd.ent A – Initial Application Report Page 6 of 24.

Report Section Identification: 4.4.4 Road and Culvert Failures
Report Page Number: 4/63
Comment: The narrative does not recognize BMP of culvert designs, particularly in anadromous stream crossings. Besides the discussion regarding bridges versus culvert crossings, any culvert crossing would be designed to accommodate fish passage except at times of extreme flooding when fish passage through ordinary stream channels may be impeded as well. The evolution of culvert design has greatly advanced in the last 20 years or more.

Report Section Identification: Chapter 5,6 and 7
Report Page Number:
Comment: EPA discusses impacts on fisheries from normal operations and the probability of tailings dam failures and potential negative impacts from single and multiple mines, but fails to compare those statistics with probabilities of other potential negative impacts such as disease, blights, drought, or over-fishing. Consequently, there is no frame of reference for understanding the magnitude of the risk.

Report Section Identification: Chapter 5, 6, 7 and 8
Report Page Number:
Comment: EPA fails to consider reclamation and closure scenarios where mines have successfully operated and closed without major, adverse environmental impacts. No potentials of success for wildlife/mining coexistence, wildlife habitat enhancement, or adaptable species such as sheep and fish incursions into active mining areas. . For example, the Fort Knox Mine and the Red Dog Mine are the locations of the two of the most productive grayling habitats in the state. A Dall sheep ram

has taken up residence on the organic stockpile from the Walter Creek Heap Leach Pad construction at the Fort Knox Mine. Exploration operations at the Pebble prospect were recently delayed because of migratory song bird nesting in a drill rig.

Report Section Identification: Chapters 5 through 9
Report Page Number: 5.0 to 9.0
Draft Comment: Quantitative chemical risk estimates are presented without an initial discussion of the basic risk assessment process of data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization. Of particular importance, the hazard quotient (HQ) method used to describe chemical risks is not clearly defined. Without such introduction, the concept to significant chemical risk may not be easily determined by the nontechnical reader. For instance when presenting hazard quotients of 0.11 versus 1.3 or 190, the reader may deduce that the HQ of 190 presents the greatest risk, but they may not have a clear understanding of the bright line defining risk.
Draft Recommended Change: Provide a summary discussion of the chemical risk assessment process to include defining key terms such as hazard quotient (HQ) and how to interpret such risk estimates.

Report Section Identification: 5.1 Fish Distribution
Report Page Number: 5-1
Comment: In regard to standard risk assessment format, descriptive sections such as 5.1 Fish Distribution are usually part of Problem Formulation. As commented above, and again related to risk assessment format, the actual Problem Formulation section is too general and sections 2, 3, and portions of 4, 5, and 6 provide more specific analysis that could be made part of problem formulation. The purpose being to focus the conceptual models and risk assessment on critical issues. This does get done to some extent, but just not in the problem formulation. The Bristol Bay Watershed Assessment as a whole does not follow a typical risk assessment format. Rather, individual sections are each generally formatted each as their own risk assessments.
Recommended Change: Section 5-1 applies to multiple sections of the report and should be moved to the Problem Formulation section of the report, to augment the very general information currently provided. Alternatively, make a specific problem formulation part of each of Sections 5 and 6, keeping a general conceptual model in Section 3 related to potential impacts, and then refine that broad conceptual model with a conceptual exposure model that better fits the scenarios in each of Sections. Problem Formulation is supposed to focus the assessment on the most important endpoints requiring assessment or investigation. As it is written there is this long laundry list of potential endpoints scattered throughout Sections 2, 3, and 4. The Risk Assessment portions need focus.

Report Section Identification: 5.2 Fish Distribution
Report Page Number: 5.2
Comment: Blanket statements are provided for fish with priority habitats (spawning, rearing, etc.) under the proposed footprint of the storage facilities, but for chum the habitat area under the storage

facility is not shown, and for other salmon the relatively small area of the impacted priority habitat is not mentioned...rather a blanket statement is made that the habitat will be impacted. Making this statement without qualification or reference to further analysis, leads the reader to an initial conclusion of "impact" without understanding extent of that impact. TSF 2 and TSF 3 are often referenced, but are not included on Figures 5-1 through 5-7. Frying Pan Lake and Koktuli Mountain are referenced for, but not included on, Figure 5-6.
Recommended Change: A qualifier or some reference to further analysis in Section 5.2 should be added to provide readers with an understanding of the general size of the impact. It doesn't have to be really specific, or the reader should be referenced to Section 5.2 for further insight to the level of impact. Add TSF 2 and 3 to Figures 5-1 through 5-7. Add Frying Pan Lake and Koktuli Mountain to Figure 5-6.

Report Section Identification: 5.1
Report Page Number: 5.2
Comment: The assessment refers the reader back to Figure ES-3. This figure should be provided in the appropriate section.
Recommended Change: Figure ES-3 should be presented as part of Section 5.1.

Report Section Identification: 5.1.1 Fish Distribution
Report Page Number: Pages 5-2 through 5-7, Figures 5-1 through 5-5 (and ES-4, Figure ES-2) Reported Salmon in the North Fork, South Fork Koktuli and Upper Talarik Creeks.
Comment: The figure comment states that life-stage-specific reach designations are likely underestimates, given the logistical constraints on the ability to accurately capture all streams that may support life-stage use at various times of the year. The limitations in collecting data on fish populations in an expansive in a remote setting. Are there other methods or techniques that could be used to estimate fish habitat populations for areas with higher uncertainty, or less available data?
Recommended Change: Recommend considering a method (or model) for estimating fish habitat (possibly using template reaches, geomorphologic river and stream characteristics) and projecting population based on habitat type for all drainages in the Bristol Bay Watersheds. Understanding impacts of the overall fish population impacts will be needed if assessing the entire Bristol Bay watershed fisheries.

Report Section Identification: 5
Report Page Number: 5-3 through 5-7.
Comment: When reading the text in the Executive Summary, Chapter 2, Chapter 5, Appendices A through F, much discussion is based on the entire Bristol Bay region. However, unless there is a water quality issue downstream or a dam break, the effects to the entire Bristol Bay region would be minimal. The Figure on page 5-3 shows that there is no rearing or spawning area of pink salmon anywhere near the mine disturbance. The Figure on page 5-4 shows that there is no rearing or spawning area of chum salmon near the mine disturbance. The Figure on page 5-5 shows that there is no rearing or spawning area of sockeye salmon in the mine disturbance (although it is close).

The Figure on page 5-6 shows that there is minor rearing or spawning area of Chinook Salmon in the mine disturbance, and the Figure on page 5-7 shows that there is definite rearing or spawning area of coho salmon in the mine disturbance, but it is small in extent and at the head of the watersheds compared to the rest of the entire Bristol Bay region. The Figure on page 5-8 shows significant use by Dolly Varden fish, but this fish does not appear to be of great value in the Bristol Bay region. It appears that the Bristol Bay Watershed Assessment is constantly citing the overall value of Bristol Bay region fisheries but downplays the actual amount of these stream lengths (that have the valuable fish) which would be affected by the mine.
Recommended Change: Depict more accurately the amount of stream segments that are rearing and spawning areas for the valuable fish and which could be affected by the mine and compare them to the total length of rearing and spawning lengths for the Bristol Bay region. It will be seen that the amount of blocked and eliminated segments are a very small percentage of the total for the region.

Report Section Identification: 5.1.2 Spawning Salmon Abundance
Report Page Number: 5-10
Comment: The repetition of the fact that fish numbers were underestimated, similar to the report-wide repetition of the importance of groundwater-to-surface water interactions, seems to be an attempt to influence the reader, without adequate supporting data. In the last sentence of the first paragraph of this section it says true spawner abundance is underestimated by a "…large and unknown factor." It is unclear that this is true for the Pebble Mine area where a large number of headwater streams are present.
Recommended Change: Use site-specific data instead of broad generalizations. Provide the data, summarize, and move on. Remove repetition. Address in uncertainty section if needed.

Report Section Identification: 5.1.2
Report Page Number: 5-10
Comment: It is stated that the abundance counts "...underestimate true abundance by a large and unknown factor" and "…true spawner abundance is probably substantially higher than the values presented…" However, by using the "highest" index counts, it is likely to be representative, or possibly an overestimate of average, and applying this "highest" index count across an entire stream system, or even across large areas (i.e., reaches) of the stream where spawning may or may not occur (because spawning is generally restricted to particular reaches or habitat conditions that do not exist everywhere in the stream), could very well overestimate impacted numbers of fish. In addition, the values presented in Table 5-1 seem to be consistent with the reported numbers of sockeye and Chinook by the ADFG counts since 1955. With over 30 years of data, apparently consistent with the 4 years of data collected for the Pebble Limited Partnership Environmental Baseline Data, using the highest index count may result in an overestimate of the number of impacted salmon. Further, the Northern Dynasty *Tailings Impoundment A Initial Application Report* by Knight Piesold (September 2006) clearly states that TSF areas were selected because of a measured lack of significant populations of anadromous fish. Some level of verification between the EPA estimated

direct fish impact and the Northern Dynasty fish data would seem to be needed.
Recommended Change: Provide discussion on similarity/differences between Pebble Limited Partnership Environmental Baseline Data (2004-2008) data and ADFG (1955 on) data, and be clear and correct on likelihood of over or under estimation of numbers, particularly across stream reaches/areas. It would be prudent to more clearly separate out discussion of effects into those caused by habitat lost under/upstream of the mine and TSF areas (e.g., direct), and those downstream from the mine area (e.g., indirect). Edit language to refrain from broad statements of significance of impact without site-specific data analysis to show it.

Report Section Identification: 5.1.2 and 5.1.3
Report Page Number: 5-10 and 5-11
Comment: Pebble Limited Partnership Environmental Baseline Available reports on spawning and juvenile numbers counted by biologists on and near the proposed mine site. However, the assessment does not present the numbers, locations, or "reaches" where the counts were made. The actual location of the counts is not provided, thus impacts within particular reaches of the streams cannot be calculated/estimated from data provided in the assessment.
Recommended Change: Provide a figure or table that documents where fish count data was collected and where peak counts were located. Provide a better understanding of where the fish are using the habitat and would be directly or indirectly impacted by mine development and operation.

Report Section Identification: 5.2 Habitat Modification
Report Page Number: 5-12
Comment: As an example of the influential tone of the report, in the first sentence of this section tells the reader what "would" happen as a result of ongoing mine operation before any data or rationale is provided. This happens again in 5.2.1. This approach is common in the Bristol Bay Watershed Assessment and is contrary to technical writing where the evidence is provided first to support any conclusions made.
Recommended Change: Start with what is possible or "may" happen to habitat, present the data, then draw conclusions/make rationale using data.

Report Section Identification: 5.1.3 and Table 5-2
Report Page Number: 5-12
Comment: Text as written is that highest reported density of spawners as 25,000 arctic grayling and 16,000 coho, but Table 5-2 reports these as 2,500 and 1,600, a factor of 10 lower. The Pebble Limited Partnership Environmental Baseline Data figures used as sources are consistent with Table 5-2, not with the written text values. Table 5-2 also reports sources for the fish densities as "Tables" when in fact they are "Figures". Also, there is no information provided in the Bristol Bay Watershed Assessment in regard to where these "maximum" fish densities were recorded. The implication being that these numbers are found throughout the potentially impacted area, when in fact, particularly for the North Fork Koktuli, many of the stream reaches within the area of the mine pit and TSF have much lower densities, or no anadromous fish at all, as clearly shown in other tables, figures, and text of the

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Pebble Limited Partnership Environmental Baseline Data.
Recommended Change: Correct text to match table numbers. Correct table Source column from "Table" to "Figure". Clearly state that the North Fork Koktuli numbers come from the main stem of the North Fork Koktuli, not within the pit or TSF footprint.

Report Section Identification: 5.2. Habitat Modification
Report Page Number: Page(s) 5-12 through 5-45
Comment: Section 5.2 Habitat Modification begins to elaborate on the complexities of inter-related impacts and effects on fisheries that were first presented in problem formulation, Section 3.6 Conceptual Models.
Recommended Change: Include a broken out schematic of (or at least refer to) the Conceptual Models originally presented in Section 3, to trace the linkages, effects and impacts to fish in Sections 5.0 and 6.0.

Report Section Identification: Main Report, Section 5.1.3, Juvenile Salmon and Resident Fish Abundance
Report Page Number: 5-12
Comment: The data reported in the text and Table 5.2 differ for Arctic grayling and coho salmon for Upper Talarik Creek.
Recommended Change: EPA needs to report the correct relative abundance numbers in both the text and the table.

Report Section Identification: 5.2.1.1
Report Page Number: 5-12 through 5-162
Comment: The Bristol Bay Watershed Assessment predicts about 10 to 17 square kilometers of wetland losses and 88 to 107 km of stream losses under the direct footprint. The Pebble Limited Partnership Environmental Baseline Data measured wetlands and streams and determined approximately 10 square kilometers of both wetlands and streams are present within and downstream of the minimum mine/TSF footprint. Thus, the general scale of the wetland/stream impact under the minimum mine/TSF footprint is similar between the two documents, but the Pebble Limited Partnership Environmental Baseline Data area of potential impact would be less than the EPA predicted impact area. The 88 to 107 km of stream losses predicted in the Bristol Bay Watershed Assessment cannot be compared directly to Pebble Limited Partnership Environmental Baseline Data data because the Pebble Limited Partnership Environmental Baseline Data reports watershed areas, not km of stream.
Recommended Change: If possible, incorporate actual wetland acreages measured in Pebble Limited Partnership Environmental Baseline Data

Report Section Identification: 5.2.1
Report Page Number: 5-13

Comment: This section provides a discussion about TSF 2 and 3 but these facilities are not on the map within this section.
Recommended Change: Put TSF 2 and 3 on Figure 5-8.

Report Section Identification: Box 5.1
Report Page Number: 5-13
Comment: NWI wetland mapping is based on aerial photo interpretation that is large scale and is not accurate at the scale being used here, particularly for road impacts. Also, NWI data is often 20 to 30 years old. Therefore, while it is appropriate for a large scale screening, it is not acceptable for predicting site-specific impacts without a large potential for error. It is a bit confusing, but it seems 100 meters along rivers and 200 meters along NWI wetlands were set aside as buffers. If the roadway in the mine site passed within these buffers, a hydrological impact was tallied. In addition the road impacts were based on a 200 ft wide road corridor, while "direct fill" was based on a 9.1 m wide roadway. These buffers are quite large and likely overestimate the hydrological impact. This overestimation offsets at least a portion of the purported "conservative" estimate resulting from inaccurate stream and fish presence maps.
Recommended Change: Most regulatory wetland and river buffers are equal to or less than 150 feet. Reducing the buffer to this more accurate area of "impact" would produce a more accurate estimate of impacts to wetlands and rivers along the road corridor.

Report Section Identification: 5
Report Page Number: 5-15 and 5-18
Comment: The two maps on this page show many very minor stream segments which, according to the maps on pages 5-3 through 5-7, simply do not contain the rearing and spawning areas of the fish. It is interesting to note that all the stream segments shown on Page 5-15 are not shown on the maps on pages 5-3 through 5-7.
Recommended Change: Either remove all these smaller segments from the maps on page 5-15 or add the segments to the maps on pages 5-3 through 5-7. Revise Table 5-4 on page 5-18 to include a new column showing the total kilometers of each stream blocked or eliminated by the mine.

Report Section Identification: 5.2.1.2
Report Page Number: 5-16
Comment: The claims of spawning habitat are very broad and undefined. Pebble Limited Partnership Environmental Baseline Data quantifies at least some of this information. Very few sockeye occur in these upper stream reaches. Mostly resident grayling and Dolly Varden. The assessment cannot define or quantify the level impact from this information. In addition, most of the stream reaches within the mine/tailings/TSF are ephemeral/intermittent, reducing anadromous and resident fish use of the streams, possibly making permanent ponds important in the area.
Recommended Change: Incorporate site-specific data. Provide consideration of the intermittent

flow regimes.

Report Section Identification:5.2.1.1
Report Page Number: 5-16
Draft Comment: Text states that loss of headwater habitats will have indirect impacts on fishes and their habitats in downstream mainstream reaches of each watershed. However, it is not prefaced that this assumption does not take into consideration any risk mitigation measures such as stream diversions.
Draft Recommended Change: Preface that this assumption is based on no mitigations measures implemented to reduce potential impacts.

Report Section Identification: Main Report, Section 5.2.1.2, Implications of Headwater Stream and Wetland Loss for Fish
Report Page Number: 5-16
Comment: At the bottom of the page, EPA uses the Anadromous Waters Catalog (Johnson and Blanche, in press) as a reference to the presence of resident fish. The catalog lists anadromous fish only.
Recommended Change: Throughout the entire watershed assessment, EPA needs to use references appropriately. In particular, the Anadromous Waters Catalog (Johnson and Blanche, in press) should not be used to support the presence of resident fish.

Report Section Identification: 5.2.1.2
Report Page Number: 5-19 and 5-20
Comment: This subsection has almost nothing specific to hypothetical mine impacts. Rather it is general discussion of potential fish/stream impacts due to various habitat changes.
Recommended Change: Make discussions/claims of impact specific to the mine scenario.

Report Section Identification: 5.2.1.2; Table 5-3 and 5-4
Report Page Number: 5-17 and 5-18
Comment: Based on available data, many of the stream kilometers within the footprint of the mine/waste rock/TSF do not have anadromous fish, and some do not have any fish. Providing the complete list of streams in a table with the column of species present is a drastic oversimplification of any decent measure of actual impact. For example, while sockeye have been found in the mine footprint, there are very few present. This nuance is lost in the assessment analysis. Also, there is no analysis of what percentage of the river kilometers is spawning areas versus rearing, nor of what percentage of the sub-basin and entire basin these river reaches represent. There is no way for reviewers to translate the EPA information into an actual impact on fish nor on the economy of Bristol Bay.
Recommended Change: Provide site-specific analysis and detail of the estimated number of each species (spawners and juveniles) of importance that would be lost, and relate that to total number of

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fish returning and escapement in the basin.

Report Section Identification: 5.2.2.1
Report Page Number: 5-21 to 5-27
Comment: There is no discussion of the fact that much of the South Fork Koktuli is dry in summer under current natural conditions, and as described in the Pebble Limited Partnership Environmental Baseline Data, that much of the lost water in the mid South Koktuli flows underground to the Upper Talarik in the vicinity of UT100B. Basically, the actual dynamics of surface water and groundwater flow and water needs for the mine are so potentially variable that it is currently not reasonable to estimate the actual stream dewatering downstream of the mine pit/waste rock/TSF. Regardless, even under EPA essentially worst case dewatering, the North Fork Koktuli and Upper Talarik are within about 8% of their natural capacity before they reach a major confluence. The South Fork Koktuli is more impacted, but it is also naturally dry (a losing stream) in many portions of its upper reaches so the impacts to fish may not be as dramatic. The Pebble Limited Partnership Environmental Baseline Data stream flow data shows that best fish conditions are below high flows. Thus, a slight reduction in flow along some reaches may actually increase favorable spawning and rearing conditions during some portion of the year. And finally, there is inadequate accounting for water that is "upstream" of the TSFs or the mine pit.
Recommended Change: A better grasp on groundwater flow dynamics and water provided into the mine pit, get better design information on TSF and TSF dam to determine potential flow through/under tailings and dam. Use site-specific information on fish presence and stream flow to calculate likely potential impacts to fish, and then relate these impacts to the watershed fish population.

Report Section Identification: 5.2.2 Effects of Downstream Flow Changes
Report Page Number: Page(s) 5-21 through 5-27
Comment: Section 5.2.2.1 Streamflow (Loss or Reduction) section estimates percent loss in stream flow and qualitatively discusses impacts on stream, floodplain and wetland habitat as a result of reductions in streamflow. Page 5-31, Section 5.2.2.3 discusses flow alteration thresholds for assessing fish habitat impacts.
Recommended Change: Include flow alteration thresholds, or refer to streamflow alteration thresholds, as part of streamflow loss discussion in Section 5.2.2.1, rather than in 5.2.2.3 (or cross reference).

Report Section Identification: 5.2.2.1
Report Page Number: 5-25
Comment: The "start-up" assumption that all precipitation is "consumed" by the mine seems very conservative. Even if they used it all, a significant portion would seem to be discharged

somewhere. If into the TSF, then groundwater will either flow out of the TSF or have to be captured, treated, and released.

Also on this page under the "minimum mine size" paragraph, 1% to 15% of the water is assumed to be returned to the streams. Yet, the most impacted stations have a higher effect than under the start-up conditions. There is no explanation of this increased impact at some stations when water is being returned to the streams.

In addition, all of the predicted stream dewatering is dependent on water balance for the mine, which is critically dependant on how much water actually is removed from the mine pit. No information is provided related to this critical groundwater flow through the subsurface to the mine pit, or through the subsurface underlying the TSFs. If not enough water coming into pit, then where will water come from? If too much water coming into pit, then there may be treatment and discharge into streams.

Recommended Change: If using a worst-case or "Reasonable Maximum" scenario, clearly state such, and provide some description of the conservative nature of the estimates of water extraction from the stream systems. Provide better summary understanding of the assumptions related to where water is coming from and going to.

Report Section Identification: 5.2.2 Effects of Downstream Flow Changes

Report Page Number: Starting on 5-21

Comment: There has obviously been some thought put into the potential changes in flow around any potential mine site. At this point, this examination can only be theoretical, but putting it in the assessment document makes it seem like the worst possible outcome. The interactions of the ground and surface water hydrology in that area are extremely complex. The uncertainty of the impacts from any disturbance should be emphasized. The importance of the surface and subsurface flow to spawning and rearing salmon cannot be understated. The theoretical treatment of this in the assessment suggests it can predict a possible outcome that in actuality cannot be predicted.

Recommended Change: Explicitly state the theoretical nature of these possible outcomes and emphasize the uncertainty.

Report Section Identification: 5.2.2.3 Table 5-13

Report Page Number: 5.41

Comment: The concepts behind this table provide some evidence of the potential for stream flow changes as a result of the proposed mine. However, the distance between stream stations used makes accurate predictions are problematic, and the text provides repeated warnings about the variability likely to be involved in the predictions. Thus, without better definition of site conditions, and incorporation of the site-specific stream flow data collected and reported for the Pebble Limited Partnership Environmental Baseline Data, the EPA analysis presented in Table 5-13 is inaccurate. In addition, there is no direct correlation made between the predicted reduced stream flows and actual impacts to fish, rendering the stream flow analysis ineffective.

The most that can be said under the assumptions provided is that some level of stream flow reduction would be realized, and this would have some an unquantified impact on fish populations.

Recommended Change: Incorporate better site-specific mine and stream flow conditions and relate directly to measured fish/salmon presence and impact.

Report Section Identification: 5.2.3
Report Page Number: 5-45
Comment: Thirty five pages of text, tables, and figures leads to the statement that the volume of water needed to maintain reasonable stream flows is unknown. And no relationship is provided between stream flow and fish impact. This is not really a risk characterization because there is no actual quantification of risk to stream flow or fish.
Recommended Change: At a minimum provide some risk summation for stream flow. Ideally, get more site-specific information to reduce uncertainties and then relate stream flow alteration to a quantified fish impact so it can be compared to overall fish population numbers in the sub-basins, basins, and overall watershed.

Report Section Identification: 5.2.3 Risk Characterization
Report Page Number: Page 5-45
Comment: Section 5.2.3 discusses hydrologic flow regime and water quality mitigation (avoidance) requirements for maintaining downstream flow rates and timing, water quality and temperature for fish. The section generally refers to a water storage and release system for maintaining downstream flow conditions. The section implies that this may be technologically significant, costly and possibly infeasible. Unless the discussion is expanded, the validity of this statement is unknown. The discussion should expand on what this structure is, the likely size and components (i.e. a water storage dam and pipe release system). There are risks associated with operation of this structure that could impact downstream fisheries resources that need to be discussed. Also, mitigation alternatives to the water storage system, i.e. stream and wetland mitigation, are not discussed but should be referred to as mitigation alternatives.
Recommended Change: Expand discussion of what type of structure would be necessary for on-site water storage flow mitigation, the risks associated with this structure, and potential alternative off-site stream and wetland mitigation. Also tie the flow regulation discussion to regulatory requirements under the Clean Water Act, Alaska Pollutant Discharge Elimination System (APDES) permits, Corps 404 permits and other State of Alaska permits.

Report Section Identification: 5.3.1
Report Page Number: 5-48
Comment: It is reported that between 5 million and 48 million cubic meters of water exceed mine needs. Why isn't this brought into the analysis or risk characterization of stream flow reductions in the previous section? It seems likely this amount is adequate to keep impacted stream flows at levels protective of fish in the reaches downstream of the mine pit/waste rock piles/TSFs.
Recommended Change: Incorporate potential water returns to the streams in Section 5.2

Report Section Identification: 5.3.1
Report Page Number: 5-48 to 5-52

Comment: While this section does discuss some preliminary "Exposure" issues, it doesn't examine and/or exclude exposure pathways for particular species or stream reaches, nor does it quantify exposure. The discussion is solely limited to aquatic life.
Recommended Change: Incorporate discussion of exposures of resident versus anadromous species. Elaborate on concern for anadromous egg and juvenile fish survival.

Report Section Identification: Vol 1 Section 5.3.1
Report Page Number: Page 5-49 through 5-55
Comment: The biotic ligand model is used to derive criteria on page 5-49 despite not being introduced until page 5-53. The values for copper derived from the biotic ligand model in Table 5-14 and 5-15 do not match the values in Table 5-19. East and West Pre-Tertiary values are swapped. Table 5-19 shows the acute criterion for the biotic ligand model for Pebble West Pre-Tertiary to be 0.43 µg/L. Table 5-15 on Page 5-50 shows it as 0.043 µg/L. All the biotic ligand values derived for copper need to be verified and accurately labeled in Tables 5-14 through 5-16 and Table 5-19. These values are used to derive dilution calculations highlighted on page ES-21. Furthermore, the chronic criteria are 10 and 90 times more stringent for the biotic ligand model than the state's water quality standards for the West and East Pre-Tertiary waste rock respectively. This is a significant difference. The lead in sentence to Table 5-19 should provide table references for the mean chemistries of the waste rock leachates. See comment for pages 5-53 to 5-37.
Recommended Change: Move Tables 5-14 through 5-16 to after Table 5-19 or remove the biotic ligand model derived criteria from Tables 5-14 though 5-16. Provide a footnote for the column header "Average Value" indicating number of leachate tests performed. Review inputs and outputs from the biotic ligand model and correct errors in values and references to East and West Pre-Tertiary waste rock in Tables 5-14, 5-15, 5-16, and 5-19.

Report Section Identification: 5.3.2
Report Page Number: 5-53
Comment: This section is a simple risk-based screening comparing average untreated waste rock leachate metals concentrations to water quality criteria. This assumes 100% exposure of all aquatic species in all streams. The results were a predicted potential for risks due to aluminum, copper, and zinc, with the greatest indicated concern being copper. Using the biotic ligand model significantly increases the predicted risks for copper. The screening concentrations predicted by the biotic ligand model are strongly related to the amount of organic material in the water. The assessment set dissolved organic carbon to 1 mg/L but provided no specific reasoning as to why, other than that dissolved organic carbon is expected to be low and 1 mg/L was the lowest possible in the model calculations. Background levels of dissolved organic carbon were measured in the Pebble Limited Partnership Environmental Baseline Data to be approximately 1.5 mg/L. Regardless, the screening suggests the potential for effects to aquatic life if untreated waste rock

leachate were discharged to streams.
Recommended Change: Clearly justify use of 1.0 mg/L dissolved organic carbon. Discuss or provide evidence of how toxicity may change downstream as concentrations of metals decrease and organic matter concentration likely increases. May be able to use data from Pebble Limited Partnership Environmental Baseline Data as dissolved organic carbon was measured, and in the North Fork Koktuli ranged from 0.5 to 4.55 mg/L

Report Section Identification: 5.3.2.2
Report Page Number: 5-53 to 5-57
Comment: This analysis of copper toxicity shows that the biotic ligand model provides a "protective" risk-based screening concentration. This method is likely overprotective as calculated because of the sensitivity of stream invertebrates used to develop the model/criteria. A site-specific investigation could provide a more accurate and meaningful evaluation of water quality criteria that would be protective of aquatic life.

Report Section Identification: Vol 1 Section 5.3.2.2
Report Page Number: Page 5-57 (Pg 210 of 339)
Comment: Third line states "bioconcentration factor of 2,000 L/kg". Bioconcentration factors are unitless. 2000 also seems very high, so is it what it says it is?

Report Section Identification: 5.3.2.2
Report Page Number: 5-57
Comment: The section on "analogous" sites is too general to be of use in risk determination. It raises the issue of the adequacy of current water quality criteria, but there is not enough information provided on conditional differences between analogous sites and the Pebble Mine site to make any inferences. Water quality, leachate parameters, acidity, water flow, stream substrate, stream invertebrate assemblages, among other conditions all may be different. The research cited in this section also suggests that there may be impacts to stream macroinvertebrates at concentrations below the water quality criteria, but essentially there is no quantification of the potential impact or the level below the criteria that is unacceptable. One article suggests a factor of 10 below the criteria provided acceptable protection. This argument would seem to be more appropriate in setting new criteria, and until such criteria are provided, there doesn't seem to be any basis for requiring concentrations below EPA approved Alaska Water Quality Criteria, apart from an APDES permitting process that takes into account site-specific conditions. No discussion is provided on any "acceptable" level of impacts to stream invertebrate populations while maintaining healthy fish populations. Siltation of the streams with contaminated sediment should be a principal concern in any mine development/permitting and effects determination.
Recommended Change: Further examination of site-specific mine conditions and potential

impacts should include stream invertebrate sampling, enumeration, and analysis to establish baseline conditions.

Report Section Identification: 5.3.2.2
Report Page Number: 5-57 to 5-58
Comment: The "uncertainties" section just states that the existing criterion may not be protective. It does not state that it also may be overly protective, depending on stream conditions at the mine. Invertebrates in many of the streams may already be impacted by naturally high metals concentrations....or the natural intermittent flow regimes of many of the streams and minor tributaries. Sensitive invertebrate species may not be present. Consideration of only the possible non-protective nature of water quality criteria, without discussion of many, many other uncertainties biases the report. Overall, Section 5.3.2.2 is a very simplified assessment of potential impact. Hence the need for site-specific analysis.

Report Section Identification: 5.4
Report Page Number: 5-59
Comment: Essentially, the opening paragraph for this section says "Roads are nearly always bad for streams" supported by a 40 year old citation. Whether intentional or not, the authors portray a biased approach to the Bristol Bay Watershed Assessment. Roads CAN be bad for fish and streams, especially lots of roads. One well-designed and managed road/bridge/culvert across/near a stream would seem to be unlikely to result in significant biological impacts to fish and wildlife populations, but traffic levels, traffic timing, road design, and other factors all play into the impacts. Management of these factors may be necessary. One road may lead to other roads and more human presence. This should be a consideration in approving/denying road/mine permits.
Recommended Change: Move first two paragraphs to an appropriate subsection on impacts. Move third paragraph up to be the introductory paragraph.

Report Section Identification: 5.4 Roads and Stream Crossings
Report Page Number: Page 5-59
Comment: The opening section has several general and broad sweeping statements regarding roads impacts on stream and river conditions. In particular, the statements are phrased such that it implies roadway impacts are broad and can propagate significant distances upstream and downstream. The following statement needs some sideboards "*The physical effects of roads on streams and rivers often propagate long distances from the site of a direct road incursion, as a result of the energy associated with moving water (Richardson et al. 1975).*" For instance, a culvert located on a steep stream (say greater than 6% slope) will not likely have extensive (several kilometer) upstream and downstream effects on the stream and floodplain due primarily to the steep valley slope.
Recommended Change: Rephrase sentence to emphasize that improperly designed road crossings

and road crossings on flat, alluvial channels and floodplains could potentially affect and impact streams for significant distances upstream and downstream.

Report Section Identification: 5
Report Page Number: 5-59, 5-65 and 5-74
Comment: The pages state that the transportation corridor crosses 34 streams and rivers. As stated in the Executive Summary "The most likely serious failure associated with the transportation corridor would be blockage or failure of culverts". This is readily avoided through either small bridges or very large culverts or a series of culverts designed to handle extremely large events. Given the sensitivity of the rivers and streams to the fisheries, the company should be required to build long lasting crossings that would not plug up. It will cost additional money to build these crossings but they would avoid the type of plugging impacts discussed on these pages.
Recommended Change: Add language that these impacts would most likely be avoided in the permit process by requiring significant long lasting crossing designs.

Report Section Identification: 5.4.1 through 5.4.6
Report Page Number: 5-59 to 5-64
Comment: These subsections are not risk assessment. There are no set conditions defined that, if met, would constitute risk or no risk. There is no comparison of likely conditions to acceptable conditions. Thus, there is no assessment of risks. Rather, there is just a litany of potential effects listed. Essentially, the risk characterization for these subsections reiterates that any and all of the bad things related to roads "could" happen. It does not provide that any specific risks would, or are likely to, occur. Without this, the section is just saying, "there is a risk of these things happening", without any likelihood estimation. Without some form of likelihood or some thresholds, any decision making or conclusions become based on individual interpretation and not a shared basis of understanding.
Recommended Change: Conditions or design thresholds, or a range of such, must be described that, if not met, could/would result in ecologically unacceptable conditions.

Report Section Identification: Vol 1 Section 5.3.4
Report Page Number: Page 5-59 (Pg 212 of 339)
Comment: The first bullet says "Some leachate and process water constituents have no water quality criteria (e.g., sulfate), or the criteria and standards are based on old literature." There is an Alaska water quality standard for sulfate; it may not exceed 250 mg/L (see 18 AAC 70.020) What is the definition of "old"? Would it be better to say that for some criteria new information supersedes the current standard (if that is the case?).

Report Section Identification: Main Report, Section 5.4, Roads and Stream Crossings
Report Page Number: 5-59

Comment: The assumptions regarding the number of culverts and bridges may be inaccurate. On numerous occasions, ADF&G has communicated to the Pebble Limited Partnership the desire for bridges at all stream crossing locations. Bridge designs, not culverts, will be the starting point for each considered road crossing.
Recommended Change: The watershed assessment should reflect ADF&G's preference for bridges instead of culverts and the roadway risks/impacts discussion should focus on possible effects of bridges on stream habitat and fish resources.

Report Section Identification: 5.4 Road and Culvert Failures, Stormwater Runoff
Report Page Number: 5/59
Comment: The narrative implies that only roads can have negative effects on stream passage. Flood events can have substantive changes in the natural stream environment in regards to 'modification of drainage networks, acceleration of erosion processes, which, in turn, can lead to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and the stability of slopes adjacent to streams.' The assumption that roadway salts would be used for general winter maintenance is a considerable jump. BMPs for roadway maintenance in winter climates depend largely on the temperatures, existing road surface, type and rate of vehicle travel, and other considerations. In colder climatic conditions, salts are not utilized for winter maintenance. If salts/brines are used for winter maintenance they are typically used on paved roadways. Given the heavy vehicle traffic this road would carry, this writer assumes a non-paved surface for the major roadways.

Report Section Identification: 5.4 Road and Culvert Failures, Stormwater Runoff
Report Page Number: 5/59
Comment: The narrative implies that only roads can have negative effects on stream passage. Flood events can have substantive changes in the natural stream environment in regards to 'modification of drainage networks, acceleration of erosion processes, which, in turn, can lead to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and the stability of slopes adjacent to streams.' The assumption that roadway salts would be used for general winter maintenance is a considerable jump. BMPs for roadway maintenance in winter climates depend largely on the temperatures, existing road surface, type and rate of vehicle travel, and other considerations. In colder climatic conditions, salts are not utilized for winter maintenance. If salts/brines are used for winter maintenance they are typically used on paved roadways. Given the heavy vehicle traffic this road would carry, this writer assumes a non-paved surface for the major roadways.

Report Section Identification: 5.4.2
Report Page Number: Page 5-60 (Pg 213 of 339)
Comment: "During runoff events, traffic residues produce a contaminant "soup" of metals (especially lead, zinc, copper, chromium, and cadmium), oil, and grease, which can run off road surfaces, enter streams, and accumulate in sediments (Van Hassel et al. 1980) or disperse into

groundwater (Van Bohemen and Van de Laak 2003)."

There is no mention of whether this report related metals to runoff from highway traffic roads or traffic similar to that expected at the Pebble project. The source of metals in the sediments may be from other sources than traffic if the findings of two other studies are considered; see information at the links: http://www.sciencedirect.com/science/article/pii/S0043135498003960 and http://www.sciencedirect.com/science/article/pii/S0160412096000803.

Report Section Identification: 5.4.1 Roads and Stream Crossings
Report Page Number: Page 5-60
Comment: The following statement needs revision. "*This can lead to increased channel scouring and down-cutting, streambank erosion, and undermining of the stream crossing structure and fill.*"
Recommended Change: Revise statement "*This can lead to **localized** increases **in** channel scouring and down-cutting, streambank erosion, and undermining of the stream crossing structure and fill.*"

Report Section Identification: 5.4.4 Road Crossings as Barriers to Fish Movement
Report Page Number: Page 5-60 & 5-61
Comment: The risks and impacts to fish passage may be overstated using new culvert design standards that are designed to accommodate fish passage. Also, many of the culvert impacts described (such as erosion and floodplain connectivity are very localized). Last sentence of the section states "*These potential reductions in downstream habitat quality and inhibited fish passage could occur in the 14 culverted streams that support salmonids.*" Previously in the section on Page 5-60, it states that there are 17 culverted streams supporting salmonids. The report then again refers to 14 culverted streams on page 5-74.
Recommended Change: The culvert and impacts should attempt to estimate aerial and spatial extent of fish impacts using current fish passage design standards for culvert design. The reason for this is that if fish passage is provided a majority of the time (with the exception of flood peak periods, washouts and blockages), then secondary effects of culverts including erosion and floodplain connectivity will be minor in the grand scheme and can likely be mitigated for. Reconcile the difference in the number of culverted streams supporting salmonids.

Report Section Identification: 5.4.2
Report Page Number: Page 5-61 (Pg 214 of 339)
Comment: "Fish mortality in streams has been related to high concentrations of aluminum, manganese, copper, iron, or zinc, with effects on populations recorded as far as 8 km downstream (Forman and Alexander 1998)." This report can be found at

http://www.edc.uri.edu/nrs/classes/nrs534/NRS_534_readings/FormanRoads.pdf.

The statement of impacts 8 km downstream actually comes from the reference in Forman and Alexander's report, i.e. Morgan E, Porak W, Arway J. 1983. Controlling acidic-toxic metal leachates from Southern Appalachian construction slopes: mitigating stream damage. *Transp. Res. Rec.* 948:10-16s

Why this is quoted is not obvious when the Assessment continues with "Although this is an important issue for streams near highways, it is unlikely that a mine access road would have sufficient traffic to significantly contaminate runoff with metals or oil."

Recommended Change: Just state realistic issues, as the sentence in 5.4.2 says: "the salts or other materials used for winter treatment of roads could present a significant issue". If this was done it would remove any perception that a bias is being presented in the report, which is to provide information on possible impacts, not impossible or improbable impacts. Even this statement about salts is brought into question when in Section 5.4.6.1 it says "Roads are treated with salts and other materials to reduce dust and improve winter traction. In Alaska, calcium chloride is commonly used for dust control and is mixed with sand for winter application. During periods of rain and snowmelt, these materials are washed off roads and into streams, rivers, and wetlands, where fish and their invertebrate prey can be directly exposed. We found no relevant data for chloride levels in streams treated in this way."

Report Page Number: 5-61

Comment: EPA references the Memorandum of Understanding (MOU) between ADF&G and ADOT&PF as a statewide standard for culvert installation on fish-bearing streams. This MOU is not a statewide standard for all entities; rather, it simply serves as an agreement between the two agencies that establishes a tiered approach to culvert installation and some minimum design requirements.

Recommended Change: The watershed assessment should make it clear that statewide standards for culvert design and installation currently do not exist. ADF&G evaluates each proposed culvert installation on a case by case basis.

Report Section Identification: 5.4.6.3

Report Page Number: 5-63 (Pg 216 of 339)

Comment: Says "Additionally, 19.4 km of roadway would intersect wetlands within and beyond those mapped by the National Wetlands Inventory (NWI). Runoff from these segments of roadway could have a significant impact on these wetlands."
Are there any examples or studies that can back up this statement?

Report Section Identification: 5.4.8.2 Stream Length Upstream and Downstream from Crossings

Report Page Number: Page 5-65

Comment: Last sentence states "*The length of stream upstream of the transportation corridor*

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likely to support fish, based on a stream gradient higher than 10%, is 240 km." The sentence should state "*gradient less than 10%...*"
Recommended Change: Reconcile sentence and Table 5-22.

Report Section Identification: 5.4.7.3
Report Page Number: 5-65
Comment: Filling of wetlands would definitely impact wetlands, but it would not necessarily eliminate habitat for salmonids unless the wetland was directly connected to a salmonid-bearing stream, or was a salmonid-bearing wetland. Placement of roads and stream crossings is, no doubt, critical in any such impacts. But, there are already rules for mitigation requirements related to wetland impacts. Thus, any such impacts would require mitigation for lost area, functions, and values, according to federal rules/regulations. The level of mitigated impact cannot be assessed from information provided within the Bristol Bay Watershed Assessment.
Recommended Change: Use site-specific road alignment data to predict level of impact, required mitigation, and any remaining impact/risk.

Report Section Identification: 5.4.8.1
Report Page Number: 5-65
Comment: The first sentence of this subsection is overstated. In the third sentence, should this be rephrased to "potential" high impact areas? According to Pebble Limited Partnership Environmental Baseline Data, there is already a road along Chinkelyes Creek from the coast to the Iliamna. If so, Pebble Limited Partnership actions may improve current road conditions.
Recommended Change: Edit text to eliminate overstatements and acknowledge there is no current impact and changes might be able to be made to alleviate some/all of the purported impacts. Note where there is any existing roadway along or near the proposed road, and what the impacts have been. Existing roads provide empirical evidence of direct impacts. They do not account for increased use-related potential impacts.

Report Section Identification: 5.4.8.2
Report Page Number: 5-65
Comment: Similar to section 5.4.8.1, total potential worst-case impact is implied and assumed. The assumption that significant impacts occur on every crossed stream both upstream to non-fish bearing conditions, and downstream to an outlet, grossly overstates and misrepresents likely impacts. It is not clearly stated how upstream portions of streams will be impacted. In earlier portions of the Bristol Bay Assessment it is stated impacts MAY extend to 200 meters away from the road.

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However, later in the assessment, it implies the impact can be measured miles downstream and upstream. The mileage represented in Tables must be qualified such that is does not imply impacts to the entire mileages listed.
Recommended Change: Provide discussion about the level of impacts close to the road and account for the distance downstream where impacts are ameliorated, particularly for those streams that are crossed only once and/or do not have any fish in them near the road crossing.

Report Section Identification: Figure 5-15
Report Page Number: Page 5-67 (Pg 220 of 339)
Comment: Question: Why is the road shown going into and out of lakes?

Report Section Identification: 2.2.3 Salmon-Mediated Effects on Wildlife
Report Page Number: 5-74
Comment: Salmon reductions caused by mining are speculated to "cause roughly proportionate declines in bears, wolves and bald eagles". The amount of decline would not likely be proportionate as salmon only constitute a portion of these species' diet. In the case of wolves, salmon may be a rather small component of the diet. The effects of reduced salmon would depend on the amount of the reduction of salmon in the diet and the relationship between salmon intake and vital rates. In addition, predators and scavengers utilizing salmon resources may interfere with each other resulting in imbalanced effects on different populations.
Recommended Change: Quantify the salmon-mediated effects better.

Report Section Identification: 5.4.10
Report Page Number: 5-74
Comment: Because a stream by stream assessment has not been done and actual stream crossings have not been designed or located, it is impossible to determine the actual impacts. The purported "likely" diminished production on 510 km of 30 streams is likely a significant overestimate of potential impacts.
Recommended Change: Examine width of stream versus width of flood plain and determine whether culverts would be adequate to maintain stream function and fish passage and where bridges are required to do the same. Given use of appropriate culverts, bridges, and road construction practices, estimate damages downstream, within the most likely length of impact, (200 meters?).

Report Section Identification: 5.4.10 Overall Risks to Transportation Corridor to Salmon Populations
Report Page Number: Page 5-74
Comment: Section states that magnitude of changes in fish populations cannot be estimated at this time. Estimates of effects and impacts on physical habitat (such as length of stream, areas of wetland loss, and percent time of fish passage barriers) could be summarized, similar to other sections where physical habitat effects are reported rather than estimated effects on fish populations.

Recommended Change: Recommend summarizing physical habitat effects, where feasible.

Report Section Identification: 5.5
Report Page Number: 5-75
Comment: Without some quantification of impacts to fish, it is impossible to quantify impacts to salmon-mediated effects on wildlife. It is not clear that impacts on wildlife would be proportional to impacts on salmon caused by the road because much wildlife can move long distances…as stated in the early sections of the Assessment. No analysis is made of roadway corridor effects on wildlife. This is purposeful, keeping impacts related to salmon, but may underestimate actual risks to wildlife. This could be stated in this section of the Assessment.
Recommended Change: Rewrite the Assessment with site specific information, or allow Pebble Limited Partnership to provide detailed permitting documents, then review/estimate likely impacts to fish and wildlife.

Report Section Identification: 5.6
Report Page Number: 5-75
Comment: The text states that any negative impact on fish could lead to negative impact on the health and welfare of Alaska Natives. Yet, of the 40,000,000 (high range) fish returning to the Bristol Bay region, it was stated earlier that approximately 150,000 are taken for subsistence. The assessment assumes that "any" impact to fish populations would necessarily result in a proportional impact to Alaska Native subsistence fish use although the relative taking of subsistence fish is small relative to the taking of commercial fish.
Recommended Change: Present a more detailed or at least report more precisely the numbers of salmon used for subsistence versus the total number of fish, and discuss the balance that could be adjusted between escapement, commercial, and subsistence fish harvest, particularly if a more detailed economic analysis shows the mine is more economically valuable than slight losses to the commercial fish industry.

Report Section Identification: 5.6
Report Page Number: 5-76
Comment: The statement that "some" residents use the area of the road corridor, and "some" negative effects on salmon habitat "would" result in displacement of subsistence users is unfounded. As presented in the next sentence, the road may actually bring more subsistence users to easily accessible streams, resulting in a bigger impact than the road itself. If 500 salmon return each year to a stream, and subsistence users only collect 50, then a 2% decrease in salmon populations returning to the river will not have any impact on subsistence use. In fact, it may go unnoticed. The road itself may have a positive impact to subsistence culture by increasing access in contrast to the direct negative impact to fish and wildlife of the road corridor.
Recommended Change: Provide quantification of salmon impact, use subsistence road use information to determine if it preferentially brings more subsistence users to the easier accessed rivers. Discuss whether Native Alaskans use roads and the positive and negative impacts roads

may have on subsistence culture. Overall, this section is poorly substantiated. Need to define what is likely, and then provide a range of variation around what is likely.

Report Section Identification: Chapter 6
Report Page Number: 6-1
Comment: Current practice across a broad spectrum of engineering and industry for risk management is to conduct a form of risk evaluation referred to as a Failure Modes and Effects Analysis (FMEA). The FMEA process is used to identify and focus in on aspects of the design with the highest relative probability of failure and the greatest consequences. An integral part of an FMEA is the identification of mitigation measures that must be implemented to ensure that any failure modes for which there is a significant consequence and risk are mitigated to the extent necessary to reduce risk to tolerable limits. These aspects are then reviewed in additional detail and measures to mitigate the risk by reducing the probability of failure are designed into the feature. For significant projects, the risk evaluation may be advance to a formal engineering risk assessment that quantifies the risk in more detail. The Assessment fails to recognize these basic risk management tools.

Report Section Identification: Chapter 6
Report Page Number:
Comment: Since the performance of Failure Mode and Effects Analyses (FMEAs) and the requirement to implement risk mitigation measures to reduce risks is the practice in Alaska, and therefore Bristol Bay, the risk to salmon ecosystems should be included in the FMEA for any dam on a mine of any size or nature. If appropriately applied the risk to salmon ecosystem habitat should be addressed on a mine by mine and/or cumulative mines basis (for actual cases) and should ensure that only mines which meet the test of acceptable risk are permitted to be developed. If the mitigation measures required to render tolerable risks result in unfavorable project economics, then development of the mine would need considerable re-evaluation.

Report Section Identification: Chapter 6.1
Report Page Number: 6-1
Comment: The dam failure analysis assumes an extreme event while the probable maximum flood (PMF) is occurring, and that the dam failure is the worst possible (a full breach of the dam), and the breach results in loss of the maximum reasonably anticipated amount of tailings (20%). This is at the extreme limit of possible concurrent consequences, and the absolute worst for salmon impacts. The likelihood of the PMF is extremely low. High hazard dams are all equipped to contain or pass the PMF. Hence there is also an extremely low probability that the dam will fail if the PMF did occur. There are also a number of failure consequences other than the extreme consequence of a breach and 20% tailings discharge, should 'a failure' occur. Thus the combination of a failure of this particular type with this particularly severe consequence is a very special case of failure with a probability much, much less than the failure probability derived from historic dam failure records. No examples of A failure of a tailings dam constructed by the downstream method with a height of

over 150 meter under any circumstances are in recent literature.

Report Section Identification: Chapter 6
Report Page Number: 6-1
Comment: The EPA assessment appears not to recognize the FMEA process or the benefits and consequences of applying the FMEA process and subsequent requirement for the implementation of the risk reduction measures to reduce risks to acceptable levels. Certainly the generic treatment of a 'mining scenario' which has not been thoroughly tested and optimized through the application of the FMEA and risk mitigation, together with the extreme size and extreme consequences assumed in the assessment results in a biased and unrealistic characterization of the true risk.

Report Section Identification: Vol 1 Chapter 6, Introductory paragraph
Report Page Number: Page 6-1 (Pg 231 of 339)
Comment: Why would the failure of a tailings slurry pipeline not be considered a significant risk to fish?

Report Section Identification: 6.1
Report Page Number: 6-1
Comment: What evidence is there regarding the 20% volume of tailings that would mobilize during a failure?
Recommended Change: Provide justification for the 20% or whatever percentage is most likely.

Report Section Identification: 6.1.1 Overview of a Tailings Dam Failure
Report Page Number: Page 6-1 through 6-2
Comment: The tailings dam failure scenarios evaluate the partial and full, breach, flood and sediment transport scenarios. Reading further into the report, such as Box 6-2, Page 6-15 the Nixon Fork Mine release highlights the variability in scale and types of failures that could occur with the tailings facilities. In order to have a comprehensive understanding of risks, a failure mode analysis should be performed on each of the major structures. For instance, the TSF facilities may have failures such as minor overtopping (as compared with the full breach scenario) on fairly frequent basis that cause chronic aqueous and sediment transport related contaminant exposure events that over the long term cumulatively have significant impacts to the downstream reaches. There are likely several other "failure" modes that are much more probable to occur (such as dam drainage and treatment equipment failures), and would have fairly significant impacts to downstream ecosystems. The assessment does not provide relative quantification of impacts, which will eventually be needed to fully evaluate the project or any proposed development in the Bristol Bay watershed.
Recommended Change: Sections 4.3, 4.4 and Section 6.1 should expand the mine failure modes to understand the more common and more likely failure mechanisms and potential impacts, in addition to the bookend No Failure and Failure. Recommend using probabilistic risk and failure assessment methods to identify Likely Failures.

Report Section Identification: 6.1.1
Report Page Number: 6-2
Comment: A tailings storage facility dam failure is the single most significant potential impact of the dam. Yet no site-specific sediment volumes are estimated or calculated and no site-specific sediment transport study was completed. The generalized discussion provided in these "failure" sections may provide some good description, but there is no substantiating evidence provided to support the hypotheses provided.
Recommended Change: Calculate likely site-specific sediment volumes that would be mobilized during dam failure and do a site- and stream-specific sediment transport study.
Comment Reference:

Report Section Identification: 6.1.1
Report Page Number: 6-3
Comment: Here the "long winter season" would not allow access, but the long winter and freezing conditions are not mentioned or evaluated in the water balance or fish use discussions.
Recommended Change: Incorporate effect of freezing conditions during the long winter season on water balance and fish use of small shallow streams and lakes.
Comment Reference:

Report Section Identification: 6.1.2
Report Page Number: 6-2
Comment: Lower dam height is listed as 107 meters here but is 98 meters in the introduction to this section.
Recommended Change: Use consistent facts and figures.

Report Section Identification: 6.1.2.1
Report Page Number: 6-4
Comment: The use of Mt. St. Helens as an example is incomplete. There is no discussion of the presence, impact, or return of fish to the streams. In addition, the discussion of transport of fine sediment into the main stem Koktuli, Mulchatna, and Nushagak is inadequate.
Recommended Change: Provide a more detailed analysis of the short-term and long-term impacts of Mt. St. Helens on fish and wildlife resources and a full analysis of sediment transport downstream to the larger tributaries. This analysis should then be applied to the area of study of the assessment.

Report Section Identification: 6.1.2.3 Risk Characterization
Report Page Number: 6-8
Comment: The personal communication reference is incorrect. River-rearing sockeye salmon can

contribute 20% or more of the total sockeye return to the Nushagak district; these fish are not "sea-type" sockeye as the report indicates. In the Nushagak River, there is a significant contribution of sockeye that are not associated with a lake but may be rearing in side channels, sloughs, or oxbows.
Recommended Change: Edit the personal communication reference to accurately reflect the conversation.

Report Section Identification: 6.1.2.3
Report Page Number: 6-8 through 6-10
Comment: Chinook effects are discussed on a Koktuli River-wide effect, but the primary impact areas are in the North Fork Koktuli. No discussion or analysis is provided of North Fork Koktuli Chinook effects versus overall Koktuli River effects. Effects are unquantified for sockeye, the primary economy-driving species. The conclusions that 28% of Chinook salmon would be impacted are not well supported. It is not necessarily "likely" given the limited level of evaluation provided. It may be possible, but is not presented as just "possible". The further statement that over 50% of Chinook population could be impacted in the Mulchatna/Nushagak Rivers is completely unsupported in the Exposure/Response and Risk Characterization sections as the extent of primary sediment transport is discussed only for the North Fork Koktuli. There is a disconnect between the broader conclusions based on limited areal analysis and limited level of the analysis. The level of such effect is what is unclear because of the limited analysis/evaluation provided within the Assessment.
Recommended Change: Do not rely on this Assessment for decision making, unless it is expanded significantly to provide significantly more detail on the actual or likely extent of physical and chemical impacts. However, as noted, Assessment can be used to identify areas of concern that require further analysis during the permitting process.

Report Section Identification: 6.1.2.4
Report Page Number: 6-9
Comment: The first sentence of this section sums up everything provided in the Assessment on dam failure. After nine pages of analysis, no new information is provided.

Report Section Identification: 6.1.2.3 Risk Characterization
Report Page Number: 6-10
Comment: The proportion of spawning Chinook salmon in the Koktuli River is likely skewed high because of difficulties counting Chinook salmon in other systems and the relatively good counting conditions in the Koktuli River.
Recommended Change: Add sentence describing the identified bias.

Report Section Identification: Chapter 6.1.2.4

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Report Page Number: 6-10
Comment: Section 6.1.2.4, *Uncertainties*, indicates that while it is "certain" that a tailings dam failure would have "devastating effects", the "timeframe for geomorphic recovery" could be "decades". However, given that EPA has assumed that because of the infinite life of the project that the dam has failed, a consistent perspective would be to assume that several decades for recovery from a very low probability event is a relatively short period of time over infinity.

Report Section Identification: 6.1.3.1
Report Page Number: 6-11
Draft Comment: It is questionable as to whether deposition of volcanic ash from Mount St. Helens is representative of tailings.
Draft Recommended Change: Provide rationale as to how ash deposition is comparable to that of tailings (e.g. particle size, constituents, ect.).

Report Section Identification: 6.1.3
Report Page Number: 6-11 to 6-12
Comment: This section provides thresholds for suspended sediment, and thus, is closer to a risk assessment than many other sections of the Bristol Bay Watershed Assessment, comparing site conditions to threshold effect conditions. However, while this Assessment does some modeling of sediment transport, there are no actual modeled suspended sediment concentrations predicted. So, the Assessment lists the threshold values, and then qualitatively estimates that site-specific suspended sediment concentrations would exceed the thresholds. The lack of site-specific values renders the any derived conclusion to be a qualitative comparison that is subject to uncertainty and opinion.
Recommended Change: Calculate estimated suspended sediment loads over time. Provide an analysis of how long and/or how often site-specific suspended sediment loads would be greater than the threshold.

Report Section Identification: Chapter 6.1.4.1
Report Page Number: 6-13
Comment: Section 6.1.4.1 mentions the 2012 overtopping incident at the Nixon Fork Mine as an example of a winter failure, incidental to their example of an overtopping event during seasonally high flows. Box 6-2 (p. 6-15) is an inaccurate description of the 2012 overtopping incident at the Nixon Fork Mine, as reported to the "State Mine Safety Engineer" by the mine operator. EPA fails to note the huge disparity in size between the Nixon Fork tailings dam and the very large tailings dam used in their hypothesis. EPA also fails to mention that there were no impacts to the environment as a result of the discharge from the Nixon Fork incident.

Report Section Identification: Chapter 6.1.4.1
Report Page Number: 6-14
Comment: Box 6-1 uses case histories to extrapolate the impacts of tailings to the current study.

However, all three examples are historical mines initially developed in the 1800s that are now Superfund sites. None of the examples would have had tailings dams or mill processes based on current geotechnical, metallurgical and environmental engineering principles or current regulatory standards. EPA states, "These brief descriptions provide background information and support the use of evidence from these cases in analyzing risks from a hypothetical tailings dam failure in the Bristol Bay watershed". The descriptions of three sites which had typical/historic operations which occurred decades ago does not support an "analogous" relationship with what "may" occur at the Pebble site. For instance it is hard to compare mining in the Coeur d'Alene River where "tailings were dumped into gullies, streams, and the river until dams and tailings impoundments were built beginning in 1901", with a modern mining facility designed and permitted under much more stringent regulations than existed over a decade ago. Similarly, analysis of a tailings dam failure in 1950 at Soda Butte Creek in Montana and Wyoming is hardly an analogous situation to what may occur in the Bristol Bay region.

Report Section Identification: Box 6.2
Report Page Number: 6-14
Comment: The examples provided in the assessment, such as Soda Butte Creek should be noted that much of the damage is the result of mining practices of the late 1800 and early 1900s, and related to acid mine drainage mobilization of metals. These issues may not apply as directly to the Pebble Mine under currently regulatory permitting and oversight conditions.
Recommended Change: Provide an analysis of the examples, comparing them with the proposed mine, identifying conditions that are most relevant to the Pebble Mine.

Report Section Identification: 6.1.4
Report Page Number: 6-18
Comment: It is uncertain that higher flows would increase leaching rates. While higher flows bring more "uncontaminated" water across the contaminated substrate, the water is moving much faster, and thus has less contact time with contaminated sediments. Then, if flow is high enough to suspend particulates, then contact could increase. The relationship between high flow, sediment contact, and chemical concentrations is not linear.
Recommended Change: Remove or provide conditions for this statement regarding higher flows increasing leaching rates.

Report Section Identification: Table 6-4
Report Page Number: 6-19
Draft Comment: First use of TEC and PEC not previously discussed in the text.
Draft Recommended Change: Define these terms in the context in which they are used in the text prior to presentation in the table.

Report Section Identification: 6.1.4.1
Report Page Number: 6-21

Draft Comment: Note that in the absence of a bioaccumulation factor (BAF) in the peer reviewed literature, a default value of 1 is used. The referenced studies therefore reinforce the use of this default BAF. However, an inverse relationship between BAF and media concentrations has been demonstrated in the majority of test species as reported by David K. DeForest et al.
Draft Recommended Change: Include more recent studies of BAFs.
Draft Comment Reference: Assessing metal bioaccumulation in aquatic environments: The inverse relationship between bioaccumulation factors, trophic transfer factors and exposure concentration, David K. DeForest,, Kevin V. Brix , and William J. Adams *Aquatic Toxicology* 84(2007) 236-246

Report Section Identification: 6.1.4.2
Report Page Number: 6-22
Draft Comment: Terms probable effect concentration (PEC) and threshold effect concentration (TEC) are not defined in the context in which they are discussed.
Draft Recommended Change: Define these terms.

Report Section Identification: 6.1.4.2
Report Page Number: 6-22
Draft Comment: Biotic ligand model is not defined in the context in which it is discussed.
Draft Recommended Change: Define this term and its relevance to the discussion.

Report Section Identification: 6.1.4.2
Report Page Number: 6-23
Draft Comment: The text states that the "*consensus TECs and PECs are used to evaluate tailings as potential sediments because they are the best supported values*". However, it may be unclear to the nontechnical reader what is meant by consensus values and whom and what basis of evaluation makes these values the best supported for use.
Draft Recommended Change: Describe what is meant by *consensus* values and why these values are deemed the best supported values. According to what/whom? Also discuss the level of conservatism the use of these values implies.

Report Section Identification: 6.1.4.3
Report Page Number: 6-24
Draft Comment: This is the first instance in the report in which an attempt is made to define the hazard quotient. The text

defines the hazard quotient as "*the relative degree of toxicity of leachate constituent or as an indication of the degree of dilution required to avoid significant toxic effects*". This interpretation is somewhat simplistic and does not provide insight into what the value means.
Draft Recommended Change: Provide EPA's definition EPA defines the HQ as *the ratio of estimated site-specific exposure to a single chemical from a site over a specified period to the estimated daily exposure level, at which no adverse effects are likely to occur.* Provide an interpretation of the HQ as HQs < 1.0 indicate acceptable risks, while HQs ≥ 1.0 indicate unacceptable risks while also taking into consideration the inherent uncertainty in the estimate.
Draft Comment Reference: U.S. Environmental Protection Agency (December 1997) Terms of Environment: Glossary, Abbreviations and Acronyms. [online] Washington, D.C. Available from: http://www.epa.gov/OCEPAterms/ [accessed 27 October 2007].

Report Section Identification: 6.1.4.3
Report Page Number: 6-25
Draft Comment: Contrary to the statement in the text, a quotient of 1.1 does not explicitly imply that the undiluted tailings would produce toxic prey for fish given the inherent uncertainty in the estimate.
Draft Recommended Change: Discuss the interpretation of the hazard quotient recognizing the inherent uncertainty in the estimate.

Report Section Identification: 6.1.4
Report Page Number: Entire section
Comment: This section is relatively well written and has a different tone from much of the rest of the document. It provides available evidence, compares possible site data with effect thresholds, discusses the uncertainties and provides a summary based on the data and analysis. In summary, sediment/tailings exposure is the media/pathway of most concern. However, the quality/availability of input data is low as presented in Table 6-6.
Recommended Change: More site-specific data and/or analysis are needed to define site conditions and likely results of various failure scenarios.

Report Section Identification: Table 6-6
Report Page Number: 6-28
Comment: Showing a "+" for the quality of exposure-response is misleading. The toxicity data, without exposure, has little meaning in regard to the potential effects at the site. The table is very confusing.
Recommended Change: Find a better way to portray information related to the weight of evidence.

Report Section Identification: 6.1.6
Report Page Number: 6-29
Comment: A catastrophic TSF dam failure would seem to be the most significant impact to the

environment. However, given the lack of definition of the probability and likely actual size of a potential spill under the hypothetical mine scenario, the conclusions stated in this section are likely overstated.
Recommended Change: Some understanding of the assumptions should be summarized here in summary form to give readers. The text should reflect that under the hypothetical assumptions it seems the described result would occur but under different conditions, a different level of impact would occur.

Report Section Identification: 6.2
Report Page Number: 6-30
Comment: The last paragraph on this page makes statements about what "would" happen. The implication here is that contaminated sediment would reach Iliamna Lake at concentrations that would impact fish, fish food, and/or fish habitat. While it is possible that smaller sediment particles will travel downstream, a vast majority could become entrained in stream sediment and permanently buried in depositional areas. And, there is a strong potential for dispersion along the stream. Thus, depending primarily on distance downstream to the lake and stream gradient, the amount/density of spilled "sediment" would vary greatly and would be attenuated with distance from the spill site.
Recommended Change: The dispersion/streambed entrainment should be mentioned here, and some further discussion of this issue should be added to the next paragraph (Page 6-32) regarding the probabilities of spills in rivers/wetlands.

Report Section Identification: 6
Report Page Number: 6-30 through 6-35
Comment: These pages address the potential effects of a concentrate spill in the transportation corridor, with its many stream crossings. Page 6-30 states that a concentrate spill would be limited to 475 cubic meters due to automatic shutoff, and it states that all or part of this mass could enter the stream. If the concentrate slurry volume is 475 cubic meters, the concentrate itself is probably 50% of that amount. It is stated that a concentrate spill into a stream or wetland would result in acute exposure of fish and invertebrates to toxic water. This is very doubtful for a few reasons: 1) the slurry concentrate consists of approximately 50% water (at a pH of likely greater than 7.0), and sulfides of copper as chalcopyrite, some pyrite and bornite. These minerals take a significant time, probably years, to fully oxidize and produce acid. The assessment does not consider that there will be time to clean up the concentrate spill before any major oxidation would take place. There may still be some stream damage or wetland damage but it is not likely that toxic water would be present, 2) There is also no mention that the vast majority of the length of the pipelines is on land and may never reach a stream and 3) the concentrate is very valuable and the Company will have a major economic incentive (as well as permit requirements) to clean up any spills to the best extent possible.
Recommended Change: Present a more unbiased view of the likelihood of a concentrate spill entering a stream and discuss that the oxidation of the sulfides occurs at a potentially very slow rate, thus lessening the impacts to water quality over time. Also, these impacts could be mitigated by requiring a detailed Spill Mitigation Plan in the permit process.

Report Section Identification: Table 6-7
Report Page Number: Page 6-31 (Pg 261 of 339)
Comment: There is no discussion of the value for dissolved organic carbon used to calculate the biotic ligand values for copper. Given the inaccuracies in reporting other biotic ligand values (see comment on pages 5-49 through 5-55), the inputs and outputs for these values should be verified.

Report Section Identification: 6.2.1.1
Report Page Number: Page 6-32 (Pg 262 of 339)
Comment: Says that 2,567 L/s of product concentrate would be spilled. This is 308,040 L in 2 minutes. This is 308 m^3. On Page 6-30 it says 475 m^3 would be spilled. It also says 1,767 L/s of leachate would be spilled; this is 212,040 L in two minutes. In Section 6.2.1.3 on Page 6-34 it says 366,000 L of leachate would be spilled.

Report Section Identification: 6.2.1.1
Report Page Number: 6-33
Comment: The last paragraph of this section, just below Table 6-8 is likely incorrect. Not all invertebrates will die at the probable effect concentration (PEC), and only predicted concentrations of copper notably exceed the PECs. Invertebrates would colonize the fine-grained sediment resulting from a pipeline spill, just not those sensitive to the metals contained within the pipeline slurry.
Recommended Change: More accurately represent what is likely to occur.

Report Section Identification: 6.2.1.2
Report Page Number: 6-33
Comment: The biotic ligand -based criteria sensitive to particular water quality parameters (i.e., pH, hardness, and dissolved organic carbon).
Recommended Change: Provide a brief statement of how water quality parameters impact biotic ligand-based criteria and whether the impacts result in an overestimation or underestimation of predicted risks and how those risk determinations are influenced by kinetics and downstream mixing.

Report Section Identification: 6.2.1.3
Report Page Number: 6-34
Comment: Why are Liters used in this section? 366,000 Liters sounds like a very large amount number, but is about 100,000 gallons or 366 cubic meters which is a relatively small volume. Also it is unclear whether this is liters of water entrained in the slurry or total volume of slurry, in which case, the water volume would be significantly less. The statement that "None of the river or streams ...could provide enough dilution to avoid the acute criterion" is misleading. Acute criteria are generally based on 48 hour or 96 hr LC50 or similar

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endpoints. As soon as the two-minute spill ended, the water within the slurry would begin to be diluted by clean stream water. Similarly, but more slowly, the pore water within the slurry would be infiltrated and diluted by clean stream water. Over some relatively short period of time the water concentrations outside of the slurry would likely rapidly decrease below acute criteria. This could be minutes to hours. Thus, it is unlikely flowing water would have metals concentrations raised up to the criteria for more than a few minutes or hours. It is also likely that within days, the pore water within the spilled slurry would be notably diluted. Longer term high concentrations could be possible in a small pond or wetland where there is no significant flow. A very small 5-liter per second stream provides 18,000 L per hour and 432,000 L per day. So in one day 5 L/s stream could provide clean water volume of 100% of the total spill volume.
Recommended Change: Provide a more accurate description/understanding of the dynamics of a slurry spill entering moving water.

Report Section Identification: 6.2.1.3
Report Page Number: 6-34
Comment: It was calculated that only one pipeline spill was likely into a stream over the 78 years of mine operation and such a spill would be in one location. This information is not provided until after all the discussion of impacts. Similar to much of the document, this discussion of potential impacts is provided before assumptions and conditions giving readers the impression effects are definite, or imminent, when in fact they may be severely limited in impact and extent.
Recommended Change: Move the summary of spill potential to the start this section, add in a discussion of the fact that a stream spill would only occur in one location or stream, and add a caveat to the beginning of the effects discussion that…"IF" a pipeline spill occurred in a water-body, then these effects were predicted to occur under the assumptions provided above.

Report Section Identification: 6.2.1.3
Report Page Number: 6-35
Comment: It is concluded that a slurry spill "…would certainly cause long-term local loss of fish and invertebrates"…"…for many years…". The provided assumptions and the myriad of potential stream crossings in the transportation corridor do not necessarily indicate that this is as certain as stated here. In fact, such a statement could only be made under some quite specific receiving water body conditions, and as calculated, only in one water body throughout the entire life of the mine.
Recommended Change: Adjust the conclusions to reflect either a broader range of potential effects, or define specific conditions under which these conclusions may occur.

Report Section Identification: 6.3
Report Page Number: 6-36 to 6-41
Comment: The topic of this section is unclear whether the assumptions provided are adequate and/or provide reasonable estimates of potential risk for very long term effects.
Recommended Change: A more site specific analysis of water balance and treatment/collection failure needs to be completed for likely mine conditions and operations.

Report Section Identification: 6.3.1
Report Page Number: Page 6-37 (Pg 267 of 339)
Comment: States "At mine closure, it is expected that acid-generating rock would be disposed of in the TSF or the mine pit. However, premature closure could leave waste rock piles in place". Comment: A bond would be available to put this rock back into the pit if there was sufficient room in the pit for this rock.

Report Section Identification: 6.3.3
Report Page Number: Page 6-38 (Pg 268 of 339)
Comment: There is an incorrect reference to Table 5-12. The correct reference is Table 5-14. "Failure of collection and treatment of leachate from Tertiary waste rock could cause acute lethality in sensitive invertebrates and chronic toxicity to invertebrates at up to two times dilution." Add after "up to two times dilution" based on the biotic ligand model".

Report Section Identification: 6.3.3
Report Page Number: 6-38
Draft Comment: Invalid reference to Table 5-12 for water quality criteria. The document does not provide a comprehensive list of water quality criteria for all mining chemical constituents of concern.
Draft Recommended Change: Provide a table that includes applicable water quality criteria for all mining chemical constituents of concern.

Report Section Identification: 6.3.3
Report Page Number: Page 6-39 (Pg 269 of 339), Page 8-7 (Pg 300 of 339)
Comment: Need to verify the 2,900 to 52,000-fold dilution required as determined by the biotic ligand model.

Report Section Identification: 6.3.3
Report Page Number: Page 6-39 (Pg 269 of 339)
Comment: For the biotic ligand model Pre-Tertiary waste rock leachates would require from 2,900- to 52,000-fold dilution. To meet state chronic water quality criterion the leachates would require from 280- to 580-fold dilution. See comment for pages 5-53 to 5-37.

Report Section Identification: 6.3.3

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Report Page Number: Page 6-40 (Pg 270 of 339)
Comment: Says "Oxygen levels are expected to be lower in the pit than in the tests, but oxygen would be provided in the pit by atmospheric diffusion from the surface, precipitation, shallow groundwater, and vertical mixing of water in the pit during turnover." Comment: It should be noted that some deep mine pits can be meromictic, i.e. they do not turn over to the very bottom where there may be a layer of dense mineral-rich water.

Report Section Identification: 6.4 Road and Culvert Failure
Report Page Number: 6/42
Comment: The definition of culvert failure is excessively broad and the citations of the literature need further clarification. Well designed culvert installations allow for fingerling fish passage during most annual high water events, are oversized, and are typically submerged to allow for water presence during low flow periods. Only having time to review one literature citation (Langill and Zamora, 2002), the risk assessment approach to culvert installation used by Nova Scotia (identified in the study) is not applicable to Alaska's standards for culvert installations. Within the Nova Scotia program, the majority of culverts are installed without design and without involvement or approval authority by the Canadian equivalency of ADFG. The large majority of the culverts that are observed to not allow fish passage are perched. Rudimentary implementation of culvert design BMPs would alleviate this problem and is already addressed at Alaska projects.

Report Section Identification: 6.4
Report Page Number: 6-42 through 6-44
Comment: Simply using bridges over smaller streams would essentially eliminate the potential for culvert failures. Proper culvert design and conservative over-sizing, would significantly reduce potential for culvert failure.
Recommended Change: Provide more detailed analysis on culvert failure rates for well designed or oversized culverts for the size of streams most likely to be culverted along the corridor.

Report Section Identification: 6.6
Report Page Number: 6-45
Draft Comment: Effects in human welfare and Alaska Native culture will be evaluated in the Health Impact Assessment (HIA) process.
Draft Recommended Change: Acknowledge that the effects in human welfare and Alaska Native culture will be evaluated in more depth in the Health Impact Assessment (HIA) process

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Report Section Identification: 7.0
Report Page Number: 7-1 through 7-16
Comment: Cumulative impacts are a potential concern, and the development of infrastructure for the Pebble Mine does make it more likely for other roads and infrastructure. However, assessing the impacts of these extremely hypothetical mines is even more difficult than for the Pebble Mine deposit. It would seem to be important to better predict the risks from the Pebble Mine before cumulative effects are examined.

Report Section Identification: 8.1.1 Routine Operations
Report Page Number: Various
Comment: Here and throughout the document when referring to the risk due to routine operations, there is a general lack of assessment of risk of loss of fish habitat relative to the total amount of available habitat in the two drainages. For example, on page 8-1 the document states that 21.7 to 33.8 km of fish habitat will be lost due to the footprint of the mine, but there is no comparison made to the total amount of available fish habitat against which to measure the level of risk. Similar statements are made relative to loss of wetlands (page 8-2) and fishless headwaters (page 8-2) with no corresponding estimate of the total amount of available wetlands or fishless headwaters in the two drainages from which to measure risk.
Recommended Change: Quantify the percent of available fish habitat, wetlands, and fishless headwaters potentially lost relative to the total available amounts of these quantities so that relative risk can be estimated.

Report Section Identification: 8.1.1 Routine Operations
Report Page Number: 8-1
Comment: Bullet number 2 of the list at the bottom of page 8-1 and continuing to the top of page 8-2 characterizes a loss of streamflows and then alludes to a reduction in production of salmon and resident species. This allusion is a mischaracterization of the overall assessment of risk, in that loss of fish production was not directly quantified, but the loss was indirectly quantified through potential losses in fish habitat (see section 8.5 concerning uncertainties and use of fish habitat loss as a surrogate for loss of fish production). This mischaracterization needs to be checked throughout the document for consistency.
Recommended Change: Throughout the document, remove all statements that characterize the risk in terms of loss of fish production and ensure all statements of risk are in terms of potential loss of fish habitat in keeping with the uncertainties presented in Section 8.5 – bullet 5.

Report Section Identification: 9.2 Chapter 2: Characterization of Current Condition
Report Page Number: Various
Comment: Section 9.2. Incorrect author citations of "ADFG" that should be "ADF&G."
Recommended Change: The citations in section 9.2 with "ADFG" as the author should be changed to "ADF&G."

Report Section Identification: Appendix A, Section 2.1, Page 15
Report Page Number: 15
Comment: Snowpack is predominant source of water and there is a water surplus in the Nushagak-Big River Hills physiographic region, which is a "wet" climate class. Thus, downstream "dewatering" is less likely to be an issue. If permafrost moves up into stored waste rock, then less groundwater flow through it. Handling of snowpack and snow melt is important to impact assessment

Report Section Identification: Appendix A, Management of sport fisheries
Report Page Number: 16
Comment: There are four, not three, local management plans guiding management of sport fisheries.
Recommended Change: Add the Nushagak-Mulchatna Coho Salmon Management Plan (see 5 AAC 06.368), which is not included here. Additionally, although it is used as a guiding tool, the Southwest Alaska Rainbow Trout Management Plan is not adopted as regulation.

Report Section Identification: Appendix A, Management of sport fisheries, Rainbow Trout section
Report Page Number: 17
Comment: Stating sport fishing is "banned" is not a good descriptor.
Recommended Change: Use closed rather than "banned". In addition, in the Kvichak drainage upstream from the outlet of Iliamna Lake, lake waters further than ½ mile from inlet or outlet streams, remain open to sport fishing during April 10 - June 7.

Report Section Identification: Appendix A, Table 6
Report Page Number: 29
Comment: Estimates of run size for Canadian Yukon Chinook salmon are incorrect. The numbers for this stock might be escapements, but are not run sizes.
Recommended Change: Check and correct the run sizes for Canadian Yukon Chinook salmon per the cited reference. Perhaps these are escapements and the catch needs to be added in to estimate the run size.
Draft Comment Reference: Run sizes for Canadian Yukon Chinook salmon can be estimated from data available in Howard, et al. 2009 as per the Appendix A, Table 6 citations.

Report Section Identification: Appendix A, Threatened and endangered salmon and conservation priorities
Report Page Number: P. 32-36
Comment: This section does not seem relevant to the stated scope of this assessment. There are no endangered species of salmon in Alaska, including Bristol Bay. Policies in regulation (e.g., 5 AAC

39.222, 5 AAC 39.223) and philosophy of assessing and managing the State's salmon stocks as dictated in statutes and the State Constitution provide mechanisms to detect and be proactive to address dramatic declines in salmon abundance.
Recommended Change: Delete Pages

Report Section Identification: Volume 3 Appendix E
Report Page Number: 15, 16, 81 and 82
Comment: These pages discuss the value of the fishing, subsistence fishing, hunting and recreation industries for Bristol Bay and list the part and full time jobs that are provided by these industries. By the nature of the weather, most of these jobs are part time. Also, no discussion of the high paying full time jobs is provided for the mine operation. A reader of the Bristol Bay Watershed Assessment Executive Summary and Appendix E versus one reading the Northern Dynasty Minerals, Ltd. report of 2011 will arrive at two different conclusions. The Northern Dynasty Minerals, Ltd. report states that the area has significantly dropped in population (16% since 1997) due to lack of jobs and that the price of sockeye salmon has dropped from an inflation adjusted peak of $3.75 in 1988 to $0.60 after the year 2000. Data presented in the Assessment on pages 81 and 82 of Volume 3 Appendix E show that prices are on the rise again although the graphs show fluctuations over time. However, none of this valuable information seems to have been included in the Executive Summary. The Executive Summary fails to state that the price has not recovered to what it was in the 1980's. The Northern Dynasty Minerals, Ltd. report fails to state that the price has made somewhat of a comeback since 2006.
Recommended Change: Include some of the fisheries statistical data that is in Appendix E in the Executive Summary. Also, it should be stated in the Assessment that the mine would provide 2500 jobs during a 4 year construction period and 1100 full time jobs over the life of the mine. All of these jobs are full time and high paying.
Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, page 419.

Report Section Identification: Volume 3 Appendix E
Report Page Number: Appendix E Volume 3 All Pages
Comment: The entire Appendix E provides statistics on the entire Bristol Bay region, where many drainages have no contact whatsoever with the mine. An example of this is on page 58 where the annual harvest in millions of fish is shown for various drainages. The Ugashik, Egegik and Togiak drainages are completely unaffected by anything that could happen at the mine.
Recommended Change: To be fair and unbiased, either revise Appendix E to remove drainages that could in no way be affected or very openly state in Appendix E and the executive Summary that these drainages could not be affected by the mine.

Report Section Identification: Vol 3 Appendix H
Report Page Number: 10 / 11
Comment: The range in which there is uncertainty of AMD is between 1 and 3, and non-PAG material has an NNP > 3. Note: Page 2 of Appendix I suggests the range of uncertainty would be

between 1 and 4.

Report Section Identification: Appendix H

Report Page Number: Page 19, 20 and 21

Comment: The following comment is an example of how could significantly alter the conclusions of impact if the mine plan used in the assessment had been vetted through the environmental and permitting review processes.

There are actual humidity cell test results for the Pebble tailings, which were started in 2005 and 2008; however, it appears that these tailings are the rougher tails (85% of the total) and not the pyritic tails (14% of the total). Table 7 on page 21 shows pH average of 7.8 for the rougher tails. No specific data is presented for the pyritic tails. It is likely that these tails are extremely acidic due to: a) a fine size of 80% passing 30 μmeters, and b) the pyrite content will range from 50% to 80% of these tails. This information came from the Northern Dynasty Minerals, Ltd. 2011 Waldrop report. The applicant may state that the acid producing potential of the pyritic tails are irrelevant since they plan to encapsulate them in the TSFs with inert rougher tails and the combination of these tails and a large water height will prevent the pyritic tails from oxidizing. It is still important to know what the potential is of the pyritic tails to produce acid, since the worst case is that these tails may oxidize.

Recommended Change: Get SPLP and/or humidity cell tests on the pyritic tails and evaluate the results.

Comment Reference: Northern Dynasty Minerals "Preliminary Assessment of the Pebble Project Southwest Alaska" issued on February 17, 2011, by Wardrop, a Tetra Tech Company, pages 49, 50 and 409.

Report Section Identification: Appendix I, Volume 3

Report Page Number:

Comment: Appendix I in Volume 3, *Conventional Water Quality Mitigation Practices for Mine Design, Construction, Operation, and Closure* by Barbara A. Butler, Ph.D. is a primer on mine waste written at a very basic level. It is heavily weighted towards the review of waste rock and tailings storage at hard rock mines (Section 1 and 2), and quickly loses detail and consistency as it discusses other mine features and waste streams such as pits, underground mines, dust, stormwater, chemicals, pipelines, and sanitary wastes. (Sections 3 through 9). In general, the report describes the feature or waste stream, the potential mechanisms or pathways for impacts to the environment, and mitigation measures presented as standard engineering and regulatory practices related to those aspects. For example, waste rock that may be potentially acid generating would be mitigated through a characterization plan, and encapsulated in storage. The body of the report is heavily referenced to a variety of publications including controversial references such as ICOLD, 2001 (Tailings Dams, Risk of Dangerous Occurrences) to potentially stale references such as Piteau Associates Engineering, 1991 (Mined Rock and Overburden Piles—investigation and design manual: Interim guidelines) to recent non-scientific publications such as Chambers and Higman, 2011 (Long term risks of tailings dam failures), as well as some government publications such as the States of Alaska (ADNR, 2005) and Idaho, USEPA, and Commonwealth of Australia. The

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final section on compensatory mitigation is abbreviated, and introduces the only references to legal issues, related to U.S. Corps of Engineers regulatory jurisdiction for wetlands. The cover page is dated May 2012 and marked "External Review Draft". The cover page includes the following two caveats: "DRAFT…DO NOT CITE OR QUOTE" and "NOTICE… THIS DOCUMENT IS A PRELIMINARY DRAFT. It has not been formally released by the U.S. Environmental Protection Agency and should not be construed to represent Agency policy. It is being circulated for comment on its technical accuracy and policy implications" [SIC]. The subsequent pages are marked "***internal deliberative materials – do not cite, quote, or distribute***" [SIC].

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