Attachment 6 of 8

to Comments filed by Northern Dynasty Minerals Ltd. in Docket Number # EPA-HQ-ORD-2012-0276 – “An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska”
COMMENTS ON THE ENVIRONMENTAL PROTECTION AGENCY’S

DRAFT “ASSESSMENT OF POTENTIAL MINING IMPACTS ON
SALMON ECOSYSTEMS OF BRISTOL BAY, ALASKA (2012)”

by

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Prepared for

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Vancouver, B.C.

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Background Information

Dr. Buell is an aquatic biologist specializing in salmonid fishes with over 38 years’ experience as a consultant, over 35 of which have been as President of his own company. He received his Bachelor’s degree in Biology at Occidental College (1966) and his Ph.D. in comparative physiology at the University of Oregon (1973).

Dr. Buell has extensive experience with large projects, including many mining projects, in Alaska, British Columbia, the Pacific Northwest and California. He has extensive experience with stream and watershed analysis, including habitat enhancement and remediation, and has worked extensively with engineers, geologists, hydrologists, wetlands scientists, resource economists and other professionals over the course of his career. He has served as special consultant to the State of Oregon, including eight years on the Oregon Fish Screening Task Force (one year as Chair), the US Army Corps of Engineers, Fisheries and Oceans, Environment Canada and Alaska Department of Fish and Game. Dr. Buell has been a consultant to owners of the Pebble prospect, first Cominco Alaska (1991-1994) and later NDM/PLP (2004-2012).

Relevant Project Examples:

- Quinsam River Coal Mine Development Project (Luscar Coal, Ltd. 1978)
- Green's Creek Lead/Zinc Mining Project (Noranda Mining 1978-86)
- Bear Valley Creek Channel & Placer Tailings Restoration and Diversion Plan (Bear Valley Associates 1979)
- Gray Eagle Mine Environmental Assessment (Noranda Mining, Inc. 1980)
- Fourth of July Creek Delta Port and Industrial Development Study and Mitigation (City of Seward 1980-81)
- Diamond-Chuitna Coal Development Project Baseline Studies (Diamond-Shamrock 1982-1983)
- Tuluksak River Placer Mitigation and Reclamation Project (Alaska Dept. of Fish and Game 1984)
- Carmel River/Los Padres Reservoir Sedimentation Case (US Dept. of Justice, Civil Div. 1985)
- Stream Habitat Enhancement Evaluation--Technical Workshop (Bonneville Power Admin. 1986)
- Valsetz Lake Dam Removal and Pond Drainage (Boise Cascade Company 1988-1989)
- Trans-Alaska Gas System Routing and Stream Crossing Assessment/Prescriptions (Yukon Pacific 1990-1991)
- Pebble Copper Prospect Aquatic Baseline Studies (Cominco Alaska Explorations 1991-1994)
- Blackbird Mine CRCLA Litigation (Noranda Mining 1994-1995)
- Southeast Alaska Riparian Timber Harvest "Variation Tree" Policy (ADNR, Forestry Div. 1993-1994)
- Santa Rosa Subregional Wastewater Treatment Plant EIR/EIS (City of Santa Rosa 1993-1995)
- Sacramento / San Joaquin / Bay-Delta "Environmental Solution" (Metropolitan Water Dist. 1994-2004)
This set of comments was prepared pursuant to a request from Northern Dynasty Minerals, Ltd. (Vancouver, B.C.). The task was to perform an impartial, independent review of the EPA’s external review draft “Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska (2012).” This review was heavily influenced by the reviewer’s intimate personal and professional knowledge of the watersheds and fish resources that are the subject of the EPA analysis, and by professional familiarity with the mining industry and its environmental impacts and those of other industrial activities in salmon-bearing watersheds in Alaska, British Columbia and the Pacific Northwest. The reviewer has no financial interest in the Pebble Project, nor any employment relationship with Northern Dynasty Minerals, Ltd., the Pebble Limited Partnership or any entity that might benefit from development of the Pebble Project or any other minerals project in the Bristol Bay region.

This review is incomplete. It covers only the Executive Summary and the first six chapters. By far the most important reason for this is the pervasiveness and sheer magnitude of inaccuracies, omissions of relevant data and factual matter, strongly biased presentation and interpretation of information and convoluted rationales used by EPA in forming their conclusions. If the EPA “analysis” had been of reasonably good quality, review could have been straightforward and efficient. This was not the case. It is appalling that the EPA’s internal peer review process did not pick up on this.

GENERAL COMMENT

This report is not what it purports to be. It was not developed in accordance with EPA’s 1998 “Guidelines for Ecological Risk Assessment” and it was not developed in accordance with EPA’s “Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency.” The comments below will provide strong evidence why this is so, and will highlight inaccuracies, inconsistencies, distortions of facts, omissions of critical and important, available information, and apparent ignorance of modern hardrock mining methods and impacts.

This report is what it purports not to be. It is a political document that reaches tortured and strongly biased conclusions based on carefully selected information while omitting or discounting other (correct) information which would tend to nullify or refute the conclusions drawn by EPA. This does a great disservice to the EPA’s most important constituency, the Public; it does nothing to further the rational, scientifically-based protection of the environment.

EXECUTIVE SUMMARY (Comments referenced to text by page and paragraph)

ES-2 ¶2
To say that the Pebble prospect “is located at the intersection of the Nushagak River and Kvichak River watersheds” is terribly imprecise. The “intersection” of these two watersheds is nearly 300 miles long. It is more precise and informative to say that it is located at the divide between two relatively minor tributaries of these two watersheds.

It is inaccurate and misleading to say that the three principal streams in the Pebble area (North Fork Koktuli, South Fork Koktuli, Upper Talarik Creek) are “biologically productive” because, despite supporting salmon runs, all three streams have very low hardness and alkalinity and relatively low biological productivities as measured by periphyton and aquatic invertebrate communities. This is particularly true of the Koktuli forks.

ES-5 ¶1
The assertion that “[t]his is not an in-depth assessment of a specific mine” is disingenuous at best. The document is highly focused on the proposed Pebble mine and completely ignores other prospects on state lands specifically set
aside for mineral exploration and development, even though some of these other prospects have much more land set aside and are substantially different in their mineralization and potential impacts (see below). To focus almost exclusively on Pebble and ignore these other prospects is a serious omission and reflective of a flawed approach.

ES-8 ¶2
While habitat quality and diversity is certainly important in maintaining healthy fish populations, the most important factor for Bristol Bay salmon is management of the fisheries, as the history of boom and bust prior to the implementation of the current management system very clearly demonstrates. Several crashes in Bristol Bay salmon have occurred since intensive harvest first arrived in the region in the 1890s, and it is only through conservative management that stocks have been able to rebound, habitat notwithstanding. EPA should have known this and taken account of this extremely important factor in the assessment. Hilborn (2006) attributes success of sockeye management in Bristol Bay to four factors: a clear objective of maximum sustainable yield; the escapement-goal system, assuring the maintenance of biological productive capacity; management by a single agency with clear objectives and direct-line responsibilities; and good luck, especially with respect to lack of habitat degradation and favorable ocean conditions during the period. An intensive Stock Assessment Program is an integral part of the Bristol Bay fisheries management system and is designed to promote scientifically based in-season fishery management. Although Hilborn does cite lack of habitat degradation, this factor is well down on his list, and the permitting and oversight system firmly in place in Alaska is quite capable of keeping habitat degradation of such a very large system at a minimum.

ES-10 ¶4
The “Mine Scenario” narrows the focus of the assessment inappropriately. The assessment is supposed to be on the effects of mining generally, not on the Pebble Mine alone. Pebble is one of five planning units in the Nushagak and Kvichak drainages specifically set aside in the Bristol Bay Area Plan (2005) for mineral exploration and mining because they have significant resources, either measured or inferred, that may experience minerals exploration or development during the planning period. In addition, there are several existing, developed mines and other mineralized areas and claims identified in the Plan that are not set aside but are ripe for development; some are considerably larger in land area than Pebble and others, though economically viable, are considerably smaller. These other mines and prospects contain a variety of ore types and target minerals, and would have a range of potential development approaches and impacts extending well beyond those reasonably anticipated for the Pebble prospect.

Region 6 in the Bristol Bay Management Plan (Nushagak, Mulchatna) contains four of the five units set aside for mining. One is Pebble; the others are:

- **Shotgun prospect – 39,409 ac** – This prospect is located in the south part of the Shotgun Hills, a rugged, glaciated upland at the divide between the King Salmon and Kogruklu/Holitna River drainages. Novagold Resources Inc. (2000) made the following resource estimates: using a cutoff pf 0.018 ounce of Au per ton, the resource is 32,765,000 tons grading 0.033 ounce of Au per ton; using a cutoff of 0.026 ounce of Au per ton, the resource is 16,550,000 tons grading 0.045 ounce of Au per ton; using a cutoff of 0.035 ounce of Au per ton, the resource is 11,650,000 tons grading 0.05 ounce of gold per ton. The measured resource is 979,660 ounces of gold.

- **Sleitat prospect – 73,099 ac** – This prospect is centered on a saddle at an elevation of 1,725 feet, between the two high peaks of Sleitat Mountain (1,979 and 1,903 feet elevation). Sleitat Mountain is the highest part of northeast-southwest trending uplands between the valleys of Harris Creek and the Nushagak River. The occurrence of granite and peripheral gold-bearing quartz gash veins was reported as early as 1938, but subsequent exploration has shown that the principal mineral deposit is a tin-, tungsten-, and silver-bearing sheeted greisen system. A bulk sample contained 0.37 percent tin, 0.04 percent tungsten, and 17 ppm silver; the Sleitat deposit is estimated to contain a total of 28.6 million tons of ore containing 64,000 to 106,000 tons of tin.

- **Kemuk prospect – 108,390 ac** – This prospect is located 12 miles east-northeast of the summit of Kemuk Mountain. This is an area of extensive surficial deposits with few conspicuous topographic features. Buried below 90 to 140 feet of unconsolidated Quaternary deposits, this prospect is believed to contain 2.6 billion tons averaging 15 to 17 percent total iron. The average grade is 10.5 to 12 percent magnetic iron and 15 to 17 percent total iron. The platinum-group metal (PGM) potential of this prospect may be significant.
Region 7 (Upper Mulchatna and Upper Hoholitna) has 13 mines, prospects and “occurrences” noted in the Bristol Bay Area Plan, although no units are specifically set aside for mineral development. The Synneva (Scynneva) Creek placer gold mine located in the Bonanza Hills area near the confluence of Bonanza Creek and Synneva Creek. Production began in 1957 in the valley alluvials; the principal commodity was gold but significant cassiterite and tungsten occur in the concentrates. The Bonanza Creek placer mine is located near the intersection of Bonanza Creek and Little Bonanza Creek and the deposit extends from Gill’s camp at least 6 km upstream to above Cabin (or Cash) Creek and about 6 km downstream to Caribou Creek. Bonanza Creek is both a placer and a gold-quartz vein occurrence. Seventy-four active mining claims and leasehold locations are on Little Bonanza Creek. Other gold occurrences in the Region include the Finnbear lode, an unnamed placer west of Long Lake, Charlie Creek, Lambert’s Bar (at the confluence of the Mulchatna and Chilikadrotna Rivers), and the Mulchatna River placer occurrences (where the southeast flowing Springway Creek enters the Mulchatna River).

Region 8 (Lake Clark, Newhalen) has one named copper-gold-silver deposit, the Millet prospect, near the shore of Iliamna Lake near the east boundary of the region; exploration potential for base and precious metals is considered high, but this parcel was not set aside specifically for mineral exploration and development.

Region 9 (Eastern Iliamna Lake) has a wide range of mineral deposits, including copper, molybdenum, gold and silver. The region has one parcel set aside specifically for mineral exploration and development, the Fog Lake prospect, a gold- and silver-bearing prospect with minor copper values. Significant amounts of exploration have been conducted on the Kamishak prospect on the southern boundary of Region 9. Seventeen drill holes totaling 3,755 feet of drilling had been completed on this porphyry copper-gold prospect as of 2005.

Region 10 (Western Iliamna Lake, Kvichak River) contains a second Pebble parcel designated specifically for mineral exploration and development. Two other units are documented in the Bristol Bay Area Plan as containing significant mineral resources, the Anelon gold prospect, located near VABM Newhalen on the north side of the lake and the Aukney gold prospect, located on the north flank of Big Mountain. A large claim block has been staked in an area 26 miles west of Igiugig and 16 miles northeast of Levelock as part of a recent exploration effort.

In order to be a comprehensive and reasonable assessment of mining in the “Bristol Bay Watershed” the EPA document must consider these other prospects and analyze how they may be developed within the existing Bristol Bay area planning process and according to the existing Alaskan permitting process. Instead, this information was completely ignored by EPA. This is a serious deficiency of the assessment. Furthermore, to ignore these prospects and mineral exploration/development designations, arrived at through a legitimate two-iteration land-use planning process with very open public participation, and then assert, as the EPA does, that the assessment “reflects the general characteristics of mineral deposits in the watershed… [and] the scale of mining activity required for economic development of the resource[s]” and is not focused entirely on the Pebble prospect, is simply not credible. The associated EPA conclusion that their mine scenario represents “the sort of development plan that can be anticipated for a copper deposit in the Bristol Bay watershed” is also not credible.

Eliminated or blocked streams – This paragraph is extremely misleading, to the point of being incorrect. It states that mine development “would result in the loss of 87.5 to 141.4 km… of possible spawning or rearing habitats” for anadromous and resident salmonids. This assertion vastly overestimates the number of km of stream that could reasonably support salmonids. Many if not most of the km of streams shown on the accompanying figure are ephemeral and inaccessible, some with poorly defined channels or no discrete surface flow channel. EPA has obviously extrapolated far beyond the information used in preparation of the assessment and has ignored readily available information on fish distribution in the Pebble area, including migration barriers in smaller tributary streams.

Reduced flow – This paragraph is based on the assumption that the only factor driving fish production in the Pebble area is stream flow. This approach is not credible, and completely ignores the importance of conducting a reasonable limiting factors analysis to put stream flow into perspective with respect to other factors that are likely driving fish production in Pebble streams. For example, absence of a nursery lake and very low organic and inorganic nutrient levels in the Koktuli forks, along with harvest in the same management zone as contains fish from
the far more productive Wood River, is much more likely driving the population of sockeye spawners in these streams than stream flow. It is irresponsible for EPA to proceed with the analysis in the way they have done.

**ES-14¶6 – ES-15¶1-4**

**Indirect effects of stream and wetland removal** – See comment immediately above.

**ES-18 Figure ES-8**

This figure incorporates an aspect of fear-mongering inappropriate in a document purporting to be a reasonable and unbiased analysis. The height of the TransAmerica Building, the Gateway Arch and the Washington Monument have nothing whatsoever to do with the stability of a modern, well-designed tailings embankment. These references only serve to emotionally arouse non-technical readers and do a disservice to the analytical process.

**ES-18¶3**

This paragraph is incorrect. The escapement of sockeye salmon to the Nushagak averages (20-year) 528,000 fish, of which about 150,000 fish are bound for the Nuyakuk River, which drains Tikchik Lake and Nuyakuk Lake, large sockeye producers.

**ES-18¶6**

**Pipeline failures** – This paragraph exhibits ignorance of porphyry processing methods and the chemistry of metal concentrates and accompanying waters that are produced by these processes. Concentrates are alkaline, not acid, and so is the accompanying water. This condition results in very little “free” copper, the toxic moiety. This being the case, the toxicity of a pipeline rupture and accompanying “spill” would be much less than represented in this paragraph. In addition, cleanup would be mandated by the State of Alaska, with stream restoration as part of the cleanup process in the event concentrates reached a stream. Regardless of the risk of rupture, the outcome of such an event would be much less dire than represented by the analysis. EPA appears ignorant of copper concentrates chemistry from a deposit like Pebble and is either unaware of the requirements of the State of Alaska, or failed to take them into account. Either way, these are significant misstatements and omissions of important information.

**ES-21¶4**

The analysis states that the most serious “failure” associated with the transportation corridor would be blockage of culverts at any of the anadromous stream crossings. The clear implication is that many of the anadromous stream crossings would involve culverts. EPA should be aware of State of Alaska policy regarding anadromous and resident fish crossings (especially since the analysis cites the ADFG/ADOT MOA dealing with this policy), the default method for which is a bridge. If a culvert would be used, each individual crossing must undergo an extremely conservative 3-tiered hydraulic analysis to assure that culverts will have sufficient capacity, with an ample margin, to pass high flows. Furthermore, the document assumes that maintenance will be performed on the road crossings on a daily basis. This is inconsistent with the road failure scenario as described by EPA. The actual likelihood of culvert failure is a small fraction of that used by EPA in this assessment, and any failure would be remedied promptly.

**ES-26¶5**

This bullet states, “It is clear that [tailings and concentrate] would have harmful physical and toxicological effects on salmonid larvae or sheltering juveniles.” This is incorrect. It is far from clear that tailings supernatant would be toxic to salmonids. A geologic analogue of Pebble near Williams Lake in British Columbia supports thriving populations of rainbow trout in both its active tailings pond and in its seepage pump-back pond. Tissue samples from these fish show no elevated levels of Cu or other trace metals when compared to fish from other pristine lakes in the area. EPA should have known this and taken this and other examples fully into account when developing both non-failure and failure scenarios. This is a significant shortcoming of the EPA analysis.

**CHAPTER 1**

**1-1¶5**

This paragraph states, “[t]he largest of these claims [in the Bristol Bay watershed] belongs to the Pebble Limited Partnership (PLP). This is not true. Of the deposits most likely to be developed within the Bristol Bay Area Plan planning horizon, the Kemuk deposit is considerably larger (108,390 ac) and the Sleitat deposit is of comparable size
The mineralization of these deposits is very different from Pebble, however. The Sleitat deposit is tin, tungsten and silver in a greisen system; Kemuk is an iron deposit with good platinum group potential. Mining methods and environmental consequences would likely be very different than those for Pebble. Consequently, the tight focus of the EPA analysis on the proposed Pebble prospect is inappropriate as a surrogate for mining in the Bristol Bay area generally.

CHAPTER 2

2-1 ¶2
Introduction to Bristol Bay Region – This introductory paragraph states, “The land area draining to Bristol Bay consists of six major watersheds—from west to east, the Togiak, Nushagak, Kvichak, Naknek, Egegik, and Ugashik Rivers.” This is incorrect. As stated in the Introduction to each of the Bristol Bay Annual Management Reports published by Alaska Department of Fish and Game, “The area includes 9 major river systems: Naknek, Kvichak, Alagnak, Egegik, Ugashik, Wood, Nushagak, Igushik and Togiak.” There are two significant aspect of this EPA error. First, the agency undertook to perform an analysis on a “watershed” without doing enough background homework to understand its areal extent and the major river systems that comprise the Bristol Bay system. Second, this error magnifies the flawed approach that considered only two albeit large drainages, rather than taking a more comprehensive and inclusive tack.

2-4 Figure 2-2
This figure highlights an error pointed out above. It shows the Wood River subsumed by the Nushagak watershed and the Alagnak River subsumed by the Kvichak watershed. This is inappropriate. The Wood River enters the Nushagak estuary (Nushagak Bay) below the salt chuck and the Alagnak enters the Kvichak estuary below the salt chuck (Kvichak Bay). Both the Wood and the Alagnak have independent escapement goals and estimates, and returns to these systems are accounted separately (from the Nushagak and Kvichak Rivers, respectively) in the Bristol Bay Annual Management Reports. Lumping these rivers with their adjacent systems is inappropriate, and reveals a lack of knowledge and understanding on the part of EPA of the systems, the associated fish populations and management of these populations by the State of Alaska, in the preparation of their analysis.

2-12 Figure 2-5
Land area statistics in the figure legend are incorrect, since the map inappropriately includes areas occupied by the Alagnak and Wood rivers.

2-20 ¶5
This paragraph correctly points out that large nursery lakes are important to sockeye salmon productivity, “river-type” sockeye populations notwithstanding. Importantly, however, the section fails to point out the almost complete lack of large nursery lakes in the great majority of the Nushagak watershed, except for the Nuyakuk River drainage, a relatively modest sized tributary that receives the drainage from Tikchik and Nuyakuk Lakes. This explains the relatively modest contribution of sockeye salmon by the Nushagak system to the Bristol Bay fisheries, in spite of its large overall drainage area. The Nushagak system without its Nuyakuk component contributes only about 15% of the sockeye to the Nushagak District and only about 8.5% of the total Bristol Bay run. This is a very important consideration when analyzing the potential impacts of mining in one of nine watersheds on sockeye salmon runs in Bristol Bay, but it was inappropriately ignored by EPA.

CHAPTER 3

3-1 ¶2
Type of Development – This introductory paragraph states, “The assessment addresses potential mining development in the watersheds of the Nushagak and Kvichak Rivers. It is limited to the mining of porphyry copper ores, which appear to be the major mineral resource type in the area.” The scope of the assessment is inappropriately circumscribed to porphyry copper deposits based on an incorrect premise, that porphyry copper is the major mineral resource type in the area. As has been pointed out above, other types of mineralization, calling for differing approaches to development, are the rule, not the exception in the Bristol Bay area. Even within the two watersheds being considered by the EPA in its too-narrow analysis, the Pebble deposit is the only porphyry copper deposit of the five planning units specifically set aside in the 2005 Bristol Bay Area Plan for mineral exploration and development,
and other identified deposits not specifically set aside for development are also not porphyry copper deposits. This incorrect premise is, unfortunately, representative of many premises in the analysis, and points out a major failing of the document.

3-1 ¶2 – 3-2 ¶1
This paragraph states, “The types of development considered in the assessment would be common to all porphyry copper mining in the area.” This is impossible because Pebble appears to be the only viable porphyry copper deposit in the area, according to information presented in the 2005 Bristol Bay Area Plan. EPA background “research” should have turned up this relevant and very accessible fact, but it failed to do so.

3-2 ¶3
This paragraph states, “[T]he assessment applies to most sites in the Nushagak River and Kvichak River watersheds.” This statement cannot be true because the Pebble deposit is not representative of other deposits specifically set aside for mineral exploration and development and considered most likely to be developed within the Bristol Bay Area Plan planning horizon. See above.

CHAPTER 4

4-17 ¶1
The EPA mine development scenario in the analysis is unrealistic and unreasonable, since, as stated in this paragraph (and elsewhere), it assumes “good, but not necessarily best, mining practices.” The State of Alaska has stated emphatically and repeatedly that Pebble (and other mines in the Bristol Bay area) will be held to best mining practices. This state position is undisputed except by organized Pebble opposition groups and, now, EPA.

4-17 ¶3
This paragraph parrots a common but erroneous assertion that the Pebble deposit is located “in the headwaters of the Nushagak River and Kvichak River watersheds.” This is incorrect. The Pebble deposit is located in the headwaters of two modest-sized tributaries of the Nushagak system and the Kvichak system. The headwaters of the 225-mi-long Kvichak system is the source of the Tlikakila River at Lake Clark Pass. This is in the Chigmit Mountain Range, which separates Southwest Alaska from Cook Inlet, approximately 137 watercourse mi upstream of the mouth of Upper Talarik Creek, or 109 mi as the crow flies ENE from the Pebble site. The headwaters of the 315-mi-long Nushagak system is not the upper (named) Nushagak River, but the source of the Mulchatna River above Turquoise Lake. This is approximately 168 watercourse mi upstream of the mouth of the Koktuli River, which is 35 mi downstream of the confluence of the north and south forks of this stream, or 79 mi as the crow flies NE from the Pebble site. This headwater location is also in the Chigmit Mountain Range. Very roughly, there are about a dozen-and-a-half drainages as large as or larger than Upper Talarik Creek tributary to the main rivers (Kvichak, Newhalen) and lakes (Iliamna Lake and Lake Clark) in the Kvichak system. This does not count Iliamna Lake or Lake Clark themselves. Again very roughly, there are about two dozen drainages tributary to the main rivers in the Nushagak system (Nushagak, Mulchatna, Nuyakuk) as large as or larger than either the North Fork or South Fork Koktuli. There are many smaller but significant drainages tributary to the main lakes and rivers in both systems.

4-17 ¶3
This paragraph repeats the misstatement that the Pebble deposit “is similar to other sites in the area where mineral exploration is proceeding (Figure 4-6). This similarity means that much of our analysis is transferable to other portions of the region.” In reality, the Pebble deposit is the only copper porphyry deposit of the five mineral deposits identified the 2005 Bristol Bay Area Plan as most likely to be developed within the planning period (see comments above).

4-33 ¶4
This paragraph states, “Premature closures can range from cessation of mining with continued monitoring of the site to complete abandonment of the site. As a result, environmental conditions at a prematurely closed mine may be equivalent to those under a planned closure, may require designation as a Superfund site, or may fall anywhere between these extremes.” This statement is unrealistic and incorrect. The State of Alaska has very strict rules regarding environmental and operational audits which recur on an enforced 5-year cycle. Two closure plans are required in association with each audit cycle, one for end of mine life and another for premature closure within the
subsequent five years, when the next environmental and operational audit is due. Furthermore, bonding requirements are re-evaluated, and sufficient bonding is required to satisfy both closure scenarios. The only reasonable premature closure scenario is “cessation of mining with continued monitoring of the site” with environmental conditions “equivalent to those under a planned closure.” EPA should have known this and incorporated this firm Alaska policy fully into closure evaluation. This is a serious oversight, and casts question on the adequacy and orientation of the analysis.

**4-34 ¶1**
The reference by EPA to the Gibraltar mine in British Columbia is interesting because this mine has thriving populations of rainbow trout in both its active tailings pond and its seepage control and pump-back pond (pers. obs., Patterson and Errington 2005, Andison 2008). Furthermore, tissue analyses show that copper and other heavy metals in these fish are as low as or lower than comparable fish from unpolluted natural lakes in the area, and pose no risk to human or animal consumption (Anon. 2007, Andison 2008, Akins 2009). In a responsible and reasonable analysis, EPA would have pointed out this relevant information.

**4-44 Table 4-7**
Conspicuous by its absence in this table is the double earthquake that occurred on October 23 (6.7 magnitude) and November 3 (7.9 magnitude; ~2 min duration) 2002 along the Denali fault south of Fairbanks, AK. This pair of seismic events is very relevant to any seismic evaluation of tailings embankments in Alaska because of its close proximity to the Fort Knox Mine tailings and water reservoir embankments and the very detailed data that were collected from seepage monitoring wells and vibrating wire piezometers installed within the embankments for monitoring purposes. After the first event, vibrating wire piezometers and seepage flows were monitored on a daily basis (Gillespie 2002). Enhanced monitoring at the tailings embankment and the water reservoir embankment downstream continued for several weeks after the second event. Inspections revealed no signs of movement, slope or crest deformation or settlement associated with either embankment. Seepage monitored at both embankments remained clear throughout the enhanced monitoring period and beyond and no signs of piping were observed. No changes in suspended solids or other parameters occurred in monitoring wells near interceptor wells below the tailings facility, indicating no change in groundwater flow (Gillespie 2002). All this information is readily available and has been since December 2002.

The bottom line is this: in spite of a double seismic event of 6.7 and 7.9 magnitude close to a modern tailings embankment, enhanced monitoring of a suite of critical parameters revealed that nothing happened. In other words, the facility behaved as designed. Omission of this important information, which is directly related to the assessment of seismicity and tailings embankment stability, and reflective of performance of a relatively modern mining facility, built and operated in Alaska, is a serious failure of EPA when engaging in a comprehensive and realistic analysis. This is a serious omission bordering on negligence, and imparts a significant bias to the assessment.

**4-53 Box 4-8**
This box makes the important point that the “headwaters” location of the assumed TSF mitigates against a large Probable Maximum Flood (PMF). It also states that “[i]f sufficient freeboard is maintained, it would be possible to capture and retain the expected volume of the PMF in the TSF.” An important additional point, that EPA failed to present, in their description of the full TSF failure scenario is that the amount of watershed available to contribute to a PMF (sloping toward the TSF) in this scenario is essentially the surface area of the TSF itself. This makes it even more unreasonable to assume that insufficient freeboard would be maintained in the full TSF scenario; even a probable maximum precipitation event (PMP) such as that presented by EPA would not add much to the water surface elevation in the TSF. Strangely, EPA does not disclose what the water surface elevation increase for either the Full TSF or the Partial TSF failure scenario would be; it should have. Furthermore, this box fails to disclose that the State of Alaska requires that sufficient freeboard be maintained in all tailings storage facilities to retain far more than the PMF, plus a sizable safety margin on top of that. The box goes on to say that “to examine potential downstream effects in the event of a tailings dam failure, we assume that sufficient freeboard would not exist and overtopping would occur,” in spite of monitoring and maintenance. In other words, EPA is forced to make an unreasonable assumption in order to have something to analyze. This is a significant departure from EPA’s own promise to develop a reasonable analysis.
Tailings Dam Failure via Flooding and Overtopping – The “full-volume failure” TSF embankment failure is unrealistic and unreasonable in the extreme and on several levels. First, there is very little watershed surrounding the TSF to contribute to a PMF; the available watershed is a fraction of the surface area of the TSF itself. Second, given the precipitation model presented later in the report in Table 4-7, the total water contribution to the TSF from direct precipitation is 0.36 m (a little over 1 ft). A reasonable contribution from the available surrounding watershed added to direct precipitation might bring the water surface elevation up as much as 0.5 m (a little over 1.5 ft). To assume that any mine operator or oversight agency would let freeboard fall to this level is completely unreasonable. Tailings impoundments operate by pumping a slurry from the mill through spigots to form beaches, primarily adjacent to embankments, and pumping water back to the mill from a deep portion of the pond. Beaches extend long distances from the spigots, often miles. Water depth over the great majority of the impoundment is either zero (in the areas occupied by beaches) or shallow. The EPA full TSF scenario would unreasonably assume no freeboard represented by tailings beaches adjacent to the embankment. This freeboard, along with the portion of the embankment crest supporting spigots and piping would alone provide sufficient freeboard to capture the PMF at this site. Curiously, EPA never tells the reader how much water surface elevation gain would be produced by the PMF, an important factor in evaluating the reasonableness of the analysis. It should be in the analysis.

Perhaps most important, however, is the assumed location of the breach in EPA’s “full-volume failure” scenario. Once the elevation of the saddle between NK 1.190 and SK 1.190 is reached by the northern embankment of TFS-1, it is unreasonable in the extreme to assume that the southern embankment would ever be allowed to be as high as the northern embankment, where freeboard is an issue. No rational mine operator would allow this to occur, and no rational regulator would, either. The safety value of a “freeze-plug” at the southern embankment, by keeping it at a slightly lower elevation, is much too great. The only logical, albeit still unreasonable, full-volume scenario is to have the failure occur at the southern embankment. The elevation of the saddle between the two watersheds containing TFS-1 is 468 m MSL. The elevation of the northern embankment crest at full status would be ~558 m MSL. The difference between the elevation of the saddle, which would serve as a control in the event of a failure, is ~90 m. Therefore, the only logical, if still unreasonable, failure would involve about 90 m (vertical) of tailings, crest to control, not 208 m. Thus, the “full-volume failure” scenario would be of lesser magnitude than the “partial-volume failure” scenario, and would be directed toward the South Fork Koktuli River, not the North Fork. Given the topography at the mouth of SK 1.190, most of the volume of material that would exit the TSF would be directed upstream (east) onto the “South Fork Flats”, with some material moving downstream through the narrower valley constriction to the west.

The bottom line is that the “full-volume failure” scenario offered by EPA is not well thought out and unreasonable on several fronts. It fails to consider the relationship between the minor water surface elevation gain produced by the PMF and any reasonable freeboard; it fails to consider the freeboard required for routine operation and maintenance with respect to common wind wave generation, among other factors; it vastly overestimates the volume and average depth of the decant pond prior to overtopping and assumes an unreasonable operating condition; and it fails to consider the strategic maintenance of a lower crest elevation at the south embankment than the north embankment, with the result that the least unreasonable failure would be directed primarily onto the South Fork Flats. For all these reasons, the EPA’s “full-volume” TSF failure is unreasonable and not credible.
and calibrated by a qualified outside expert and tested against actual valley cross-sectional profiles with rational
flood routing, including up the South Fork Koktuli flood plain. In addition, any assumed impacts relying on this
modeling exercise should be disregarded as resting on a faulty foundation.

4-59 Table 4-13
The sediment deposit depths and cross-sectional area values in this table are preposterous, especially in light of the
EPA assertion made in the text that 70% of the ~300 million m³ of material from the TSF remains in suspension past
the modeled reach (past the confluence of the North Fork Koktuli and the South Fork). Regardless of the model
output, a depth of deposition of tailings in the full TSF scenario of 14m at Station 0.6 km would result in a cross-
section of deposition far greater than given in the table.

The channel elevation of the North Fork Koktuli stream bottom at Station 0.6 is approximately 182 m MSL. For a
deposition depth of 14 m, the water surface elevation would have to be at least 194 m or higher, assuming this depth of
deposit was at the channel bottom, which it could not be, given EPA’s velocities. If deposits of this depth were at
some lateral distance from the channel bottom, the top of a 14 m deep deposit would have to be at a correspondingly
higher elevation. At an elevation of 194 m (the lowest possible albeit unrealistic elevation), the valley flood plain
available for deposition is in excess of 4 km, and includes the flood plain of the South Fork. Along a transect at right
angles to the valley at this point, the flood plain profile is the shape of a saucer, with a maximum elevation of about 1
m separating the North Fork Koktuli from the South Fork, and with much more than half the product of length and
height available for deposition. Given the depth of deposition in Table 4.13 (14 m), the cross-sectional area given in
the table of 3,635 m² is inconsistent with a saucer-shaped flood plain >4 km across. In the EPA scenario, the South
Fork Koktuli would be backwatered, and its entire flood plain would be available for deposition. In reality, an actual
cross section at Station 0.6 would easily be capable of receiving >35,000 m³ of deposited material per lineal m of
valley bottom to an elevation of 194 m MSL.

At Station 5.4, the North Fork Koktuli River channel bottom is at elevation ~197 m. According to Table 4-13,
deposition would be to a depth of 8.1 m higher than the ground elevation in the deposition area, which would have to
be significantly higher than the channel bottom. This would result in a water surface elevation well in excess of 205
m MSL. At this (unrealistically low) elevation, the flood plain available for deposition is in excess of 5.3 km, and
again includes the flood plain of the South Fork Koktuli. In spite of a “hump” in the middle of a transect (still
considerably lower than flood water elevation) at this station, there is far more sediment storage available in the
South Fork Koktuli, which is 9 m lower in elevation than the North Fork in this area, and has a broad, flat profile.
Given these relative elevations, flood waters would be routed south to and up the South Fork a distance of at least 11
km, which was not included in the model. Easily more than half the product of length and height along a transect at
this station is available for sediment deposition, or >21,400 m³ per lineal m of valley bottom, which is inconsistent
with the depositional cross-sectional area of 4,857 m² given in the table.

Finally, at Station 9.4, the channel bottom is at elevation ~213 m MSL. According to Table 4-13, maximum depth of
deposition would be nearly 9 m, requiring a water depth to elevation well in excess of 222 m MSL. A transect
across the flood plain available for deposition at this station would have a length in excess of 6.6 km and, again,
would include the South Fork, which was not included in the model. Along this transect, the South Fork Koktuli
channel is more than 10 m lower in elevation and the associated local flood plain contains vastly more sediment
storage and flood water routing capacity than the North Fork. Obviously, a significant proportion of the flood wave
would be routed into the South Fork Koktuli flood plain, especially since the stream in that area would have trivial
flow compared to the hypothetical flood. In this area, about half the product of the lowest possible elevation transect
length and height would be available for sedimentation, or >25,000 m³ per lineal m of valley bottom. EPA neglects
to give elevations of the flood crest at each of the stations, making further evaluation of routing difficult, but even
without these elevations, it is obvious that routing to the South Fork Koktuli flood plain would occur. This is
extremely important information, and EPA was remiss in omitting it from the document. In addition, maps of major
sediment deposit areas, at least those associated with the “example” stations along the North Fork Koktuli should
have been included in the document. In any event, given the available low elevation flood plain profiles in the lower
North Fork and South Fork Koktuli Rivers and obvious routing to the South Fork, there is ample storage capacity
away from the main North Fork channel to store the entire mass emanating from the TSF several times over.
Another shortcoming of the EPA modeling exercise is the failure to account for flood water routing upstream on the North Fork Koktuli. According to sediment depths given in Table 4-13, water surface elevations over the North Fork Koktuli channel at Station 30.0 would be at least 333 m MSL. This would produce a backwatering of the North Fork Koktuli for a distance of ~5.5 km (as the crow flies), with an average backwater width of ~2.2 km, and would inundate Big Wiggly Lake. This flood routing and associated sediment deposition capacity is significant and should have been included in the EPA model, as well as flood routing up the South Fork Koktuli for a distance of >11 km.

These facts call the entire EPA modeling exercise into serious question. It is likely that unrealistic parameters were entered into the model, and that the surrounding landform was ignored when the model was run. In any event, EPA must explain what cross-sectional profiles for the North Fork Koktuli, including the backwatering upstream as well as flood routing up the South Fork Koktuli were used and what assumptions were made regarding the deposition of tailings in the available valley bottom flood plain. In addition, all of the assumed impacts based on this model’s output are cast into serious doubt, and should be regarded very skeptically or disregarded completely until the model is fully explained and independently validated. That EPA itself did not catch any of these errors is astonishing.

4-60 ¶1
This paragraph states, “the remaining tailings in the breached TSF, would serve as concentrated sources of easily transportable, potentially toxic material.” This statement assumes that no effort would be expended to repair and remediate the tailings embankment rupture, should it occur. This is an unreasonable assumption.

4-62 ¶8 – 4-63 ¶1
The data regarding culvert failure in this paragraph is based on studies of logging roads (primarily) built to 50+ year old standards and generally intended to be temporary access. Earlier in the document, the assessment assumes an all-weather, permanent industrial road with daily maintenance. Given the earlier assumption, these data are irrelevant. EPA should have used failure frequency data for hundreds of miles of modern, all-weather, permanent, well-maintained industrial roads in Alaska for its analysis. For example, the Red Dog Mine haul road is a 51+ mile long gravel road from the mine to the coast with many culverts, some very large. There have been no culvert failures (e.g. blockages or wash-outs) in its 23 years of operations (Ott 2012, pers. comm.). The Pogo Mine haul road is 49 miles long with 17 culverts. Although in operation for only a few years, there have been no culvert failures. There are many other examples, including the North Slope Haul Road. Information of this kind is readily available and should have been accessed and used by EPA instead of the agency apparently relying on a literature search focusing on old information related primarily to logging road culvert failures and other poorly designed systems with little or no monitoring and maintenance. Conclusions regarding impacts or failure frequencies for the transportation corridor in this EPA analysis based on these data are likewise irrelevant and meaningless in the context of this analysis, and should be disregarded until the text is corrected according to this comment.

CHAPTER 5

5-48 ¶3
This paragraph states, “[d]uring the start-up phase, all water from the site would be collected and used in operations.” This assumption is unwarranted and unlikely.

5-53 ¶5
This paragraph deals with the EPA’s new National Ambient Water Quality Criteria for Cu, which incorporate the use of a “biotic ligand model” (BLM), which accounts for the observed effects of Cu on aquatic organisms as a function of the amount of free metal (and, to a lesser extent, Cu(OH)₂) present that is bound competitively (with Ca and other cations) to organic ligands or receptors on exposed sensitive tissues of an aquatic organism (e.g. fish gills). EPA correctly asserts that their new model is an advance over the older hardness-based criteria. Several investigators have recently confirmed that the EPA’s BLM is protective of olfactory impairment in salmon, but that further refinements, including application to salt water, are warranted. See, for example, Meyer et al. 2010, DeForest et al. 2011 and Meyer et al. review MS 2012. These investigators concluded that the olfactory-based BLM should use Ca and Cu binding constants that are 16- and 4-fold higher than the branchial model, but the Na and Mg binding constants should be 32- and 126-fold lower than in the branchial model. EPA should consider revising its model to take account of the results of this research.
Risk Characterization – The EPA’s Biotic Ligand Model has been shown independently to be fully protective of salmonids in a large number of waters of the western United States and British Columbia, but could be improved further. See comment immediately above (5-53 ¶5).

This paragraph states, “[c]ulverts designed to meet the State of Alaska’s requirements and regularly maintained should not block fish passage; however, hydraulic characteristics such as low water depth or high water velocities and culvert configurations can impede or prevent fish passage.” This statement is incorrect. The State of Alaska’s criteria for culverts in fish-bearing waters, which represent a variance from the default requirement for a bridge, specifically address low flow conditions as related to fish passage, as well as high flow hydraulics as related to fish passage. Any culvert permitted for a road crossing of a fish-bearing stream, especially crossings of anadromous fish streams, must undergo a 3-tiered set of hydraulic analyses, which become more conservative for streams where hydrologies are uncertain. Since EPA has cited the MOA on this subject between ADFG and ADOT, the agency should be familiar with these requirements.

This paragraph discusses the tendency of culverts to concentrate surface (and presumably shallow groundwater) flows at the expense of surrounding aquatic and wetland features. While this can occur in poorly planned and executed alignments, these phenomena are well known to ADFG, DNR and other regulatory and permitting agencies in Alaska. It is unreasonable to assume that provisions for under-drains, supplemental culverts for wetlands connectivity and other accommodations will not be required as part of permitting for the Pebble transportation corridor. EPA should acknowledge and take account of this.

This paragraph states that “the roadway would be monitored daily to ensure that [culvert] failures could be rapidly identified and repaired” but that “inhibition of fish passage and reductions in habitat still could occur.” This is, at best, a stretch. Daily monitoring and maintenance would surely identify and correct the vast majority of culvert issues before or at the beginning of any passage or erosion problems. The ADFG/ADOT MOA is technically based and is currently working very well in preventing the kinds of problems EPA is apparently concerned about. Where risks of culvert inadequacy based on MOA criteria and hydraulic analyses are identified, it is reasonable to assume that both the mining company (which would certainly not want to experience a road failure) and Alaska regulatory and permitting agencies will call for either a bridge or much more conservative culvert design. The very low significance of this risk should be acknowledged by EPA and taken fully into account in the analysis. See comment on pp. 4-62 ¶8 – 4-63 ¶1.

This paragraph discusses the potential use of calcium chloride (CaCl₂) for road dust suppression. Calcium chloride is not toxic, as suggested by the first sentence in this paragraph, to fish and other aquatic life when used for dust suppression. It is a benign chemical that is used to aggregate fine particles together and is hygroscopic, helping to stabilize gravel road surfaces and reduce fugitive fine particles. This should be good news to those in EPA who are animated over potential fine sediment derived from the transportation corridor. Calcium (or magnesium) chloride is recommended by the US Department of Transportation in their Gravel Roads Maintenance and Design Manual (Skorseth and Selim 2000; available on the EPA website: http://water.epa.gov/polwaste/nps/gravelroads_index.cfm) for gravel road stabilization and reduction of erosion and fine particle loss. Studies by the University of New Hampshire sponsored by the State of Main and the Federal Highway Administration on the migration of calcium chloride after application to gravel roads, including movement into groundwater, found that calcium chloride is resistant to leaching and tends to bind to fine particles (hence its effectiveness) and stay where it is placed when used for roadway stabilization. This study also concluded that there is no indication that negative environmental impacts have occurred from the use of calcium chloride for dust control. EPA should become aware of these facts especially since much of this material is posted on the EPA web site, and temper or eliminate its statements concerning potential adverse impacts of calcium chloride application for dust control and road surface stabilization.
5-64 Table 5-21
Given the tendency of calcium chloride to stay put, bound to fine particles, and its benign nature (see comment immediately above), this table is largely irrelevant and should be removed from the document.

5-64 ¶1 – 5-65 ¶2
These paragraphs are an exercise in hyperbole by EPA. Although some wetlands will be filled or altered, the Pebble road alignment has been carefully planned to avoid or minimize these impacts, especially as they might affect fish or fish habitat. The State of Alaska regulatory and permitting agencies are acutely aware of the needs to protect wetlands and fish habitat along this transportation corridor, including along that portion of the Iliamna Lake shoreline used by sockeye salmon for spawning. Assuring connectivity between wetland polygons and among aquatic and wetland elements, and especially shallow groundwater flows to shoreline spawning areas, will certainly be incorporated into the road design and permitting process, and it is unreasonable to assume otherwise. The salt issue is moot (see above).

5-65 ¶4
This paragraph is factually incorrect. The existing (and proposed) road alignment is not parallel to or in close proximity to that portion of Chinkelyes Creek to which sockeye (or any other) salmon currently have access. Anadromous access is blocked by a series of three impassible falls and several bedrock cataracts. Large numbers of sockeye spawn in the lower reach of Chinkelyes Creek which is not adjacent to the road alignment.

5-70 ¶2 ff.
Fish Populations along the Transportation Corridor – This section gives some interesting fish occurrence data, but apparently has failed to use any of the readily available fish occurrence data generated by Pebble. EPA should have used Pebble data as well as other available data when generating this section of the analysis.

5-73 ¶2
This paragraph states that “[little] is known about the occurrence or abundance of other salmon species in streams and rivers crossing or adjacent to the transportation corridor. Chinook, coho, and chum salmon are present in the Kvichak River watershed, but data for spatial occurrence are for isolated points in the system (ADFG 2012). Chinook and coho salmon are reported in the Newhalen River; Chinook, coho and chum salmon are reported in the Iliamna River; and coho salmon are reported in Tomkok and Youngs Creeks.” If EPA had looked at readily available Pebble fish occurrence data for the transportation corridor, this section of the report could have presented it. As it is, EPA overlooked or chose to ignore this relevant information.

5-73 ¶4
This paragraph purports to summarize overall risks of the transportation corridor to salmon populations. It concentrates on very low probability occurrences (e.g. filling of wetlands, hydrologic modification) and very low level impacts (e.g. siltation, road salts) and concludes that these factors “are likely to diminish the production of anadromous and resident salmonids in more than 30 streams.” This conclusion is unwarranted and irresponsible without specific links to quantitative analysis, especially with respect to siltation and the possible use of calcium chloride for road stabilization. The paragraph goes on to speculate that “[s]almonid migrations and other movements may be impeded by culverts in 14 streams. The habitat potentially affected below the road crossings totals 270 km of stream, and an additional 240 km of stream upstream of the crossings would be affected if culverts impede fish movement.” These speculations are unreasonable and unwarranted in light of the standards and specifications that will certainly be applied conservatively to stream crossings along this transportation corridor and in light of the EPA assumption of daily monitoring and maintenance.

CHAPTER 6

6-1 ¶3 – 6-2 ¶2
The failure scenarios, especially the “full-volume failure” scenario, are unreasonable on several levels, as noted in comments on related sections of Chapter 4 (see comment, 4-50 ¶3 ff, and subsequent comments). The scenario consequences presented by EPA are not credible given the land form available to receive sediment deposition, and the full-volume failure scenario itself is patently unrealistic. Consequently, none of the consequences of TSF failure outlined in this part of Chapter 6 have any credibility. Even if an overtopping event were to occur, which is
unreasonable on its face, the consequences would be very much smaller than described here, and the “event” would likely be in another watershed (the South Fork Koktuli).

6-3 ¶1
This paragraph states, “[i]n the case of a tailings dam failure at TSF 1, the flood itself would mobilize existing sediments in the North Fork Koktuli River watershed. The volume of sediment mobilized would supplement the tailings released and could leave meters of material deposited in the floodplain.” This speculation, which is amplified upon later in the document, displays an alarming lack of understanding on the part of EPA of the basics of sediment transport. The flood waters pulling sediment out of the TSF would be, by definition, and given the decreasing velocities proceeding downstream (Table 4-11), fully burdened with fine sediment. EPA supports this by describing deep sediment deposits resulting from the event. Aside from some local scour that may occur in the immediate vicinity of the embankment due to kinetic action of the failure jet crossing the North Fork Koktuli valley, the event would be completely depositional. No scouring of the existing bed or valley bottom would be possible. In a depositional mode, and from an energetics perspective, water with a decreasing velocity cannot trade a fine particle for a larger one. While large sediment deposits would be produced if this unreasonably improbable event could occur, the underlying landform would not be scoured. Subsequent stream flows would transport deposited sediments from the existing stream channel quickly, especially considering grain size. Deposited sediments would be transported from the existing meander corridor, which would be a very small proportion of the depositional flood plain, according to sediment depths in Table 4-13, by natural high flows over a longer period, and as the river meanders within that corridor at a rate roughly similar to its current rate. All remaining sediments would remain perched, with slow erosion due to precipitation, mediated by re-vegetation. EPA’s description of the potential for scour of existing materials from the bed and flood plain of the North Fork Koktuli is not credible.

6-3 ¶2
This paragraph again erroneously refers to scour of the North Fork Koktuli valley. This could not occur, given the depositional mode described by EPA. See the comment immediately above.

6-3 ¶3
This paragraph states, “we assumed that the velocities calculated during the tailings dam failure flood event (Table 4-11) would result in a nearly complete reworking of the existing North Fork Koktuli channel and much of the valley.” This could not occur, given the depositional nature of the event described by EPA (see above). The paragraph goes on to say, “[g]iven the volumes of material that would be exported from the TSF, we assumed that the new valley floor would be predominately tailings material with particle sizes ranging from less than 0.01 mm to just over 1.0 mm, of which 70% would be finer than 0.1 mm. Following the recession of the tailings dam failure flood event, we assume that the bed and bank would be primarily tailings material, with incorporated dam fill and valley fill material accounting for less than 20%.” Since scour and “reworking” of existing materials in the North Fork Koktuli could not occur in a completely depositional event, this subsequent consequence could also not occur. Again, EPA is exhibiting an alarming lack of knowledge of the fundamentals of sediment transport and deposition in an event hypothecated by this document. This should have been caught by EPA’s internal peer review process, but was not, demonstrating an inadequacy of that process.

6-4 ¶1
This paragraph uses recoveries of streams affected by the Mount St. Helens eruption in terms of sediment yield to describe reductions through time. EPA concludes that recovery of “suitable structural habitat… would likely take decades given the volume of sediment that would potentially be delivered under the tailings dam failure.” Apart from the unreasonableness of the EPA scenario, the agency failed to consider here and elsewhere the biological recovery in streams receiving the brunt of the Mount St. Helens blast. Recovery of fish (salmon and resident fish) and aquatic/terrestrial invertebrates was very rapid, astonishing most investigators, and productivity (fish and invertebrate biomass gain per unit time and area) was also very high. Bisson et al. (1988) monitored habitat use and summer production of young-of-the-year (YOY) coho in three affected streams (one on a mud-flow terrace) starting three years after the blast. Although temperatures were in excess of commonly-regarded incipient lethal limits, and cover and pool habitats were essentially absent, average tissue production ranged from 2.3 to 21.6 g/m² over an average 150-d summer period, equal to or in excess of production rates for similar-size streams in the region. By 6 years after the blast, coho salmon production was found to be twice the value reported for nearby old-growth forested streams. Lowest production occurred where coho juveniles were in sympathy with large numbers of rearing
juvenile steelhead, which had re-invaded the streams earlier. High abundance of aquatic and terrestrial invertebrate food items was noted, and growth was rapid even at temperatures at which food conversion by coho is usually inefficient. In their compilation of information related to recovery of fish populations in Mount St. Helens streams, Bisson et al. (2005) state, “[i]n the absence of harvest, steelhead returns rebounded much more rapidly in these rivers than many managers and biologists had predicted… The remarkable recovery of the wild steelhead population in the South Fork Toutle River during the mid-1980s exceeded all expectations.” These authors attribute rapid (within three years) recovery of resident fish species, including sculpin and non-anadromous salmonids, to unaffected stream refugia from which “seeding” of affected areas could occur. The bottom line here is that the conclusions reached by EPA in this assessment regarding the recovery rates of salmon and resident fish species following an albeit unreasonable TSF failure scenario are speculative, unreasonable, and contrary to the best available scientific evidence.

6-4 ¶2
This paragraph states, “[t]he volume of sediment remaining in transport at the confluence following the 208-m (full) tailings dam failure would range from 15.9 to 239.3 million m³ (Table 4-13).” Given deposit depths given in Table 4-13, realistic flood routing (to the South Fork) and the width of the flood plain actually available for deposition (>4 km), this is impossible. As indicated in the comment on pg. 4-59 Table 4-13, the actual flood plain available for deposition to the depths in the table could contain the entire mass from EPA’s hypothecated failure several times over; there would be nothing left to transport if deposits were to be as deep as described by EPA and if their model allowed routing of flood waters into the South Fork. If this much material is actually still in suspension at the North Fork – South Fork Koktuli confluence, the deposits along the North Fork Koktuli, and into the lower elevation South Fork Koktuli, would have to be a small fraction of the values given in Table 4-13. Again, EPA cannot have it both ways; either the material is deposited to depths in Table 4-13, with little left to transport, or it isn’t.

6-7 ¶1
This paragraph describes EPA’s albeit unreasonable and unsupported view of sediment deposition (see earlier comments), and then states, “[a]s a result of these habitat changes, suitable spawning environments and overwintering habitats for salmon would be greatly diminished in this watershed. This would likely lead to severe declines in salmon spawning success and juvenile survival.” This is all speculation, not based on the best available scientific information, arguably the experiences following the eruption of Mount St. Helens. Given the unexpected but real fish population recovery rates following the blast, EPA’s speculation is unwarranted.

6-7 ¶3
Although an event such as that hypothecated by EPA would surely wipe out aquatic invertebrate populations within the area of deposition, recovery would likely be rapid. Based on the Mount St. Helens experience, recovery of salmon food supplies would likely occur within 3-4 years, if not sooner.

6-8 ¶2
This paragraph begins, “[t]he complete loss of suitable salmon habitat in the North Fork Koktuli mainstem in the short term (less than 10 years), along with the likelihood of very low-quality spawning and rearing habitat in the long term (decades), would result in near-complete loss of the mainstem North Fork Koktuli fish populations downstream of the tailings dam. These impacts would persist for multiple salmon life cycles, so salmon cohorts that are at sea during the tailings dam failure would eventually return to find degraded spawning and rearing habitat.” This is speculative and not supported by the best available scientific information, the recovery of the Toutle and Lewis rivers and their affected tributary streams following the Mount St. Helens blast. Recovery of the affected area would likely begin and rapidly build within 3-4 years. See comments on pg. 6-4 ¶1.

This paragraph also summarized information on Chinook salmon distribution and abundance in the Nushagak River and major contributing tributaries. This information is misleading. Although the “total inshore run” of Chinook salmon to the Nushagak District is on the order of 160,000 fish, the escapement to the Nushagak River itself is half that amount or about 80,000 fish (Jones, et al. 2012). Of these, according to Figure 6-1 (pg. 6-9), about 16,000 fish (20%) were observed during peak counts in various Nushagak-Mulchatna drainage streams as reported in Dye et al. 2006. Although not directly comparable to ADFG escapement estimates, peak counts conducted in the North Fork Koktuli from 2004 through 2008, making adjustments for underestimates, suggest that the North Fork Koktuli supports somewhere around 3-5% of the Nushagak-Mulchatna system escapement. Given the serious problems with
the EPA scenario for TSF failure outlined in other comments, this is likely the maximum habitat at significant risk from an albeit extremely unlikely failure. Finally, based on the experiences with Mount St. Helens streams and the salmon and steelhead runs they supported, and similar responses to the Mount Chaginigak lahar and acidification of Mother Goose Lake and the King Salmon River in 2005, the most reasonable expectation is that fish bound for the North Fork Koktuli would simply head elsewhere nearby and spawn and reproduce successfully. Based on real data, not EPA’s speculation, this entire paragraph is hyperbole and has no business appearing in this document.

6-8 ¶2

The data in this paragraph are incorrect and misleading. Annual escapements of sockeye salmon to the Nushagak River system averages (20-year) 528,000 fish, of which about 150,000 fish are bound for the Nuyakuk River, a modest-sized tributary which drains Tikchik Lake and Nuyakuk Lake, large sockeye producers. This EPA data discrepancy was also noted in the comment on pg. ES-18 ¶3. The Nushagak system without its Nuyakuk component contributes only about 15% of the sockeye to the Nushagak District and only about 8.5% of the total Bristol Bay run. This is a very important consideration when analyzing the potential impacts of mining in one of nine watersheds on sockeye salmon runs in Bristol Bay, but it was inappropriately ignored by EPA (see comment on pg. 2-20 ¶5).

6-9 ¶2

This paragraph states, “[s]uccessful re-colonization of the North Fork Koktuli by resident fish would depend on whether unimpaired tributary habitats function as suitable refugia and source areas for re-colonization of the North Fork Koktuli following disturbance.” Based on experiences with streams affected by the Mount St. Helens blast, re-colonization by both resident fish and anadromous species would be rapid.

6-10 ¶2

The EPA’s speculative leap that there would be a “near-complete loss of the North Fork Koktuli fish populations” ignores the fact that significant spawning and rearing of sockeye, coho and Chinook salmon occurs upstream of NK 1.190, the stream from which the EPA’s failure scenario would emanate (some sockeye rearing occurs in Big Wiggly Lake; coho and Chinook rearing occurs throughout this area). The rapid channel recovery that would occur (EPA’s erroneous speculations notwithstanding; see comments above) would allow fish to proceed past any unsuitable channel segments to areas which would be unaffected, according to EPA’s failure scenario. Furthermore, as noted above, and in accordance with the best available comparative information (e.g. Mount St. Helens blast, Mount Chaginigak lahar), any fish bound for the North Fork Koktuli but “offended” by stream conditions, would bypass this part of the system or fall back to spawn successfully elsewhere, with little or no loss of production. EPA should have been familiar with this well-documented behavior of salmon and steelhead, and should have folded it into their analysis. As it is, this part of the document exhibits a strong negative bias, as do other parts. This paragraph appears to be speculation on the part of uninformed authors and is inappropriate and unrealistic.

This paragraph also states, “downstream transport of sediment to the Koktuli mainstem, and the subsequent loss of access to the South Fork Koktuli would affect, on average, 28% of the Nushagak River Chinook salmon run in a given year. If the deposited tailings material is deep enough to impede fish access to the Mulchatna and Stuyahok Rivers, then a tailings dam failure could affect more than half of the Nushagak River Chinook salmon population” This is preposterous. Even at the depths of deposited sediment given in Table 4-13, blocking of the South Fork Koktuli River would be impossible. As pointed out in comments above on Table 4-13, there is ample volume in the combined flood plains of the North Fork and South Fork Koktuli to contain the entire mass (unrealistically) assumed by EPA to emanate from the full TSF failure scenario, if deposits would be to the depths given in the table for just the lower 9.4 km. Where would the water in the South Fork Koktuli go? The channel would likely be cleared to its approximate original elevation in a matter of days, with the vast majority of deposited sediment remaining perched on higher elevations. Where would the Stuyahok River water go? Velocities would be far more than ample to continue transport of any materials that would reach its confluence with the Mulchatna. Where would the Mulchatna River water go? Furthermore, as pointed out in comments on Table 4-13, it is physically impossible to produce deposits as deep as given in the table and as wide as the available flood plain (which includes the lower South Fork Koktuli) and have anything left to transport. Finally, it is physically impossible do dam a river with sediment it is transporting. If that could occur, every glacial stream in Alaska would have dammed itself and the Yukon River would have long since contained itself behind a self-imposed dike (but where would it go?). This paragraph demonstrates an astonishing ignorance by EPA of the fundamentals of sediment transport and is speculative in the
extreme on the part of some author or authors who are out of their element. This entire paragraph, indeed the entire failure scenario, is completely unrealistic.

6-10 ¶4
This paragraph states, “[w]e estimate that recovery of suitable structural habitat in the mainstem North Fork Koktuli and offchannel [sic.] areas would likely take decades, given the scouring action of the flood wave and the volume of fine-grain sediment that would potentially be delivered under the tailings dam failure… Recovery of suitable gravel substrates and development of channel morphology suitable for salmon habitat could be delayed even further if the flood wave were to scour much of the North Fork Koktuli valley to bedrock, which would then be buried under massive deposits of tailings fines.” Again, this paragraph displays an alarming ignorance on the part of EPA of the physical processes that would be put in place in the event of an albeit unrealistic TSF failure they invoke. As pointed out in comments on 6-3 ¶, existing sediments cannot be mobilized in what would be a fully depositional event. Once again, this paragraph is the result of incorrect speculation by an EPA author who lacks understanding of the basics of sediment transport and deposition. The recovery periods speculatively presented in this paragraph are fanciful, at best, and have no place in an unbiased, and supposedly realistic assessment.

6-11 ¶2
This paragraph states, “[w]e estimate that the combined effects of direct losses of habitat in the North Fork Koktuli, downstream in the mainstem Koktuli and beyond, and impacts on macroinvertebrate prey for salmon could adversely affect 30 to 50% of Chinook salmon returning to spawn in the Nushagak River watershed.” Please review comments above. The estimates given here are an exercise in hyperbole and are unrealistic, based on the unrealistic outcomes of an unrealistic failure scenario posited by EPA and experiences elsewhere (e.g. Mount St. Helens blast, Mount Chaginagak lahar, among others). A more realistic estimate of returning Chinook salmon “at risk” would be approximately one-tenth that put forward by EPA for their albeit unrealistic scenario, with behavioral accommodation not taken into account.

6-11 ¶5
Surprisingly, EPA has forgotten or ignored ice scour and “plowing” during break-up. This is a very important element in existing sediment movement and re-organization processes in both the North Fork and South Fork Koktuli. This may be another example of EPA authors being unfamiliar with the system they are attempting to analyze or out of their technical depth.

6-11 ¶6
This paragraph states, “based on studies of volcanic ash deposition at Mount St. Helens, reduction of suspended sediments to natural levels is expected to take decades (Section 6.1.1).” Please see comment on 6-4 ¶1.

6-12 ¶2
This paragraph states, “if the dam was eroded or overtopped by a flooding event, as in a tailings dam accident (Section 4.4.2), the pore and surface water could be diluted by fresh water.” While this is true, it is also trivial, according to the scenario presented by EPA. For the full-TSF failure scenario, the PMF would add only ~0.5 m of depth to the pond at most, which is trivial compared to the volume of pore water that would be present in >300 million m³ of tailings.

6-12 ¶4
This paragraph begins, “[o]nce in the stream, toxic constituents dissolved in the water, unlike the tailings, would not settle out.” This sentence assumes facts that are not supported by any relevant evidence, and are contradicted by evidence of which EPA should be aware. Both the active tailings pond and the seepage pump-back pond at the Gibraltar mine near Williams Lake, BC (7 mi from the Fraser River), a geologic analogue of Pebble, support thriving (rapid growth rates) populations of rainbow trout. Tissue samples from these fish show no elevated levels of Cu or other trace metals when compared to fish from other pristine lakes in the area (pers. obs., Patterson and Errington 2005, Anon. 2007, Andison 2008, Akins 2009). This is hardly reflective of a “toxic” tailings pond or “toxic” pore water. EPA should have known this, since they cite the Gibraltar mine in another part of this analysis. At another group of four geologically similar copper mines in British Columbia, the Highland Valley Mine (4 mi from the Thompson River, which supports a robust population of sockeye salmon; Mathew 2010), a reclaimed tailings pond (Trojan Pond) supports a self-sustaining population of Kamloops rainbow trout that are subjected annually to a
trophy fishing contest (proceeds going to the hospital in Kamloops, BC) (Hamaguchi et al. 2008). Fry from the small feeder stream to this pond, where adult fish successfully spawn, are out-planted to other water bodies in disturbed areas on the mining property, where they do well. The bottom line is that not all copper porphyry tailings ponds are toxic. While the expected chemical make-up of the Pebble tailings pond water has not been firmly established, it is inappropriate for EPA to blithely assume toxicity that would preclude fish (and food item) life when there is relevant evidence that such an assumption could easily be false. This is another significant shortcoming of the EPA analysis.

6-14 – Box 6-1

**Background on Relevant Analogous Tailings Spill Sites** – None of these “tailings spill sites” is relevant to the EPA hypothetical development and failure scenario for Pebble. The Clark Fork (MT) site(s) resulted from mines and smelter operations dating from periods when there was little understanding or regulation of the potential consequences of mining activities. The mineralization in this area is not like the Pebble deposit, and other metals (lead, silver) are generally much more toxic than Cu (or Zn). Milling and metal extraction processes were not like those anticipated for Pebble. Pebble tailings, and the tailings pond itself (and porewater) would be alkaline, not acid. This is an irrelevant and unrealistic choice for an analogue, and EPA should know this.

The South Fork Coeur d’Alene River was the recipient of particularly noxious tailings and smelter slag, much of which was simply bulldozed into the river to be washed downstream at high water. The rich mineralization of this area was nothing like the Pebble deposit (copper is not a pollutant of concern), and mining, milling and smelting activities bear little if any relevant similarity to activities anticipated for Pebble (nobody is proposing “plank tailings dams” for Pebble). The Bunker Hill smelter fire and toxic smoke plume spread wind-borne toxic materials great distances with terrible consequences. Nothing like this is anticipated for Pebble; there will be no smelter. This, too, is an irrelevant and grossly unrealistic choice for an analogue, and it is disturbing that EPA did not recognize this.

The Soda Butte Creek tailings embankment failure resulted from a dike retaining tailings from operations that began in nearly 80 years ago and continued for 20 years. Originally, tailings were placed directly in the creek meander corridor on an oxbow behind a low dike (that could never be permitted for a modern mining operation in Alaska). The dike failed in high flows in 1950 spilling “a large amount” of tailings into the creek (Boughton 2001). The spilled tailings apparently did not move far, because the stream was re-routed around the deposit, which was capped and re-vegetated by EPA and Kennecott in 1969, nearly 20 years after the “spill” (Boughton 2001). The total amount of tailings originally deposited was 115,000 m³, minute in comparison to the EPA scenario for Pebble. The actual source for much of the contamination of Soda Butte Creek itself is also problematic. USGS has stated in its evaluation of this site and the surrounding geology that “[a]lthough the impacts of mining are documented, differentiating between natural and human-induced sources of metals is extremely difficult because the geologic units in the watershed are highly mineralized.” Numerous other historical mining operations and streamside tailings deposits in the area have likewise contributed to the uncertainty surrounding true sources of contaminant loading of Soda Butte Creek. In its intensive tracer-injection and synoptic-sampling study of the McLaren mine tailings, USGS was able to detect copper and other metals in seeps emanating from the McLaren tailings, but was unable to calculate loads for cadmium, copper, lead and zinc for the stream itself because these trace elements were below detection limits in stream water synoptic samples. The USGS concluded, “[t]he lack of detection of these elements in the downstream mainstem synoptic samples is probably because of sorption (coprecipitation and adsorption) to metal colloids in the stream” and that some loading of Soda Butte Creek came from Republic Creek and another unnamed tributary (Boughton 2001). It is noteworthy that it is dissolved (“free”) copper that is the toxic moiety in the aquatic environment. Finally, the McLaren mine was not a geologic analogue of Pebble and the milling and extraction process used a cyanide heap-leach method, not a floatation circuit such as would be used at the Pebble mill. This is an irrelevant and unrealistic choice for an analogue for the Pebble prospect and it is surprising that EPA would have identified it as such.

6-18 ¶2

This paragraph states that “the tailings leachate to which biota would be exposed could resemble leachates from supernatants and humidity cells.” This would be true only absent dilution. According to Tables 6-2 and 6-3, the only dissolved constituent of concern for aquatic life (approaching or exceeding aquatic life water quality standards) would be copper. This element would exceed the most protective standard, the Biotic Ligand Model (BLM) standard, but would not exceed the federal or State of Alaska hardness-related standard; the Cu concentration would...
be approximately equal to the acute BLM standard and would be 1.8 times the chronic BLM standard (CMC and CCC quotients are the same for both supernatant and humidity cell waters). Thus, a 2:1 dilution of the inferred tailings supernatant or porewater concentrations would bring Cu concentrations below BLM chronic criteria. One critical factor in this scenario is the relative leaching rate of tailings material once mobilized and re-deposited and the percolation rate of local precipitation and uncontaminated (up-gradient) shallow groundwater through re-deposited tailings. Another critical factor would be the delivery rate of already diluted (by up-gradient groundwater and precipitation) porewater to surface waters supporting fish and aquatic invertebrates relative to uncontaminated stream flow from other parts of watersheds. EPA gives no clue of these critical rates, even though they are crucial to forming conclusions regarding the toxicity, or lack of toxicity, of surface waters in affected streams. This is a critical shortcoming of the analysis, because it profoundly affects the credibility of claims of impairment of aquatic life down-gradient of the event.

This paragraph also states, “high flows would be expected to increase leaching rates.” This statement is specious. The dilution effects of high flows would vastly overwhelm any increase in leaching rates, which would depend on chemical kinetics and the solubility product constant governing co-precipitants and complexes of copper in the associated substrate. The fact that USGS was unable to detect Cu in surface water samples in Soda Butte Creek (an EPA tailings spill example; see comments on Box 6-1), which they attributed to “sorption (coprecipitation and adsorption) to metal colloids in the stream” suggests that the effects of leaching of Cu from perched or other re-deposited tailings would be trivial to non-existent.

6-18 ¶3
In this paragraph, EPA re-introduces Soda Butte Creek as an example of disseminated tailings. It is important to note, but EPA does not make it entirely clear, that the copper concentrations to which they refer are for sediments, not water. EPA fails to note that the readily available USGS tracer and synoptic sampling study (Boughton 2001) could not detect Cu in stream water, although this element was readily detectable in seep water from tailings deposits, and that USGS attributes this to adsorption and co-precipitation of Cu onto metal colloids in the stream. EPA also fails to point out that Cu has very high affinities to fine particulates, dissolved and particulate organic matter and other chemical constituents in water, and it may be as likely to be removed from water by fine particles than be leached into water from them, depending on pH and a host of other considerations. This is a serious omission by EPA in the discussion of the fate and effect of Cu associated with tailings in their TSF failure scenario.

6-19 ¶1
This paragraph states, “rain and snowmelt would run across and percolate through tailings deposited on floodplains, leaching metals and carrying them into the stream. Leachate would also form during lateral groundwater movement through tailings, particularly where tailings deposited in wetlands.” This is highly speculative, and such occurrences would depend greatly on site-specific conditions and relative rates of leaching (in turn dependent on porewater chemistry) and percolation. See comment immediately above.

6-20 ¶1
This paragraph states, “[c]oncentrations [of copper] in Bristol Bay would probably be lower than for the acidic Clark Fork tailings and [soluble copper] salt accumulation on the surface would be less as a result of greater precipitation.” This statement is specious and an exercise in extreme hyperbole. It has no place in this document. The chemical origins and modes of transport and deposition in the Clark Fork area were radically different than anything that could be associated with the Pebble deposit. Furthermore, given the combined flows of the Nushagak watershed streams, along with the other eight major rivers feeding Bristol Bay, and the affinities of copper for colloids, particulates, dissolved and particulate carbon and its tendency to form co-precipitates and adhere to substrates, it is questionable that any differences in concentrations of copper in Bristol Bay water from pre-event background could be detected. Although it varies greatly, the generally accepted concentration of copper in seawater is about 0.25 ppb (Blossom c. 2001).

6-20 ¶2
This paragraph re-introduces the South Fork Coeur d’Alene River as a comparative example of “metal-enriched tailings” by flood waters. This is an inappropriate example. See comments on pg. 6-14 – Box-6-1. Copper was not a significant actor in the South Fork Coeur d’Alene site.
This paragraph states, “bedload transport… could release sediment pore water (leachate) into the water column. First, copper could leach from the tailings and accumulate in sediment pore water during low flow periods. Then when flows increase sufficiently to mobilize the sediment, pore water would mix with surface water, resulting in exposure of aquatic biota and downstream copper transport.” This is highly speculative and likely incorrect. Copper has extremely high affinities for colloids, fine particulates, dissolved and particulate carbon, periphyton (for which it is a micro-nutrient, as it is for virtually every form of life on the planet) and forms complexes with other chemical constituents in water with much lower bio-availability. Again, the inability of USGS to detect copper in water (as opposed to sediment) samples from Soda Butte Creek, and the attribution of this failure by USGS to adsorption and co-precipitation suggests that the speculation of EPA in this paragraph is incorrect.

Dietary Exposures – This section of the analysis discusses potential dietary exposures of fish to aquatic invertebrates that constitute food supplies. The clear implication of this section is that there will be some negative impact to salmon and resident fish that consume aquatic invertebrates in an area affected by the EPA-postulated TSF failure. This discussion is both deficient and, in several respects, incorrect.

Copper is important for animals as it is involved in the activity of enzymes such as cytochrome oxidase, superoxide dismutase, lysyl oxidase, dopamine hydroxylase and tyrosinase. In addition, copper-proteins and chelates also have metabolic roles. The National Research Council (NRC) gives minimum dietary requirements of copper for rainbow trout as 3 mg/kg/day and for Atlantic salmon as 5 mg/kg/day (note: the units are ppm, whereas water concentrations discussed in the EPA analysis are μ/l or ppb, one one-thousandth of the ppm used in discussions of dietary requirements). Dietary studies on salmon and trout, among other fish species, have concluded that minimum dietary requirements for trout and salmon can be met by copper concentrations in food from 3 – 5 ppm on the low end to 500-600 ppm on the high side of the range, with no adverse affect on Rainbow Trout (Watanabe et al. 1977). However, concentrations over 730 ppm reduced growth rate (Lano 1985). Much of the effect of dietary copper depends on its bio-availability; in most salmonid fish nutrition studies, copper is far more bio-available (as, e.g. CuSO₄•5 H₂O) than in the natural environment (Berntssen et al. 1999). Very strong homeostatic mechanisms are at work in salmonids when it comes to copper metabolism and dietary exposure. Berntssen et al.(1999) confirmed the work of others that gut concentrations reflect dietary exposure levels and found that whole-body minus intestine Cu concentrations were significantly increased in Atlantic salmon only at dietary copper regimens of ≥900 mg/l. Kamunde et al. (2001) found that dietary copper exposure up to 1,000 ppm (as CuSO₄•5 H₂O) for 28 days (4% wet body weight/day) had no effect on growth, condition factor or food conversion efficiency. They also found that plasma copper concentrations were not different from controls, but that bile copper was greatly elevated for fish fed higher concentrations of copper in their diet, confirming the role of liver and bile excretion (via the gut) in homeostatic control of body burdens of copper, even at greatly elevated dietary exposure. Finally, these authors showed that pre-exposure to dietary copper decreased the uptake of waterborne copper across the gills, “providing the first evidence of homeostatic interaction between the two routes of uptake.”

EPA should have included this or similar information in its discussion on dietary exposures, with emphasis on homeostatic control and metabolic pathways for copper, noting that organisms accumulate this essential micronutrient from waters and food when ambient concentrations are low and excrete (depurate) it when dietary sources exceed metabolic needs. This is a fundamental of fish and invertebrate physiology, and EPA is remiss for not including these facts in this discussion, with the result that the entire discussion is misleading. It is interesting that in EPA’s worst case analysis, (inappropriately) inferred copper concentrations of copper in aquatic invertebrates (683 mg/kg or ppm) is near the albeit high end of the no-effects range of dietary exposure of highly bio-available copper for salmonids, whereas copper in the natural environment is generally far less bio-available. EPA should have pointed this out, but failed to do so, resulting in a biased presentation of available information.

Persistence of Exposures – This paragraph sites a review of the persistence of “high metal content sediment in streams after 10 to 100 years” without specifying which metals were considered in the review. This is an extremely important omission by EPS, since different metals have different affinities for particulates and other materials, and accordingly may be more or less persistent in sediments. Copper has very high affinities for particulates and colloids, and can be expected to persist in deposits for long periods. However, and importantly, this is inconsistent...
with EPA’s persistent view that copper would readily and rapidly leach from sediments and enter surface waters at concentrations sufficient to adversely affect fish and aquatic invertebrates. Either copper would leach rapidly enough to impair aquatic biota, or it will persist. It cannot do both. Again, evidence of the persistence of copper in sediments, but its lack of appearance in the water column, is given by EPA’s own Soda Butte Creek case, as reported by USGS (Boughton 2001). This paragraph also cites the South Fork Coeur d’Alene River case, but does so inappropriately. Copper was never an actor in the South Fork Coeur d’Alene River (Moberly et al. 2009); Cd, Pb and Zn were the culprits, but have very different behaviors. Copper should be the only metal of interest in the EPA scenario involving the Pebble deposit, given the agency’s own assumptions on tailings and porewater concentrations of other constituents.

6-23 ¶3
This paragraph sites Borgmann et al. (2005) and states, “[a] dietary chronic value for rainbow trout derived from multiple studies is 646 μg/g ([ppm or] micrograms of copper per gram of dry diet), at which survival and growth are observed to decline in multiple studies.” This is a biased misrepresentation of the information in Borgmann et al. In fact, the “no-effect” concentrations in the eight studies cited by Borgmann et al. ranged from 458 to 895 ppm, with most of them using highly bio-available copper in dietary regimens, which would not be the case in the natural environment. In the same chapter, which deals with the issue of dietary metals exposure in the regulatory environment, Borgmann et al. write the following, which may serve as a caution to EPA:

*Although models have a considerable potential for application in the development of guidelines that incorporate dietborne [sic.] metal exposure, we emphasize that the current state of knowledge is insufficient to allow full use of this approach. More experimental data are required demonstrating the relationship (or lack of relationship if none exists) between toxic effects and metal concentrations in food. We need to know for which species and for which metals toxic effects correlate well with metal bioaccumulation and whether critical body or tissue concentrations for metals accumulated from food are similar to, greater than, or less than critical concentrations for the same metals accumulated from water. We need to be able to quantitatively link accumulation from water and food to effects. Then the modeling approaches discussed in this chapter need to be tested for applicability and reliability and modified if necessary. Although full use of the modeling approach in a regulatory framework cannot be recommended at this time, the approach has considerable promise.*

CONCLUSION

The EPA’s external review draft “Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska (2012)" is a strongly biased analysis that relies heavily on selected, incomplete or inappropriate information and seriously flawed analytical methods to reach tortured conclusions, many of which are patently incorrect. In order to reach these conclusions, much relevant and correct information that would tend to nullify or refute them was excluded from the analysis. As stated early in this review, this circumstance does a great disservice to the public and does nothing to further the rational, scientifically-based protection of the environment.
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