Final Peer Review Summary Report

External Peer Review of Chambers and Higman 2011 (*Long Term Risks of Tailing Dam Failure*) and Levit and Chambers 2012 (*Comparison of the Pebble Mine with other Alaska Large Hard Rock Mines*)

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I. INTRODUCTION

In May 2012, the U.S. Environmental Protection Agency (EPA) released a draft report entitled *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*. The purpose of this report was to put forth a prospective risk assessment of large-scale mining in the Bristol Bay watershed, focusing on a specific case study for a hypothetical but realistic mine scenario at the Pebble deposit. Specifically, the assessment examines how future large-scale mining may affect water quality, habitat, and salmon fisheries in the Bristol Bay watershed. During preparation of this draft assessment, EPA identified the following two reports developed by non-EPA scientists that contained information relevant to this topic, but were not included because they had not been peer-reviewed: *Long Term Risks of Tailing Dam Failure* (Chambers and Higman 2011) and *Comparison of the Pebble Mine with other Alaska Large Hard Rock Mines* (Levit and Chambers 2012).

The purpose of this letter peer review is to determine if the information contained in these reports is of sufficient scientific quality and credibility to be incorporated into EPA's revised Bristol Bay report.

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II. PEER REVIEW OF CHAMBERS AND HIGMAN 2011 REPORT

II.1 Charge Questions

1. Are the conclusions of the report well-supported by the evidence provided? Why or why not?

2. What are the strengths and weaknesses of the Chambers and Higman 2011 report, in terms of:

   a. Methodology?

   b. Results and conclusions?

3. Are there important limitations or uncertainties associated with applying results from the Chambers and Higman 2011 report to the EPA assessment? If so, what are they?

II.2 General Impressions

David Brett

Quite a good overview of tailings dam risks, but some statistical interpretation is misleading. However, overall conclusions are mostly appropriate. In particular:

1. It is true that tailings dams have a poor safety record judged by historic statistics and that upstream construction has poorer record than downstream, but there has been a rapid development of understanding related to earthquake design and liquefaction in recent years and this is reflected in more recent statistics as reported by myself to the ICOLD tailings dams committee last meeting (2012). The Australian committee (ANCOLD) has updated the 2001 data. Results are presented in Figure 1.

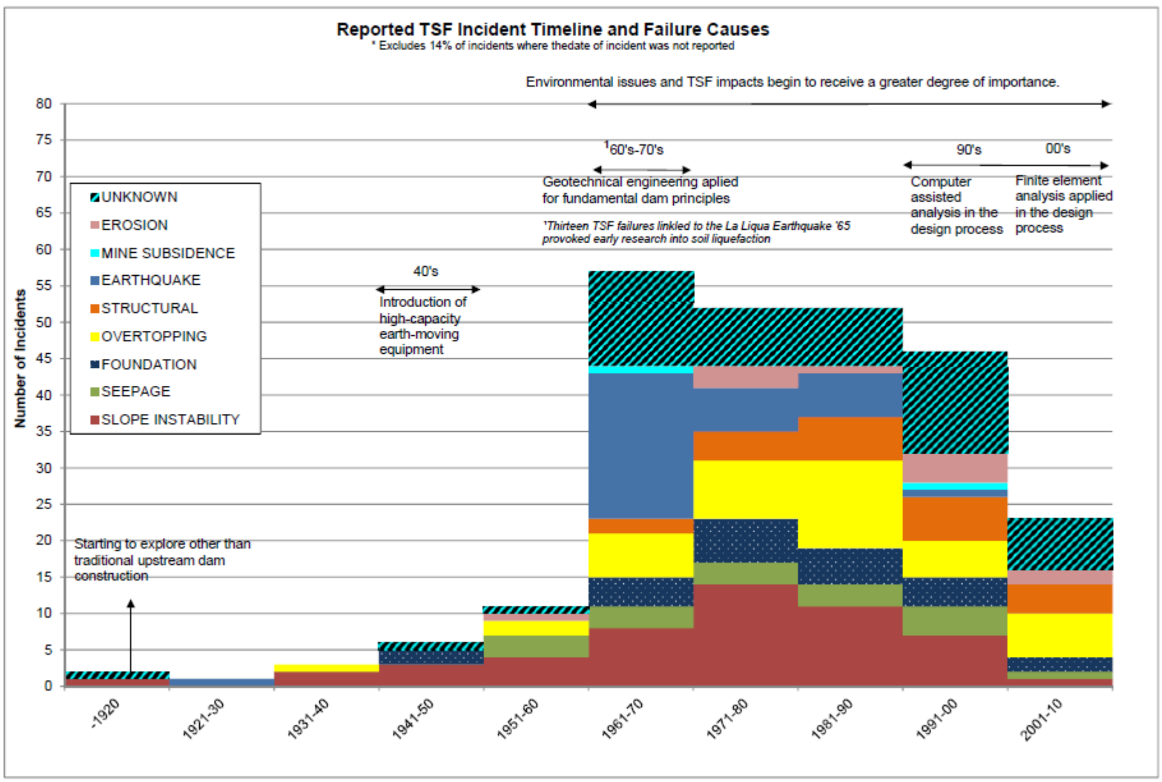

Figure 1. Tailings Failure Statistics[1]

This shows a reduced total failure rate over the last decade, but still over two per year. As can be seen, the number of earthquake related failures and slope stability appear to have been less over the past 20 years. The recent work has included an assessment of the failure rate in terms of the annual tonnage of tailings produced with clear indication of improvement as shown in Figure 2.

[1] Citation was not provided. Figure from unpublished data presented to ICOLD Committee on Tailings Dams in 2012.

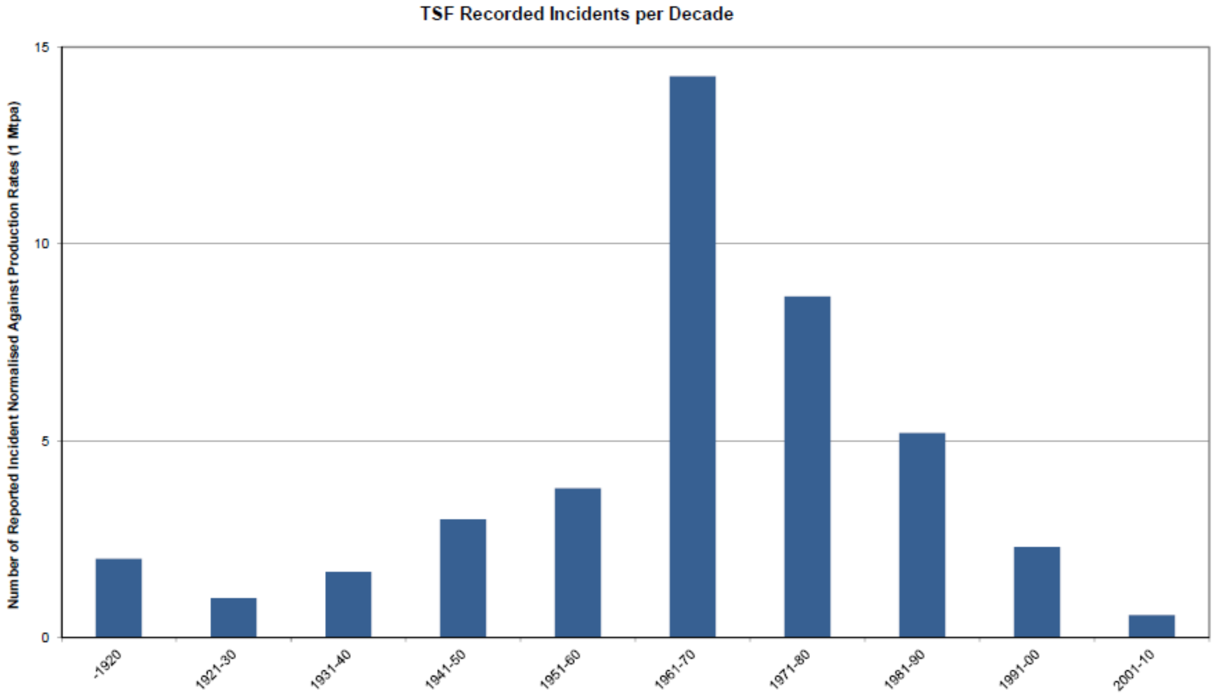

Figure 2. TSF Failures/Mtpa tailings production[2]

The major ongoing cause of TSF failure can be seen to be overtopping. This is due to ongoing failure to recognize the appropriate design parameters and also failure to understand and train site personnel in proper water management. Recent failures in China that I have personal knowledge of are due to inappropriate flood design parameters and lack of emergency spillway provisions. These cases affect the statistics and do not allow modern design practices and operations in well regulated environments to be fully appreciated.

2. Page 3 – It is believed that the number of tailings dams far exceeds 3,500 quoted from Davis and Martin. This figure only accounts for "industrial scale" mines. There are understood to be over 13,000 tailings dams in China alone, many from small operations. Nevertheless, failure of these is likely to be included in the statistics.
3. Page 4 – The "alarming" data relating to the high rate of failure of tailings dams in USA is distorted by the fact that the USA has had, for many years, one of the best reporting systems, so the ICOLD data is skewed towards the USA.
4. Despite some references used being slightly dated and misinterpreted, the conclusions are valid and are completely in line with Guidelines used in some advanced mining regulations. This includes the new 2012 ANCOLD Guidelines for Tailings Dams – Planning, Design, Construction, Operation and Closure. These require, for example, that tailings dams at closure are designed for Probable Maximum Floods and Maximum Credible Earthquakes.
5. The commentary on seismic event determination is considered to be a good summary. However, the precise determination of the design earthquake event may not end up being particularly critical. The most important issue, if upstream construction is contemplated, is to

[2] Citation was not provided. Figure from unpublished data presented to ICOLD Committee on Tailings Dams in 2012.

determine if liquefaction is possible, either during operation or at closure, and if it is, then what is the residual post liquefaction shear stress that should be used in design. In cases of upstream construction in my experience, liquefaction is likely to occur at earthquakes smaller than the Maximum Design Earthquake, so allowing a larger earthquake is unlikely to make significant change to the dam stability. More important will be an estimation of post-earthquake deformation as this could have significant impact on surface drainage.

Conclusions on pages 17 and 18 are reasonable and appropriate. This is not to say that a safe tailings dam cannot be designed but to agree that conservative design parameters need to be established and include a long-term closure plan considering maximum credible design floods and earthquakes and also the impact of multiple such events.

Andy Fourie

The report is based on consolidation of information relating to the performance of tailings storage facilities. The information has been sourced from reputable sources, including a number of international journals and conferences of high quality, as well as reports from agencies such as ICOLD (International Commission on Large Dams). The information presented is thus not derived from the authors' own research or investigations, but is based on a discussion and interpretation of information that has already (largely) been independently vetted.

The report is clearly presented and is logically laid out. The conclusions are consistent with the information presented, although it may be possible to draw somewhat different conclusions if one were a strong proponent of the proposed Pebble mine. The potential impacts of a mine the size of the proposed Pebble operation is undoubted; it is the ability to prevent these impacts and ensure safe and environmentally sound operation of the facility that is in question. The authors of the report accurately and clearly spell out potential risks and hazards. What cannot be clearly established is the ability of current legislation to ensure such risks are made negligible.

Robert Kleinmann

The subject report is a well-reasoned discussion of tailings dams and concerns about their long-term safety. It nicely introduces the various aspects that underlie the potential hazards and explains the various rationales that lie behind potentially using more conservative standards, especially at sites where the potential risks, if failure should occur, are very serious. It then examines the proposed Pebble Mine in particular, and argues that risk-based standards, although by definition reasonable, are not conservative enough.

Natalia Ruppert

The report is well written with appropriate illustrations, tables, and appendices. A large portion of the report deals with describing seismic risk at the proposed Pebble Mine location, how characteristic earthquake was chosen for identifying seismic hazard of the area. To the best of my knowledge, facts presented in this report are correct, at least in the sections dealing with seismic assessments. The authors describe in great detail long-term risks of tailing dams. Their main argument is that 'worst case' scenarios should be considered for design of the dams. These are more conservative assumptions than ‘credible’ scenarios may present. The authors identify ‘worst case’ seismic risk for the Pebble mine – a ‘floating earthquake’ very near the proposed facilities. While this scenario is possible, it remains very unlikely.

II.3 Response to Charge Questions

Question 1. Are the conclusions of the report well-supported by the evidence provided? Why or why not?

David Brett

The data are slightly dated, but nevertheless the final conclusions are supported and are reasonable.

Andy Fourie

Yes, the conclusions are well supported. A key recommendation is to utilize a 'conservative, probabilistic perspective' in evaluating the impact of the Pebble project. It would be possible to draw other conclusions, such as the use of conventional, deterministic approaches being appropriate, but the key recommendation remains valid. The observation that upstream constructed facilities are much more susceptible to seismically induced damage or failure than downstream constructed facilities is irrefutable. Other key suggestions are that the extended time periods over which tailings storage facilities must perform satisfactorily are of the order of millennia, as opposed to decades for most other engineered structures.

The suggestion for using probabilistic approaches for evaluating the long-term stability of tailings storage facilities is likely to meet with some resistance, particularly as current legislation appears to allow a purely deterministic approach. Nevertheless, the suggestion that the uncertainty in estimating long-term monitoring and maintenance costs, especially in providing adequate monies for repairs that may be required, is appropriate. Although there have been a number of catastrophic failures of tailings facilities, requiring extensive clean-up activities, the true costs of such clean-ups are not well-documented.

Robert Kleinmann

Yes, the conclusions are well considered and well supported. The authors first introduce the reader to the fact that far too many tailings dams fail, and make the case that because tailings dams must last for many centuries longer than the mines, they must be built to last. They then demonstrate that, in general, mining companies and regulatory agencies are making decisions about construction methods that are based too much on short-term economics rather than long-term dam safety. The authors then go on to discuss how difficult it is to make accurate predictions of seismic activity/magnitude in regions that are known to experience severe earthquakes, but are not very well studied in terms of fault locations. Based on this uncertainty and the high level of risk associated with dam failure, the authors argue effectively that the most conservative standards should be applied.

Natalia Ruppert

The main conclusion of this report is that design features of a tailing dam, in general and Pebble in particular, should be guided by most 'conservative' assumptions about the risks involved (seismic, hydrological, etc.), not by simply 'reasonable' assumptions. Design under most 'conservative' risk assumptions would undoubtedly cost more. The conclusion logically follows discussion of seismic and hydrological risks in the report. Dam failures do happen with some frequency and not all risks are always anticipated, as with other natural disasters.

Question 2. What are the strengths and weaknesses of the Chambers and Higman 2011 report, in terms of:
a. Methodology?
b. Results and conclusions?

David Brett

a. Methodology?

Strengths - The report has reviewed a considerable number of appropriate references.
Weaknesses – Has not fully understood the data from ICOLD 2001 (see general comments above).

b. Results and conclusions?

I concur with the conclusions that conservative design parameters should be applied in a case such as Pebble Mine. This approach is consistent with current international Guidelines such as the 2012 ANCOLD Guidelines for Tailings Dams.

Andy Fourie

a. Methodology?

The report draws extensively on published research papers and reports. This is entirely appropriate as there is a wealth of relevant information available. The work is not speculative or subjective, although it clearly assumes a particular stance, namely that a conservative approach is appropriate.

A particular strength is that it avoids sourcing information from individuals, whether these are people who might potentially be affected by the proposed mine, or people who advocate the project. By relying on factual, published information, the authors retain a detached perspective in their discussion.

b. Results and conclusions?

The work of Rico et al. 2008 is perhaps over-emphasized. Although the work by Rico et al. 2008 is very valuable, it is misleading to draw inferences on risks associated with other facilities using their data. This is because every tailings facility is unique, with widely varying operating conditions, water balance parameters, management strategies and material properties (amongst others). Without detailed knowledge of these parameters for the cases reported by Rico et al. 2008, it is not considered appropriate to use these data to make projections about the possible impact or likelihood of failure of the Pebble project.

The discussion of the appropriate design earthquake is an important contribution. It discusses the use of a deterministic approach when information is available on existing faults, but emphasizes the importance of carrying out probabilistic analyses when uncertainties exist. This is a very sound suggestion, and its relevance is confirmed by the recent earthquake in Christchurch, New Zealand, where the devastating earthquake of 2010/11 occurred beneath the city on a fault that had not previously been deemed a risk (if it had in fact even been recognized). The report further suggests that there is fundamental flaw in the Alaska Dam Classification Seismic Stability Regulations, principally because categorization of a facility as Class II facility means that the design return period is less than or equal to 2,500 years. This topic is certainly worthy of more deliberation, as it is key to adequately quantifying the risk of a facility in perpetuity.

Robert Kleinmann

a. Methodology?

Strengths: The report bases its conclusions on the high level of potential environmental danger and financial risk associated with dam failure and the known seismic activity in the region, along with the fact that exact locations of faults are not known in the immediate vicinity of the proposed mine site. The reasoning is well-explained. It then examines the proposed Pebble Mine in particular, and argues that the risk-based standards, although reasonable, are not conservative enough.

Weaknesses: None noted.

b. Results and conclusions?

The authors argue, given the environmental and economic damage that would accompany dam failure, that it is sensible to err on the side of conservatism, and to assume that an unknown fault might exist in the immediate vicinity of the proposed mine <u>and</u> that the magnitude of the earthquake that might result from movement along that unknown fault would be as great as what would be associated with a maximum credible earthquake at the nearest known fault.

The authors then point out that the mine operators decided to assume a maximum credible earthquake as their design standard, but assumed that the earthquake would occur at the closest known location of a fault (18 miles away) and assumed that the planned-for earthquake might occur sometime during the next 5,000 years, thus generating a certain rate of acceleration. The authors disagreed with this assumption and felt that mine operators should assume that the earthquake might not occur for 10,000 years, and would therefore generate more force for a longer period of time. They then also argue that the mine operators should assume that it might occur immediately under the mine site. Although the authors make a very credible case for being conservative, are they perhaps urging too much conservatism?

Natalia Ruppert

a. Methodology?

Authors write in great detail about tectonic setting, seismicity, and faults in the area. They cite peer-reviewed scientific articles written on the subject and generally correct in their assessments of tectonic features. However, much about tectonic features of Western Alaska (such as what tectonic blocks compose western and southern Alaska) remains speculative at best. Lake Clark fault (major tectonic feature nearest to the proposed mine location) remains a point of contention. Most recent map of active faults in Alaska produced by the Alaska Division of Geological and Geophysical Surveys (ADGGS) does not show this fault as presently active structure. Therefore, question remains as to whether this fault is capable of generating significant earthquakes. Perhaps with more geological mapping in the area, this question can be answered as well as whether other active faults are present in the region of interest, as the authors suggest. Without detailed geological studies, all arguments for or against present geological activity of the faults in area remain speculative.

Another point of contention is choice of the ‘Maximum Design Earthquake’ (MDE). The authors site recommendation of ICOLD (International Commission on Large Dams) to define return interval for such an event is 10,000 years. The Alaska Dam Safety Program, however, does not follow such stringent requirements (Appendix B). The Knight Piesold Pebble Project Seismicity Report (Appendix A) adheres to the Alaska Dam Safety Program requirements and its selection of MDE seems to be appropriate.

b. Results and conclusions?

Paraphrasing the main conclusion of the report is that society should always consider worst risks. Tailing dams should be built to withstand these risks for eternity. In my opinion, this is a noble goal, but may not be achievable in the real world. The authors site a few recent examples of unforeseen disasters (the Gulf oil spill, nuclear disaster following major earthquake and tsunami in Japan). The report draws a distinction between ‘credible’ risks and ‘worst case scenarios’. The latter ones are probable, but less likely. The authors identify ‘worst case scenarios’ for the Pebble project, such as ‘floating’ earthquake under or very near future tailing dams. I have to admit, everything is possible, however, with limited amount of resources one has to be careful not to over-spend on design features that may never come into play. It’s a careful balancing act.

Question 3. Are there important limitations or uncertainties associated with applying results from the Chambers and Higman 2011 report to the EPA assessment? If so, what are they?

David Brett

No – suggest EPA review the ANCOLD Guidelines, a copy of which can be provided on request or sourced by email to ancold@leishman-associates.com.au.

Andy Fourie

The report could have included a discussion of design approaches and relevant legislation in other countries and jurisdictions. Clearly the governing Alaskan legislation is what counts, but reference to other countries approaches would have provided a valuable comparison. Concepts of stewardship of tailings storage facilities and associated design approaches are evolving rapidly and a predominantly risk-based approach is gaining increasing traction.

The discussion of design seismic loading concentrates on the magnitude of the design earthquake and the maximum horizontal ground acceleration. This approach is consistent with accepted practice internationally, but additional discussion on the added value of carrying out dynamic computer-based modeling studies using representative seismic input records (e.g., from previous, recorded earthquakes) would have been valuable.

Robert Kleinmann

Arguing for the most conservative approach -- in terms of location of a potential earthquake (at the mine site) and the magnitude (the worst case possible, assuming that the nearest known fault is extended to the mine site) -- may be over the top, but the report certainly convinced this reader that regulatory authorities should err on the side of conservatism. However, it is also reasonable to consider economics and to decide if the extra measures of conservatism urged by the authors puts too much of a burden on the mine operators and whether imposing one of the two more conservative assumptions would sufficiently mirror the risks associated with the uncertainties of the site.

Natalia Ruppert

There are big uncertainties in how seismic risk is identified for any region. The same remains true for proposed Pebble mine site. Detailed geological mapping would help in identifying these risks more accurately. As it stands now, tectonic models for western and southern Alaska remain speculative at best.

III. PEER REVIEW OF LEVIT AND CHAMBERS 2012 REPORT

III.1 Charge Questions

1. Are the conclusions of the report well-supported by the evidence provided? Why or why not?

2. What are the strengths and weaknesses of the Levit and Chambers 2012 report, in terms of:

    a. Methodology?

    b. Results and conclusions?

3. Are there important limitations or uncertainties associated with applying results from the Levit and Chambers 2012 report to the EPA assessment? If so, what are they?

III.2 General Impressions

David Brett

A well-presented paper with clear information about overall characteristics of the proposed Pebble Mine and other Alaskan mines. I am unable to comment on the accuracy of the data presented, but there was no information that I would consider inaccurate in terms of the scientific statements and conclusions, apart from statistics of tailings dam failures which is discussed below.

There is no specific "Conclusion" but rather a range of conclusions spread throughout the paper. These are dealt with as follows:

- **Size**- There seems no doubt that Pebble Mine will be a large mine by international standards, let alone Alaskan. The proposed mining rate of 30 to 60 million tonnes per annum is large, but this is the trend of modern mining as lower grade ores are targeted. There are larger mines, such as Escondida in Chile, which has a mill throughput of 120 million tonnes per annum, i.e., 2 to 4 times bigger. The proposed size is not unusual in terms of projects being developed or considered around the world.

- **Potential Impact –** The data provided does indicate that the size and location of the proposed mine will mean that there will be a potential for environmental impact that will need to be carefully addressed and managed in the approval and future regulatory process.

- **Hydro-Geology -** The presence of permeable gravels and apparently high water-table will mean that waste storages will need to take into account the potential for groundwater impact.

- **Mine Type –** The paper describes the potential impact of large waste rock stockpiles and block-caving that are essentially correct, but this can highlight the areas to be attended to in design and operation rather than being fatal flaws.

- **Geo-Chemistry –** The conclusions that waste materials, including tailings and waste rock, will contain residual mineral levels is likely to be correct due to the normal practice of establishing an economic cut-off grade to divide ore for processing from the "waste rock" and the fact that the process is selective in the minerals extracted and is not 100% efficient. There are technologies that can be used to classify the waste materials and allow separation and appropriate management to reduce the risks discussed in this paper. This can apply to both waste-rock material and also tailings, which will vary depending on the details of the mill process. It is possible that low-sulphide tailings could be produced, at least for part of the waste stream.

  The precise nature of the porphyry deposit is unclear, but it is reasonable to conclude that there will be a risk of ARD from the waste materials and that there can be a shortage of neutralizing materials. On the other hand, it is likely that there will be a range of Potentially Acid Generating (PAG) rock types and Non-Acid Generating (NAG) rock types that can be separated and used in different ways to design and construct appropriate waste dumps with reduced risk of ARD. It is agreed that prevention of ARD from other mines has been "notoriously ineffective," but there is a growing understanding of this issue and there are effective methods that can be implemented, given the will and economic feasibility.

It is not agreed that the climate is necessarily problematic. In fact having a wet climate can be a significant benefit in developing conditions which reduce the risk of oxidation of sulphides by maintaining saturated or near-saturated conditions.

- **Long-Term Waste Storage –** This section is a little misleading as firstly it is not clear yet what the final plans for waste dumps and tailings storages are, but it is likely that there will be scope for landform design that could include pit-lakes and water covered tailings storages that could provide safe, long term storage opportunities. It is unreasonable to quote tailings dam failure rates as 1 every 8 months. This relates to historic data that is out of context. Virtually every tailings dam failure can be attributed to several simple causes that have engineering solutions. Conservatively designed, properly constructed, and appropriately operated tailings dams have very low risk of failure. This comes down to either the conditions of approval or if these are not stringent enough, the attitude of the mining company itself, for which there is a growing trend for the more reputable miners to properly evaluate their own risks and develop appropriate strategies.

- **Fisheries –** I am not particularly qualified to comment on the fishery aspect other than to agree that relatively low levels of copper contamination can have a significant impact on fish. My experience includes knowledge of the historical impact of copper mining at Mount Lyell Mine in Tasmania, where 26 km of the Queen and King River have been impacted to the extent where I believe that 99.9% of the soluble copper load in the rivers would need to be removed to restore fish life to those streams. On the other hand a viable salmon farming operation exists in Macquarie Harbour into which the King River discharges.

- **Road –** A road will have impacts so these should be assessed and may influence design and operation requirements.

Andy Fourie

The document is clearly written and easily read and assimilated. It consists primarily of a brief summary of a range of hard rock mines in Alaska and draws some comparison with the proposed Pebble Mine. The primary references that are used are freely available reports, mostly accessed from the internet, with all relevant references given in footnotes. I cannot comment on the veracity of the information in these reports, but must assume that because they are publically available for scrutiny, the information must be as correct as is possible.

The summary table at the end of the document provides a useful indication of the magnitude of the difference between Pebble and other Alaskan mines listed. Whether or not the differences represent 'distinctly different' conditions (as stated in the document) will depend on interpretation of the word 'distinct'. Without wishing to indulge in semantics, the factual data presented in the summary table does support the authors' claims, in my opinion. The proposed Pebble mine life is at least twice as long as the other mines listed, the mining rate is at least one order of magnitude higher than most of the other mines, the tailings volume is similarly much larger than the others, and it has acknowledged potential acid mine drainage issues. It is also listed as being, 'on top of' fishery resources, these resources apparently being amongst the most valuable in North America. Therefore, using the concept of Consequence Category, which is outlined in the recently revised Australian Guidelines on the Design, Construction, Operation and Storage of Tailings Dams (ANCOLD, 2012), this facility would certainly rate as a High category facility, whereas some of the others listed in the document by Levit and Chambers may not. A more definitive categorization of the various operations listed would only be possible if more detailed information were available.

Robert Kleinmann

The subject report provides an introductory overview of the proposed Pebble Mine and compares it to other Alaskan (proposed and operating) mines. It begins by effectively making the case that the Pebble Mine is far larger than any of the other mines in the state and that it potentially threatens an extremely valuable fishing area. These aspects are undisputed. The report then provides a superficial listing of negative aspects associated with the Pebble Mine before going on to once again compare it to other Alaska mines. However, the impression this report leaves is that the authors would have argued just as strenuously against any mining activity, including the mines that they compare the proposed Pebble Mine to.

Natalia Ruppert

My first impression is that the report is not what I would have expected based on its title. I expected a technical document highlighting similarities and differences between the proposed Pebble Mine and other past/existing/future mine projects in Alaska. Instead, it seems that the whole point of this report was to emphasize how much more threatening Pebble project's impact would be to the environment overall and to the fisheries in particular. Therefore, the report lacks impartiality. I am not familiar with the charge that was given to the authors, if any. Therefore, I remain suspicious as to soundness of the conclusions presented in this report. While I do not doubt discovery facts presented in this report, I am suspicious of what the authors chose not to mention in order to maintain their perception of the Pebble mine threats.

III.3 Response to Charge Questions

Question 1. Are the conclusions of the report well-supported by the evidence provided? Why or why not?

David Brett

The report addresses the comparison question well but does tend to go into a relatively shallow commentary of potential impacts from the particular mine.

Andy Fourie

The primary conclusions of the report are that the Pebble mine is, 'on a scale entirely of its own in Alaska' and that its potential impact could be significant and irreparable. The latter conclusion is certainly supported by the data summarized in the document. It could, without doubt I believe, potentially have impacts that are extremely severe and even irreparable. Whether it is in a class of its own once again comes down to semantics. How is the 'class' being defined? What constitutes an 'order of magnitude' greater risk? The difficulty in answering this question comes not from the Levit and Chambers report, which does a good job of summarizing factual differences between Pebble and other hard rock mines in Alaska, but from the apparent lack of a sufficiently robust system for designating differences in the potential impact of different facilities. A more refined categorization strategy, in which the potential scale of impact were more clearly defined, would greatly aid in evaluations of the type being discussed in the document.

Robert Kleinmann

This report includes a very brief summary but few conclusions as such. The authors do provide evidence that the proposed mine is much larger than the other Alaskan mines and quite reasonably makes the claim that the Bristol Bay fishery (which would be affected by adverse effects downstream of the mine, should they occur) is indeed very valuable. It then goes on to state that, "Size alone does not determine impacts, but based on other factors such as acid producing potential, easy movement of water away from the mine, a world class fishery, wet climate regime, etc., the mine's potential impacts could be significant and irreparable." Indeed, the mine's potential impacts could be significant, though the authors provide little quantitative information with which the reader can judge how significant their impact would likely be and provides no basis for the claim that such damage will be irreparable.

Natalia Ruppert

The main conclusion of the report is that there is no past/existing mine project in Alaska that bears all the same characteristics (size, environment, geology and geochemistry) as the proposed Pebble project. This is a correct conclusion. However, some characteristics are shared and I wish that the authors devoted more time to exploring these similarities and how these were mitigated at past/existing projects. The authors also conclude that "*Pebble poses* ***greater*** *qualitative and quantitative threats than any other Alaska mine to fisheries, the environment, and cultural and* *economic resources*." Every mining project poses certain threats to the surrounding environment and communities. There is no justification in this report to make the conclusion that the Pebble project poses greater threats. If these potential threats are properly mitigated, they may become smaller threats than those in other existing projects but that were poorly mitigated.

Question 2. What are the strengths and weaknesses of the Levit and Chambers 2012 report, in terms of:
a. Methodology?
b. Results and conclusions?

David Brett

a. Methodology?

Good and clear comparison of the size and technical differences of Alaskan mine sites that will assist in appreciation of the issues by readers. Use of tables is good. Also, the highlighting of potential issues is a good starting point, but some of the language used is a bit alarmist and not based on presented data.

b. Results and conclusions?

As above – comparisons are clear. Conclusions are spread throughout text and some are out of context or not supported by data.

Andy Fourie

a. Methodology?

It is difficult to comment on the adequacy of the methodology used without knowing what the brief was for the document, and what resources were made available. It is an objective summary of facts and figures, and avoids emotive language. It would have been useful to have comparative data from other North American and international mining operations of similar scale (if available), but perhaps this was outside the scope of the brief.

b. Results and conclusions?

The results are a brief description of individual mining operations and a detailed summary table of these operations, with apparently sound quality data included in the table wherever possible. This summary table provides an extremely useful and accessible summary of a number of key features of the mining operations discussed, and should form a valuable aid to discussions about the proposed Pebble project. The conclusions are backed up by the data presented, although as already mentioned, it could be relatively easy to quibble about the semantics used, for example, the use of the phrase, ‘distinctly different’.

Robert Kleinmann

a. Methodology?

Strengths: The authors provide a nice introduction to how the proposed Pebble Mine could potentially cause environmental problems to the Bristol Bay fishery.

Weaknesses: Methodology is not really applicable in this case since the report is just a comparison of the proposed Pebble Mine with other Alaskan mining operations. It discusses potential problem areas but generally in a superficial way that relies, to a large extent, on non-peer reviewed literature.

b. Results and conclusions?

Although the report has no results and conclusions, it is clearly intended to convince the reader that the Pebble Mine should not be permitted to operate, primarily because it: is much larger than other Alaskan mines, will disturb much more potentially acid-generating rock than other Alaskan mines, and is located in a valuable and potentially sensitive watershed that houses a valuable fishery. Other aspects (the nature of the mining operation, the length of the proposed road construction, the regional hydrology, etc.) are also addressed but in a far less convincing manner. The claims of the authors may indeed be true with respect to these points, but there is insufficient evidence provided in this report to convincingly make this case to anyone who does not already have an opinion that these aspects will have the adverse impact that the authors claim.

Natalia Ruppert

a. Methodology?

The authors did thorough job compiling information on all major past/existing mining projects in Alaska. They considered type of mining and waste disposal, geology and geochemistry of the rock formations, and other factors. I did not check facts in the referenced literature, but trust that these are correct. The authors documented in great detail differences between Pebble and other mine projects. However, I wish they explored more what are the similarities between Pebble and other mines.

b. Results and conclusions?

The main conclusion of the report is that the proposed Pebble Mine is different from all other past/existing mine project in Alaska when considering all factors together, such as environment, geology/geochemistry, size and waste disposal, level of development in the region, climate, etc. I feel that all comparisons were drawn to support authors' statement that the Pebble project poses greater threat than the other mines. No fair discussion was given on similarities between Pebble and other projects, and how these threats were mitigated.

Question 3. Are there important limitations or uncertainties associated with applying results from the Levit and Chambers 2012 report to the EPA assessment? If so, what are they?

David Brett

I think the benefit of the Levit and Chambers report is to put the size of the Pebble Mine into perspective and to indicate high level topics that need to be addressed in assessment. These include hydrological conditions of the site, geo-chemistry of the wastes and water quality as the major ones.

Andy Fourie

There do not appear to be any obvious uncertainties. The data listed in the summary table are complete and apparently accurate. Having undertaken similar studies myself, I believe that in order to populate the summary table as extensively as they did, the authors would have had to work through a very large number of documents. This summary table is, as already mentioned, extremely valuable.

The primary limitation I would suggest is the lack of any comparative studies that discuss the magnitude of a particular mining operation and the *actual*, reported impact of that operation. Although each site is unique, and it is not really possible to draw conclusive comparisons between various sites, some indication of 'predicted versus actual' impact would have added greatly to the value of this document. However, once again, the brief under which the document was prepared may well have excluded this opportunity

Robert Kleinmann

Yes. This report provides no new information that the EPA has not already considered; it simply restates arguments that have appeared in previous testimony and in previously published documents. Its intended audience is clearly the general public rather than informed scientists and administrators. As such, it provides a concise, understandable summary of the arguments against permitting the mine to operate, but provides no guidance on what regulatory agencies or the mining company can do to mitigate potential adverse effects, should the mine be permitted to open.

Natalia Ruppert

No fair discussion was given on similarities between Pebble and other projects, and how these threats were mitigated. The emphasis was given to differences. Therefore, I remain skeptical about what the authors chose not to mention in the report in order to maintain their concluding remarks of the greater Pebble mine threats when compared to other mine projects in Alaska.