

BHP Billiton's Submission of the 2007 AEMP Required by Part I, Item 6 of Water Licence MV2003L2-0013 – Submitted June 2nd, 2008

Tracking Number	Comment ID	Topic	Review Comment	Company Response / Proposed Revision	WLWB Response / Recommendations
A: Independent Environmental Monitoring Agency (IEMA) Comments – Received June 18th, 2008					
1	IEMA – 1	Water Quality	We note that molybdenum levels continued to rise in Moose Lake relative to previous years, but declined slightly in Leslie. Both are near or at the CCME guideline. This is still a worrisome development.		
2	IEMA – 2	Water Quality	While molybdenum is near the CCME guideline level, we notice that selenium has risen above it for the first time in Leslie, Moose & Nema lake water. It is noteworthy that trout livers in Moose Lake also contained higher selenium levels (mean of over 1 mg/kg more) than those sampled in 2002. This result is not adjusted for age however. This indicates to us that selenium should be evaluated in future AEMP reports.		
3	IEMA – 3	Water Quality	The Agency is disappointed to learn that no winter oxygen measurements were taken in 2007 due to problems with the measuring instruments. Since Cujo and Kodiak lakes have had to be aerated in past years to overcome problems of low winter oxygen levels, winter measurements have proven critical to warning BHPB of potential anoxic conditions that may need to be mitigated before fish are harmed.		
4	IEMA – 4	Fish	We are interested in the finding that infection rates of the tapeworm <i>Ligula intestinalis</i> in slimy sculpin are much higher in lakes immediately downstream of mine activity (Kodiak, Leslie, Moose & Cujo) than those further downstream and in reference lakes (see Fig. 3.7-77 of AEMP report). As heavy parasite infection is often associated with exposure to stressors in fish, we think BHPB should consider		

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			<p>continuing this area of study in future years. The frequency of monitoring of slimy sculpin could be every 2 or 3 years rather than every five, as this is a more abundant species in AEMP lakes than either lake trout or round whitefish and thus populations should withstand more frequent lethal sampling.</p>		
5	IEMA – 5	Fish	<p>Molybdenum was elevated in whitefish livers in Moose Lake in 2007 compared to 2002 (See Fig. 3.7-62). Even so, the report states that “there is no evidence for an effect of mine activities” on the uptake of molybdenum in round whitefish. This conclusion does not seem to be compatible with the Moose Lake results. We think this question is deserving of greater attention.</p>		
6	IEMA – 6		<p>A “total of 24 lake trout liver samples and 10 myomere samples exceeded the Health Canada mercury guideline of 0.5 mg/kg WW” (p. 3-109 of AEMP report). It has been brought to our attention by BHPB that these numbers are erroneous. It was actually 12 liver and 3 myomere samples above the guideline value. The majority of these samples were from lake trout caught in lakes downstream of the LLCF (Kodiak, Nema and Slipper). In contrast, in 2002 lake trout liver samples from only Slipper Lake exceeded the mercury guideline. Average mercury concentrations in 2007 exceeded the guideline in livers of lake trout caught at Kodiak and Nema lakes (average concentrations were 0.874 mg/kg WW and 0.531 mg/kg WW, respectively). The average mercury concentration in lake trout livers caught farther downstream, in Slipper Lake, approached the</p>		

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			<p>guideline but did not exceed it.</p> <p>Since mercury is not elevated in the water of any of these lakes, and two of the 12 trout liver samples above the Health Canada guideline value were from control lakes, the Agency does not dispute the following RESCAN evaluation, "The elevated mercury concentrations in some potentially affected lakes may be linked to the larger, older fish that were captured during 2007 monitoring." However, it would have strengthened that contention if it had been supported by comparison of the ages of the contaminant-studied trout in 2007 with those of 1999 and 2002, since not all aged fish were sampled for contaminants.</p>		
7	IEMA – 7	Fish	<p>Hydrocarbon metabolites in the bile of both whitefish and trout of Leslie Lake are equivalent to levels found in areas elsewhere in the world exposed to significant oil spills. RESCAN finds that there was no increased incidence of parasitism in these fish species in Leslie, which would suggest no adverse physical effects from hydrocarbon exposure.</p> <p>However, slimy sculpin from both Leslie & Moose lakes did have elevated rates of parasitism compared to control lakes. It would be helpful to know if those infected fish also had evidence of hydrocarbon exposure.</p> <p>RESCAN suspects the source of the hydrocarbons is the LLCF and suggests sampling fish within Cell E in</p>		

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			future to verify this possibility. This is a very good idea. We also note that BHPB's ICRP Section 4 responses (tracking #168) states that underground minewater contains hydrocarbons averaging <u>29.1 mg/l</u> although Eric Denholm of BHPB is looking into this situation as he believes the number may be erroneous. Even if the minewater is high in hydrocarbons, it is not clear to the Agency whether a significant portion of that loading to the LLCF would make its way into Cell E from the upper cells. Additional work may be required to resolve this matter.		
8	IEMA – 8	Minimal Detectable Differences	As a result of the AEMP Re-Evaluation workshop in November 2006, the Agency understood that BHPB committed to determining effect sizes--that is, what degree of change in water quality variables is deemed to be <u>acceptable</u> . What we have received instead is an examination of what level of change to those variables is <u>detectable</u> . In our view, these are not the same thing. The intent of this requirement needs to be clarified. If it is the former, BHPB needs to show it intends to canvass stakeholders to determine the maximum level of change acceptable to them so as to establish effect sizes for the statistical analyses in the AEMP. If it is the latter, the study currently presented appears to address the issue.		
B: Department of Fisheries and Oceans (DFO) Comments – Received June 20th, 2008					
9	DFO – 1	Linkages to the Adaptive	DFO agrees with BHPB that the AEMP is a key component of an adaptive management plan		

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		Management Plan (AdMP)	<p>(AMP). However, the direct linkages with an AMP are not currently clear. As per the Guide for Preparation of Adaptive Management Plans prepared by ESSA Technologies Ltd, components of a successful AMP include:</p> <ul style="list-style-type: none"> • A list of the key uncertainties (management questions) to be addressed by the AMP. • A description of the alternative management actions to be employed in the AMP, and how they relate to the uncertainties listed above. <p>DFO realizes that BHPB has recently submitted an AMP to the WLWB and that it is not yet approved. There is now an opportunity to modify the AMP to address key uncertainties that have been identified in the 2007 AEMP report (water quality parameters, zooplankton increase, <i>Ligula intestinalis</i> infection rate for slimy sculpin).</p>		
10	DFO – 2	Water Quality	<p>In 2007, 10 water quality parameters were found to have increased significantly in affected lakes and streams in the Koala Watershed and 9 parameters increased significantly in the King-Cujo watershed in comparison to reference lakes and streams. In the report CCME limits are focused on.</p> <p>CCME WQGs are not to be used as "pollute up to" limits as stated in the CCME non-degradation policy: <i>"The degradation of the existing water quality should always be avoided. The natural background concentrations of parameters and their range should</i></p>		

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			<i>also be taken into account in the design of monitoring programs and the interpretation of the resulting data”.</i>		
11	DFO – 3	Water Quality	Low effect levels, compared to baseline conditions should also be identified that trigger adaptive management. Each parameter that is shown to be increasing over time as a result of mine activities offers an excellent opportunity to use the Adaptive Management Cycle to explore why the effect was happening, followed by mitigation experiments to attempt to reduce levels to acceptable limits prior to reaching CCME thresholds. It is noted that nitrate has already reached the CCME interim guideline and the confidence intervals for molybdenum overlap the CCME guideline, emphasizing the importance of triggering adaptive management at an early stage.		
12	DFO – 4	Water Quality	For parameters such as TDS and total phosphorous where no CCME water quality guideline or WL criterion exists, it is unclear how the monitoring results will be used. There is no sense in monitoring for the sake of monitoring so effect levels have to be provided that are linked to the AMP.		
13	DFO – 5	Zooplankton	In 2007, zooplankton density increased in Kodiak Lake and Cujo Lake. The AEMP report states that the cause for the increase was unknown as it was not accompanied by an increase in phytoplankton biomass or density which would be expected for a trophic effect. The following response was provided by Michael Turner, a DFO research scientist at the Freshwater Institute.		

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			<p><i>I disagree with BHP's assertion that it is necessary for increased zooplankton abundance (density) to be associated with increased phytoplankton abundance. In a simple system an increase in zooplankton abundance would be expected to increase grazing pressure (assuming that it was algal grazers that had increased). Increased zooplankton grazing would decrease algal abundance if algal growth rates were unchanged. If the algae were growing more rapidly (as might have occurred in response to increased nutrients), then there might not be any large change in abundance.</i></p> <p><i>Unfortunately there is insufficient information provided to determine unequivocally the exact relationship between the zooplankton and phytoplanktons. Information on zooplankton (or zoobenthos) and phytoplankton (or phytobenthos) density or abundance provides information only about the size (and composition) of the standing crop (i.e. the compartment size). There is no information provided about the rapidity of algal growth, productivity or photosynthesis (i.e. the rate of compartment turnover). (This is important because a small population growing very rapidly but with high loss rates might be as [or more] productive as a large population growing slowly.) Nor is there information provided about zooplankton grazing rates. Without understanding algal growth rates and grazing rates, it would be speculative to try to link algal and zooplankton densities based on abundance</i></p>		

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			<p><i>information alone. (Another compositional piece of the puzzle that would be helpful would be to understand which of the zooplankters are algal grazers given that not all zooplankton are created equal in terms of trophic function.)</i></p> <p><i>Zooplankton grazing could selectively decrease 'edible' algal taxa, leaving less desirable species. It is also possible that there were lags in responses of the zooplankton populations to shifts in phytoplankton abundance, which is an argument for increasing the sample frequency.</i></p> <p>As stated in the AEMP report, the cause of the increase in zooplankton density is uncertain. With this uncertainty identified the AM cycle should again be implemented.</p>		
14	DFO – 6	Infection Rates	<p>“Ligula intestinalis infection rates were generally greater in potentially affected lakes in the Koala watershed than in reference lakes and the infestation incidence appears to resemble the spatial pattern of a mine effect. However, it is uncertain whether this truly a mine effect because of the lack of a plausible mechanism to link ligulosis in slimy sculpin, the absence of ligulosis in any other species of fish monitored by the AEMP, and the absence of historical information for before-after comparisons.” This was also the case for the King-Cujo watershed. Again this is an uncertainty that should be addressed by the AMP. Is it possible for the tapeworm to be transferred to lake trout that feed on infected</p>		

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			sculpin or even infected copepods?		
15	DFO – 7	Fish Sampling	As reported in the 2007 AEMP report, catch per unit effort (CPUE) of round whitefish and lake trout has declined when compared to baseline years and to 2002, most likely as a result of historical sampling. However, further reduction of the sample sizes of these species may not allow the detection of significant changes in a number of parameters being assessed. It is important to ensure sampling is not having a negative effect on fish populations; however, some level of monitoring is required to determine whether mine effects are occurring. BHPB has indicated that “the use of slimy sculpin as a surrogate is not yet supported scientifically for EKATI.” While sculpin have a different life history and habitat requirements than lake trout and whitefish they should remain as an important component in the AEMP. Elevated levels of mercury in sculpin were recently identified in Lac de Gras through the Diavik AEMP.		
16	DFO – 8	Fish Sampling	In order to reduce the amount of whitefish and lake trout sacrificed in the next sampling phase of BHPB's AEMP, other alternatives should be assessed. One possibility would be the use of lake chub as a primary indicator species. The following comments on the suitability of lake chub are from Pete Cott, DFO Science and Dr. John Gunn, a professor at Laurentian University, Canada Research Chair for stressed aquatic ecosystems.		

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			<p><i>Lake chub are a good candidate for fish health studies, and would show affects more quickly than large bodied fish, that tend to be long lived and slow growing and slower to react to environmental changes. Lake chub are low in the food chain - eating benthic organisms – and fast growing and short lived. They are ecologically important linking benthic and near shore energy flow to top level predators like lake trout. Also, they occupy a wide variety of habitats in the lake, so would be representative of the whole lake. From a logistics standpoint they are abundant and easy to catch, and can be caught year after year. Their high fecundity and abundance means that the sample size can be quite large without risk of population level impacts from sampling.</i></p> <p>It should be determined what information is necessary to obtain from future lake trout and whitefish sampling and then identify how it can be accomplished in a non-lethal manner. For instance, non lethal fish tissue plugs could be used for metals analysis to compare to past sampling results if the number of metals being looked at is reduced to focus on particular ones of interest.</p>		
C: North Slave Metis Alliance (NSMA) Comments – Received June 20th, 2008					
17	NSMA – 1	Traditional Knowledge	The AEMP report does not detail the inclusion of Metis Traditional Knowledge. The NSMA desires more involvement in the design and the implementation of the Ekati Aquatic Effects		

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			Monitoring Program (AEMP), as well as better reporting of our involvement. In particular, we desire involvement in establishing acceptable limits of change, or effects sizes. Acceptable limits of change should not to be mistaken for detection limits of analytical techniques.		
18	NSMA – 2	CCME Guidelines	<p>We do have concerns about the reported results showing that water contamination with molybdenum, selenium, and nitrate are exceeding or almost exceeding CCME guidelines. We strongly disagree with the reasoning used to discount the importance of exceeding the COME guidelines, which was, essentially, that since the 95% confidence interval overlaps the CCME guideline, you can't prove that the CCME guideline was surpassed until you get a value quite a bit over the CCME guideline.</p> <p>We do not consider the CCME guidelines to be "pollute up to" variables, and this argument is not compatible with the "precautionary principle" of environmental management which we insist on.</p>		
19	NSMA – 3	Oxygen Measurements	We are alarmed by the reports of elevated 'hydrocarbon, mercury, molybdenum, and selenium in fish, and very disappointed to hear that no winter oxygen measurements were taken in 2007, in lakes where low winter oxygen has been a problem in the past. Traditional Knowledge should have been solicited, and used, to obtain the required winter oxygen measurements.		
20	NSMA – 4	Infection Rates	We are also concerned about the elevated infection rates of tapeworm in slimy sculpin.		

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D: Indian Northern Affairs Canada (INAC) Comments – Received June 20th, 2008					
21	INAC – 1	Linkages to the Adaptive Management Plan (AdMP)	<p>First, INAC feels it is important to note that BHPB has identified that the AEMP is a key component of adaptive management because it provides the annual monitoring data and analytical assessments that are used to determine if the mine is affecting aquatic ecosystems. INAC agrees with this statement but does not believe that the AEMP is being used properly to interpret potential impacts in the receiving environment, and as such, formal adaptive management of aquatic effects is not presently being conducted (these two things need to be instruments of each other).</p> <p>INAC believes the main reasons for this are: the lack of effect sizes (see discussion below), and, the fact that a formalized Adaptive Management Plan (AdMP) has only recently been submitted but not yet reviewed or approved.</p>		
22	INAC – 2	Increasing Parameters	<p>Each year BHPB's AEMP identifies a number of increasing parameters. Again this year concentrations of nine parameters, which include pH, sulphate, total dissolved solids, chloride, potassium, nitrate, arsenic, molybdenum and nickel have continued to increase. At some point these increases will cause impacts which BHPB may or may not be able to fully mitigate. Therefore, the adaptive management framework must be applied now to help address these issues before they become significant impacts.</p>		

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23	INAC – 3	Minimal Detectable Difference	INAC commends BHPB for committing to develop effects levels for the site. Unfortunately, there seems to be a misunderstanding in what INAC and others were requesting. BHPB has estimated the Minimal Detectable Difference (MDD) from the current sampling regime using CCME water quality criterion; minimal detectable differences are not effects. Effects levels are levels that stakeholders agree are unacceptable. Once effect levels are agreed upon, some lower value or early warning signals trigger action (i.e. adaptive management). This is done before unacceptable effects are observed.		
24	INAC – 4	CCME Guidelines	INAC is very concerned that BHPB's 2007 AEMP results are being assessed relative to CCME guidelines and not particular baseline, background or reference conditions. Again, as INAC has stated before, CCME guidelines are not "pollute up to limits" and therefore should not be used to develop triggers for adaptive management. Active adaptive management should occur when low level effects or impacts are observed to prevent effect levels from being exceeded.		
25	INAC – 5	CCME Guidelines	Lake water quality in the north usually falls below laboratory detection limits and is typically reported as <DL (Kokelj <i>et al</i> , 2008, 2009; Peinitz <i>et al</i> (1997a, b)). The CCME non-degradation policy states that: <i>"The degradation of the existing water quality should always be avoided. The natural background concentrations of parameters and their range should also be taken into account in the design of</i>		

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			<p><i>monitoring programs and the interpretation of the resulting data”.</i></p> <p>Therefore the allotted change inherent in using CCME guidelines is too large and should not be use as the primary trigger mechanisms for adaptive management. INAC understands that BHPB has proposed benchmarks as part of their AdMP but at this point this plan has not been fully reviewed or approved by the Wek'èezhii Land and Water Board. As such INAC is suggesting that potential low level effects or impacts should be determined in a way which is more consistent with other mines. An example of which is provided below; note, this is not an exhaustive list:</p> <ul style="list-style-type: none"> • Statistical differences in the immediate receiving environment (to be determined) relative to baseline, background or reference conditions; or, • Statistical increasing trend predicting exceedances of thresholds or benchmarks (to be determined) within three years in the immediate receiving environment; <p>It is these effects levels that may signify early warnings or potential low level impacts that would trigger active adaptive management and lead to potential mitigation strategies. The absence of effects levels or triggers for adaptive management can only lead to continued monitoring and identification of effects.</p>		

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26	INAC – 6	Linkages to the Adaptive Management Plan (AdMP)	INAC understands that BHPB does have internal processes that are used to determine if operational changes can help mitigate effects in the receiving environment; however, 1) this process has not yet been formalized; 2) the recent AdMP has not been approved; and, 3) acceptable/unacceptable effects must be developed through consultation with stakeholders. INAC stresses that the results of the AEMP must be used to help make decisions regarding operations. Aquatic effects monitoring must not only be a monitoring and assessment tool. Direct linkages between the AEMP to the AdMP must be evident and concrete in order to facilitate continued improvement and to mitigate any potential future impacts.		
27	INAC – 7	Effect Levels	In closing, BHPB has taken steps to distinguish between changes, effects and impacts. However, BHPB has not identified at what point an effect becomes an impact nor have they defined what constitutes a significant effect (effect levels). BHPB has stated (p. 1-3) that there are no impacts resulting from their operation; INAC notes this is a broad statement which is open to interpretation because the word significant has not yet been defined. Since concentrations of parameters of concern may be much higher than baseline, background or reference conditions "impacts" may already exist. BHP (p. 3-4) states that there is a potential for adverse biological effects in Leslie and Moose lakes even when CCME guidelines are used as the definition of "significant".		

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<p>E: EcoMetrix Incorporated (HART) Comments – Received June 27th, 2008</p> <p>Note: Complete background information and observations are contained within the review of “EKATI Diamond Mines 2007 Aquatic Effects Monitoring Program” Report</p>					
28	HART – 1	Power Analysis	The power analysis for the fish parameters seems to contain errors; we <u>recommend</u> that this analysis should be thoroughly checked and revised, and that the conclusions drawn from this analysis should then be reconsidered;		
29	HART – 2	Statistical Discrepancies	There are some inconsistencies between the statistical analyses of fish parameters and the conclusions drawn in the summary, and there is no useful discussion of the lake x period interactions that were found; we <u>recommend</u> that the conclusions should be checked against the results, discrepancies resolved, and significant interactions discussed as to whether they are mine effects;		
30	HART – 3	Chloride	The report appropriately highlights water quality parameters that are both increasing relative to reference, and approaching or exceeding water quality guidelines, e.g., nitrate and molybdenum; the exponential increase in chloride in the LLCF and downstream lakes should also be highlighted;		
31	HART – 4	Ammonia & Nitrate	The reason why some lakes and not others have increasing ammonia downstream of the LLCF is unclear, e.g., Moose Lake but not Leslie Lake; if the dynamics of ammonia and nitrate can be explained in the report, it would be appropriate to do so;		

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32	HART – 5	Two-sided Tests	It is unclear why two-sided tests have been used in identifying water quality parameters that are increasing relative to reference; if there is a reason, it should be explained in the report; otherwise, one-sided tests should be considered;		
33	HART – 6	Minimum Detectable Differences	It is unclear if the comparison of lake mean to water quality guideline, anticipated in the derivation of the MDD, has a place in the decision framework within the Watershed Adaptive Management Plan; this should be clarified in the AEMP report, or in the Adaptive Management Plan;		