HEMMERA

Suite 250 – 1380 Burrard Street
Vancouver, BC V6Z 2H3
T: 604.669.0424
F: 604.669.0430
hemmera.com

January 8th, 2013
File: 1464-001 (Hemmera)

Lupin Mines Incorporated
201-750 West Pender Street
Vancouver, British Columbia
V6C 2T8

Attn: David Vokey, Health Safety and Environment

Dear Mr. Vokey;

Re: ADDENDUM TO THE LUPIN GOLD MINE 2011 EEM INTERPRETATIVE REPORT - RESPONSE TO TECHNICAL ADVISORY PANEL AND ENVIRONMENT CANADA COMMENTS

1.0 INTRODUCTION AND OBJECTIVES

Lupin Mine, Nunavut, was a former gold producing mine that is currently under care and maintenance. The federal Metal Mining Effluent Regulations (MMER) requires that all metal mines either in operation, or in care and maintenance, complete environmental effects monitoring (EEM) studies as per the regulations. In 2010, field programs for the Cycle 3 EEM study were completed, and in June 2011, the final interpretative report was submitted to Environment Canada. Lupin Mines Incorporated (LMI), a wholly-owned indirect subsidiary of Elgin Mining Inc., the current owner of Lupin Mine, received review comments from the Technical Advisory Panel (TAP) in January 2012.

The TAP provided 36 review comments, plus 11 minor comments and errata. The TAP requested responses to be provided in the form of an addendum to the final report. This document is intended to serve the purpose of such an addendum, and provides our collated responses to comments received by LMI from Environment Canada on January 11, 2012, regarding the 2011 *Environmental Effects Monitoring (EEM) Interpretative Report – Lupin Gold Mine, Nunavut.*

Per the Statement of Work executed between Hemmera and LMI on March 26, 2012, the information below was developed by Doug Bright, Ph.D. (Hemmera), Colleen Prather, Ph.D. (Golder Associates Ltd.), and James Phibbs, M.Sc. (AECOM).

The responses are provided below to each of the five pages of numbered comments provided in the Environment Canada January 11, 2012, letter, with a numbering system that is the same as used by Environment Canada. For each comment, we have provided the comment from Environment Canada and TAP, followed by our response in the indented paragraph(s) immediately following.

2.0 GENERAL COMMENTS

1. "The interpretative report for the Phase 3 Environmental Effects Monitoring (EEM) Program at Lupin presented the results of an Investigation of Cause (IOC) study. The TAP appreciated the inclusion of detailed maps and figures and the discussion of results in the context of published studies."

   No response required.

2. "The IOC study investigated possible causes of lower condition in arctic grayling from the exposure area. It was hypothesized that the effect on condition was caused by habitat differences, specifically lower water temperatures in the exposure area relative to the reference area. This hypothesis was not supported by the current study, which found slightly higher mean water temperatures in the exposure area over a seven week period during July and August. At the request of the TAP, the proponent investigated the potential effects of elevated trace metal concentrations in the exposure area. Based on a literature review of the trace metal toxicity studies, it was determined that aqueous copper concentrations in the exposure area were within the range of concentrations previously shown to have effects on fish."

   We acknowledge this point and agree it is worth discussing in comparison with the 2009 monitoring results. Based on the aqueous copper concentrations analysed in the Cycle 3 report (July to October 2009), only three data points exceed the upper threshold of the CCME AW standard (4 μg/L). Our synthesis of the literature search on salmonids indicated that "LC_{50} values have been calculated for 96 and 168 h exposure periods to copper in soft water (10 mg/L $CaCO_3$) at pH 4.7, 5.7, and 7.0. For this test fish were acclimated to the test pH for eight days prior to testing. The 96 h LC_{50} values for copper at the three pH levels were 66.0, 4.2 and 2.8 μg/L, respectively". The three data points above were also the only data points that fall within or exceed the range provided (2.8 - 4.2 μg/L) by the formula. The associated pH, hardness, copper concentrations and predicted LC_{50} concentrations of these data points are presented in Table 1.

Table 1. Summary of hardness dependent copper concentrations and predicted LC_{50} values.

	LUP-10				LUP-20		LUP-22
Date	Jul 13 2009	Sept 20 2009	Oct 8 2009	Oct 20 2009	Aug16 2009	Aug 30 2009	Oct 20 2009
Hardness	194.0	Not Recorded	Not Recorded	221.0	22.1	195.0	11.1
pH	5.35	6.60	6.62	6.55	6.55	5.50	6.42
[Cu]	0.013	0.003	0.003	0.015	0.004	0.004	0.084
Predicted LC_{50} based on equation (mg/L)	0.09	-	-	0.10	0.02	0.09	0.01
Exceeds Predicted LC_{50}?	**No**	N/A	N/A	**No**	**No**	**No**	**No**

Based on the highest aqueous copper concentrations observed during the 2009 sampling period and the associated hardness readings, none of the copper concentrations noted above exceed the predicted LC_{50} values.

3. "The proponent has indicated that the site should resume normal intervals for EEM monitoring studies. Consideration should be given to conducting another phase of the IOC, with an interpretative report submitted by June 6, 2012. Otherwise, the next study should include a complete biological study (site characterization, fish, fish tissue (if applicable), and benthos), with an interpretative report submitted by June 6, 2014. Please note that the study design report must be submitted for the authorization officer at least 6 months before the biological monitoring study is conducted. Please refer to the Metal Mining Effluent Regulations (MMER), Schedule 5, Sections 19 to 22."

   We very much appreciate the guidance on the options under MMER for this minesite. We understand that Elgin has opted to next conduct another complete biological study, with field work completed during the summer of 2013 in order to meet the reporting timeline of June 6, 2014.

3.0 EXECUTIVE SUMMARY

4. "p. *i.* The main conclusions suggest that metal concentrations in the exposure area are too low to cause differences in fork length and YOY body mass. However, the historical range of aqueous copper concentrations in the exposure area (Table 5-2) overlap with the range of concentrations shown to have sublethal and lethal effects on fish in laboratory studies (Figure 8-1, Table 8-2). Please comment."

   The primary focus of the Investigation of Cause (IOC) study was condition of YOY (0+) and 1+ age classes of arctic grayling. The water quality measurements obtained at the time of the study provides the most direct measurement of current mining-related contaminant exposure potential.

There is little doubt that the historical data indicates mining-related inputs into the exposure area (which, of course, help to define the areal extent of the area of interest). It might be hypothesized that historical contaminant releases can affect current and future water quality and the potential for exposures of aquatic life within the receiving environment based especially on the fact that metals/metalloids released in mine effluent would tend to sorb to various substrates, including sediment, within the receiving environment. The re-evaluation of possible differences in condition between the exposure area for 0+ or 1+ grayling provides a means of directly examining the possibility of sub-lethal effects related to mining effluent. Because of the differences in substance concentrations between some of the historical water and sediment data and more recent (summer, 2010) data, this emphasizes the importance of the MMER biological effects assessment portion of the EEM.

5. "p. *i* .The report suggests that differences in grayling size between reference and exposure areas are not likely attributable to effluent discharge. It is acknowledged that two out of three EEM studies were conducted during years without effluent discharge, suggesting another causative factor. However, it seems possible that historical effluent discharge has contributed to elevated concentrations of trace metals in the exposure area, which may be related to effects in grayling; please discuss."

   Please see our response to comment (7), below.

6. "p. *i.* The report recommends the resumption of normal intervals for EEM monitoring studies, and subsequently indicates that the next interpretative report would be due within 24 months of the submission date of the current report. Please note that the standard biological monitoring studies are conducted on a 36 month timeline (refer to MMER, Schedule 5, Section 22)."

   Acknowledged. The 2 year reference was assuming TAP considered Lupin to be within an active IOC cycle. The next interpretative report therefore would be due before May 2014, which is 36 months following the submission date of the EEM Cycle 3 Interpretative Report.

7. "p. *iii.* It is indicated on p. *iii* and elsewhere in the report (e.g. p. 60, 66, 68) that condition was not significantly different between reference and exposure areas. Please note that the statistical results from the current study indicate that there was a significant effect on condition in YOY and age 1+ grayling, as indicated by the significant difference between y-intercepts (Table 7-6). The effect is similar to that reported in earlier phases (i.e., lower condition in the exposure area)."

   We apologize to the TAP for the confusion.

   AECOM (November 26, 2010) produced a "Lupin EEM Cycle 2 Report Addendum" which summarizes the results of the Cycle 2 fish condition assessment:

"Arctic grayling were statistically different between exposure and reference areas; reference area fish weighed more and were longer than exposure area fish. Condition (length to weight) differed between areas but the slope of the relationship was the same in both areas. Condition was 18% higher in the reference over the exposure area.

Ninespine stickleback were statistically different between exposure and reference areas; reference area fish were lighter and shorter than exposure area fish. The slope of the length to weight relationship did not differ between areas but condition was 15% higher in the reference area as compared to the exposure area."

For the Cycle 2 EEM study, an ANCOVA was run to assess whether there were differences between the exposure area and reference area in grayling condition. The analysis was performed using only a single year class, and using the fork length and body mass data without any transformation. Because Environment Canada and the TAP did not comment on this, we erroneously assumed in the preparation of the Cycle 3 EEM analysis that this was the preferred approach, and also completed the ANCOVA without transforming the data. Clearly, comments received from the TAP on the Cycle 3 report indicate a mutual understanding of the problems that can arise from such an approach (i.e., based on comment 30, as reproduced below).

ANCOVA results are predicated on four important assumptions:

- Observations are independent from each other and are consistent with random sampling principles;
- The dependent variable (body mass) must be normally distributed;
- The independent variable (site), dependent variable and any covariate (fork length) must exhibit homogeneity of variance (the variances of the dependent variable must be equal for all levels of the independent variable and covariates); and
- The slope of the line predicting the dependent variable from the covariate must be equal for each level of the categorical independent variable (homogeneity of regression slopes). This assumption is violated when there is a significant interaction between site and length.

For the Cycle 3, IOC, analyses, the homogeneity of variance for the untransformed data was examined using a Levene's test. Table 7-6 of the Cycle 3 report further provides a p-value for the interaction term of 0.359.

The results of ANCOVA on the 2010 untransformed data, performed using software provided by VasserStats, Website for Statistical Computation (http://vassarstats.net/index.html), are as follows:

Table 2. Analysis of co-variance for untransformed weight-length data for YOY fish for Exposure Area and Reference Area 1

	Reference Area 1	Exposure Area
Number of 0+ results	13	21
Area Average (body mass, g)	2.95	2.11
Adjusted Means (body mass, g)	2.57	2.34
Test for homogeneity of regressions		
F	0.04	
P	*0.843 (ns)*	
ANCOVA (Test for difference of adjusted means)		
F	9.46	
P	0.0044 (significant)	

This indicates that the condition of the reference area 0+ grayling is significantly greater than the exposure area, and that the exposure area 0+ fish have a 9.2% on average lower body mass than the reference area fish.

The test for homogeneity of regressions failed to detect a significant difference between the slope of the body-mass: length relationships between the exposure and reference area; however, the small sample sizes suggest a very low power for this test.

An ANCOVA was re-run on the natural log transformed (ln) fork length and body mass data:

Table 3. Analysis of co-variance for logarithmically transformed weight-length data for YOY fish for Exposure Area and Reference Area 1

	Reference Area 1	Exposure Area
Number of 0+ results	13	21
Area Average (ln body mass, g)	1.068	0.717
Adjusted Means (ln body mass, g)	0.906	0.817
Test for homogeneity of regressions		
F	3.57	
P	*0.069 (ns)*	
ANCOVA (Test for difference of adjusted means)		
F	7.11	
P	0.012 (significant)	

For the 0+ data, therefore, the analysis - based on use of ln-transformed data - indicates that the slope of the regression of body mass on fork length would be significantly different at an α of 0.10 but not 0.05. This relationship is further illustrated in Figure 1.

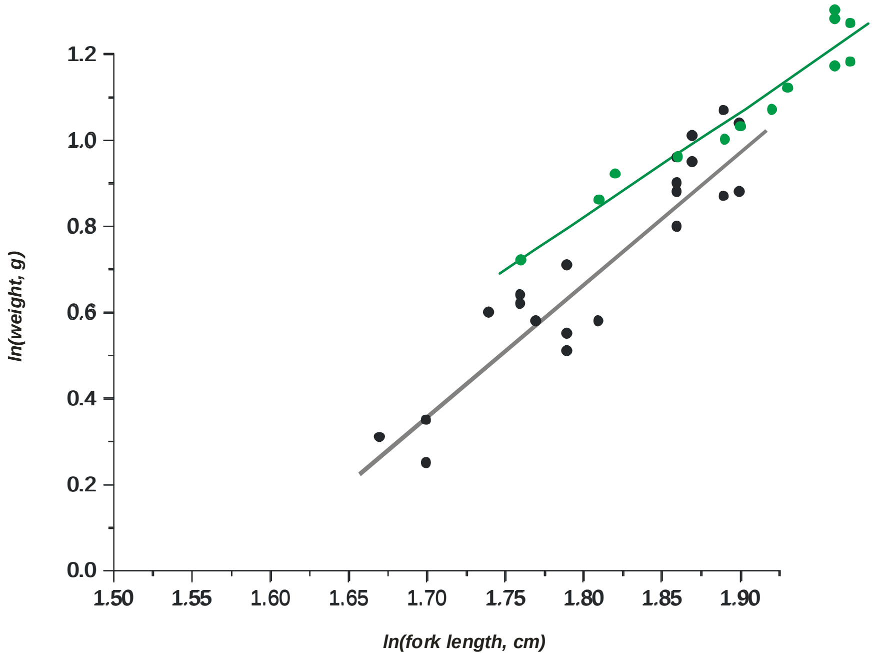

Figure 1: Regressions for 0+ grayling based on *ln*-tranformed data. The linear least-squares best fit line is shown for the two different areas. Green symbols: reference area 1 fish; Black symbols: exposure area fish.

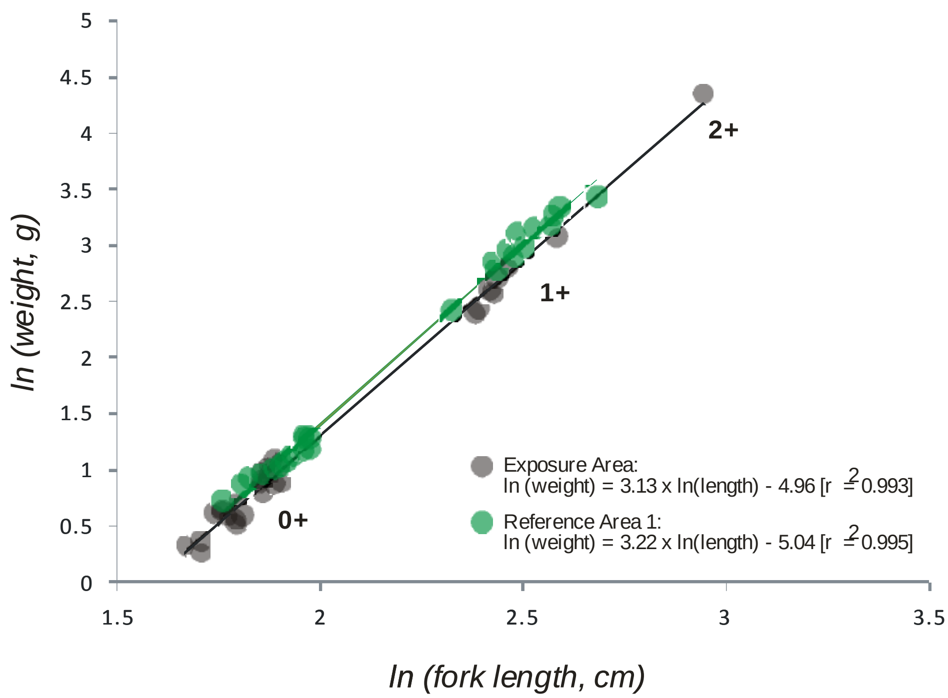

Figure 2: Regressions for all year classes based on *ln*-transformed data. The linear least-squares best fit line is shown for the two different areas. Green symbols: reference area 1 fish; Black symbols: exposure area fish.

As shown in Figure 2, use of a ln-ln covariance model is conducive to the use of all age classes from the exposure and reference area.

The results of an ANCOVA run on the natural log transformed fork length and body mass data across all age classes are provided below:

Table 4. Analysis of co-variance for logarithmically transformed weight-length data for Exposure Area and Reference Area 1: All age classes combined

	Reference Area 1	Exposure Area
Number of results – all age classes	25	29
Area Average (ln body mass, g)	2.01	1.31
Adjusted Means (ln body mass, g)	1.69	1.59
Test for homogeneity of regressions		
F	1.77	
P	*0.19 (ns)*	
ANCOVA (Test for difference of adjusted means)		
F	20.28	
P	0.000039 (significant)	

Across the three age classes, the adjusted means for reference area and exposure area fish were 1.69 and 1.59 respectively. Based on this result, the exposure area 0+ fish have a 9.5% on average lower body mass than the reference area fish (based on back-transformation of the adjusted mean values).

4.0 INTRODUCTION

8. "p. 1. Please note that the Metal Mining EEM Technical Guidance Document is in the process of being updated and revised chapters are available on the EEM website (http://www/ec/gc/ca/esee-eem)."

   Noted. LMI and their agents will avail themselves of the updated guidance for subsequent rounds of EEM.

9. "p. 8. The report states that a fish survey was required to assess the difference in fish age and length observed in Cycle 2. Please note that the IOC study was triggered by a confirmed effect on condition in arctic grayling in Phases 1 and 2.

   The authors and LMI acknowledge this point.

5.0 STUDY AREA AND SETTING

10. "p. 14. The TAP appreciated the inclusion of Figures 2-1 to 2-5. The figures show numerous exceedances of CCME water quality guidelines for priority contaminants As, Cd, Cu, Ni, and Zn, particularly in the latter half of the July-October discharge period in 2009. Please discuss possible explanations for increased concentrations of these metals towards the end of the effluent discharge period.

According to the sampling conducted the effluent was released from July 13 to October 20th and the monitoring took place from early August to October 20th. Basic details of the temporal trends in question for As, Cd, Ni, and Zn are summarised below.

- *Arsenic – Towards the end of the effluent discharge period As concentrations continued to trend downward at the effluent release point and yet the As concentrations in the receiving water body (Seep Creek) increased slightly.*
- *Cadmium – The cadmium concentrations at the effluent discharge point were consistently near the CCME AW guideline until September and then showed several large spikes before finishing the last two monitoring dates back near the CCME guideline. The Cd concentration in Seep Creek and Contwoyto Lake sampling stations increases markedly and 2 fold, respectively following the spikes in the effluent concentration identified above.*
- *Nickel – The effluent concentration of Ni showed very little change during the sampling window. The Ni concentration in Seep Creek increased sharply in early August, plateaued and then increased sharply again in early October. At the same time the Ni concentrations in Contwoyto Lake increased above the lower hardness dependent threshold of the CCME AW guideline from August to mid September and then fell again to near the detection limit by the end of the discharge period.*
- *Zinc – The effluent concentration of Zn changed very little during the sampling window. The Zn concentration in Seep Creek increased sharply in early August, plateaued and then increased sharply again in early October. At the same time the Zn concentrations in Contwoyto Lake increased above the lower hardness dependent threshold of the CCME AW guideline from August to mid September and then fell again to near the detection limit by the end of the discharge period.*

The potential causes of the trends identified above are discussed below:

- *Sharp increases of metals concentrations in Seep Creek during the late summer and early fall despite a near static or falling metals concentration in the effluent may be the result of reduced creek volume during the late summer (less dilution), sediment partitioning, biological cycling to either release metals back into the water column or to be taken up by organisms that are inadvertently sampled as part of the water column and the potential reduction of groundwater influx and therefore reducing dilution of Seep Creek concentrations.*

- *Late season shifts in aqueous metals concentrations contrary to effluent release trends in Contwoyto Lake could also be the result of lake mixing caused by water circulation, destratification from fall winds and/or temperature change.*
- *The most important influences on lake mixing are wind, inflowing water, and outflowing water. Strong winds will influence the surface waters of all lakes, and depending on the wind strength, its ability to mix the entire water volume of summer stratified lakes. If the fall winds in the receiving areas were strong enough they might destratify and therefore affect contaminant distribution between sampling events.*
- *If the effluent output decreases significantly over the summer the resulting residence time in the receiving area will change accordingly, potentially having a significant effect on the dynamics of the system between the release and non release periods.*

Historical records indicate that the flow levels in Seep Creek decrease significantly over the summer period. During the late summer low flow period the effluent may make up approximately 90% of the water in Seep Creek leading to increased concentrations of these metals (As, Cd, Ni, Zn) towards the end of the effluent discharge period.

11. "p. 15. Please identify the location of the LUP-01 station."

The data reported in Figures 2-1, 2-2, 2-3, 2-4 and 2-5, came from data supplied by the mine owner. In the data file, the station LUP-01 is identified as "Contwoyto Lake at Intake". The raw data were provided for inclusion in the Cycle 3 report, but coordinates for the stations were not provided.

It has subsequently be ascertained by LMI that the intake is located at approximately 490030 East 7294933 North, NAD 83, UTM Zone 12. The actual intake is not a fixed location during care and maintenance and the sample site moves along the shoreline to reflect where water is being taken from.

12. "p. 25. The report notes that "best attempts" were made to use the same sampling stations as in previous phases. Please note that the latitude and longitude of sampling areas are required under the MMER (Schedule 5, Section 17(b)), therefore, the crew should be able to locate the sampling stations with a GPS unit, based on coordinates provided in previous interpretative reports."

The field crew had the coordinates on hand while in the field. It cannot be guaranteed with 100 percent certainty that the exact location has been sampled in all three reporting cycles due simply to precision of handheld GPS units. Thus the wording "best attempts to use the same sampling locations" was used in the report. The sampling coordinates recorded in the field notes from both Cycles 2 and 3 have been consolidated (see Table 5*). For most stations, the coordinates were the same, but for some stations, the coordinates varied slightly between years of study.*

Table 5: Sample station coordinates from Cycle 3 and Cycle 2 EEM studies at Lupin Gold Mine

				Stations for Cycle 3			Stations for Cycle 2		
Survey Type	**Area**	**Station Type**	**Station**	**Zone**	**Easting**	**Northing**	**Zone**	**Easting**	**Northing**
Field Chemistry. Water Quality Stations and Temperature Loggers	Exposure Area	Water Quality	SCD1	12W	485695	7289659	12W	same coordinates	
		Water Quality, Field Chemistry	SCP1	12W	481289	7290694	12W	same coordinates	
		Water Quality, Field Chemistry	SCP5	not sampled in Cycle 2			12W	480594	7290534
		Water Quality	SNP925	12W	480216	7290212	12W	same coordinates	
		Temperature Logger	TL2	12W	480337	7290186	not sampled in cycle 2		
		Temperature Logger	TL1	12W	482136	7290462	not sampled in cycle 2		
Field Chemistry. Water Quality Stations and Temperature Loggers	Reference Area 1	Water Quality, Field Chemistry	FC2	12W	494671	7289051	12W	same coordinates	
		Water Quality, Field Chemistry	FL3	12W	493679	7287178	not sampled in cycle 2		
		Water Quality	FL5	12W	492552	7286547	12W	492618	7286327
		Water Quality, Field Chemistry	FL1	not sampled in Cycle 3			12W	494145	7287789
		Temperature Logger	TL4	12W	496045	7291052	not sampled in cycle 2		
		Temperature Logger	TL3	12W	495494	7290112	not sampled in cycle 2		
Field Chemistry. Water Quality Stations and Temperature Loggers	Reference Area 2	Water Quality, Field Chemistry	R2-1	12W	497453	7284512	not sampled in cycle 2		
		Water Quality	R2-2	12W	497305	7285367	not sampled in cycle 2		
		Water Quality, Field Chemistry	R2-3	12W	495529	7287452	not sampled in cycle 2		
		Temperature Logger	TL6	12W	499241	7285912	not sampled in cycle 2		
		Temperature Logger	TL5	12W	497312	7286576	not sampled in cycle 2		
Sediment Sampling Stations (cycle 2	Exposure Area	Sediments, Field Chemistry	SCP1	12W	481289	7290694	12W	481248	7290713
		Sediments	SCP2	12W	481065	7290479	12W	same coordinates	
		Sediments	SCP3	12W	480953	7290309	12W	same coordinates	

				Stations for Cycle 3			Stations for Cycle 2		
Survey Type	**Area**	**Station Type**	**Station**	**Zone**	**Easting**	**Northing**	**Zone**	**Easting**	**Northing**
and 3); benthic sampling stations (cycle 2)		Sediments	SCP4	12W	480747	7290395	12W	same coordinates	
		Sediments, Field Chemistry	SCP5	12W	480594	7290521	12W	same coordinates	
Sediment Sampling Stations	Reference Area 1	Sediments	FL1	12W	492274	7286480	12W	492340	7286260
		Sediments	FL2	12W	493776	7287162	12W	493924	7286987
		Sediments, Field Chemistry	FL3	12W	493679	7287178	12W	493806	7287077
		Sediments	FL4	12W	492970	7286781	12W	492915	7287024
		Sediments	FL5	12W	492552	7286547	12W	492620	7286332
Sediment Sampling Stations	Reference Area 2	Sediments, Field Chemistry	R2-1	12W	497453	7284512	not sampled in cycle 2		
		Sediments	R2-2	12W	497305	7285367	not sampled in cycle 2		
		Sediments, Field Chemistry	R2-3	12W	495529	7287452	not sampled in cycle 2		
		Sediments	R2-4	12W	497648	7284697	not sampled in cycle 2		
		Sediments	R2-5	12W	494949	7287511	not sampled in cycle 2		
Fish Sampling Stations	Exposure Area	Electrofishing	Start	12W	480153	7290206	12W	480172	7290236
		Electrofishing	Finish	12W	481515	7290642	12W	482899	7290103
Fish Sampling Stations	Reference Area 1	Electrofishing	Start	12W	496119	7291050	12W	495872	7290588
		Electrofishing	Finish	12W	494680	7288932	12W	494655	7289018
Fish Sampling Stations	Reference Area 2	Electrofishing	Start	12W	499230	7285887	not sampled in cycle 2		
		Electrofishing	Finish	12W	497213	7286679	not sampled in cycle 2		

Notes: TL = temperature logger
SCP = seep creek pond
FL = fingers lake
R2 = reference lake 2
SNP = surveillance network point
SCD = seep creek dam

Overall, we confirm that the stations were re-located and sampled within the degree of accuracy achievable with a hand-held GPS (Table 5).

6.0 METHODS

13. "p. 31. Regarding the analysis of dissolved metals, were the samples filtered on site or at the analytical laboratory? What filter pore size was used?

    Samples were filtered in the field using a hand pump, and were filtered through the standard 0.45 µm filter apparatus. Samples were preserved in the field using the lab supplied preservative.

14. "p. 32. During a site visit by the EEM coordinator on Aug 23, 2010, sediment samples collected from the Seep Creek Ponds were observed to be loose, which prevented the crew from isolating the top 3 cm of sediment. Was this similar for all three sampling areas? Were any of the sediment samples sufficiently intact to allow for sub-sampling of the top 3 cm?"

    Field notes are not available so it is not possible to comment with accuracy on procedures in the field; however, field staff recollect that at most sites, the upper sediments were quite firm, so the upper 3 cm were likely sub-sampled for sediment quality analysis. Nonetheless, the sampling issues encountered during the EEM coordinators visit in 2010 appear to be a common trend for sediment sampling at the Lupin Mine: It is generally possible to obtain a sediment sample that approximately represents the upper 3 cm of deposition, which in many cases is poorly consolidated; however, the ease with which the sediments are disturbed often preclude a more detailed vertical characterization, either within the top 3 cm or in deeper strata.

    During the Cycle 2 field work conducted during the summer of 2008, sediment sampling was attempted using a 63 mm core sampler. The substrate composition was too sandy, however, and the sediment samples would not stay in the tube. Therefore, sediment samples were collected using the same Petit Ponar Samples used to collect the BIC samples. When deployed through greater depths of water column, and appropriately weighted Eckman grap is generally superior to a Petit Ponar grab for obtaining a sediment sample that is minimally disturbed near the sediment water interface; however, in these shallow systems, the method of hand deployment permits careful placement and retrieval of either grab type, along with equivalent performance.

15. "p. 32. Please describe QA/QC protocols for the sediment survey. Were replicate samples collected and analyzed as proposed in the Phase 3 Study Design Addendum (see study design review comment #23)?"

    Sediment samples were collected during the Cycle 3 field work using an Ekman grab, and sub-samples were taken from each grab using a plastic and not a metal spoon so as to avoid potential *contamination. Field replicate samples were not collected. The lab quality control (QC) reports were reviewed, and all internal QC measures were within the reporting limits, and all lab duplicates returned results with less than 20% relative difference between values.*

16. "p. 36. The report indicates that 10 grayling from each age class were sacrificed for ageing structures, but the results appear to suggest otherwise. Please clarify."

    Fish ageing structures were extracted from 53 Arctic grayling, but 8 were lost in transport between the field and the lab. In total, 45 ageing structures were analyzed (Table 6). Twenty-one fish in age class 0, 13 in age class 1, and 11 in age class 2 were aged.

Table 6: Number of ageing structures from arctic grayling by age class and study area

Age Class	Total Fish	Exposure Area	Reference Area 1	Reference Area 2
Age 0	21	14	7	0
Age 1	13	6	7	0
Age 2	11	1	1	9
Sum	**45**	**21**	**15**	**9**

17. "p. 36. It was reported that less than the target number of grayling (100 age~0+) were collected during the fish survey, which was completed from August 18-29. Please note that all reasonable effort should be made to the collect the target number of fish (please refer to 3,9.3,1 and 3.9.4 of the guidance document). The EEM program generally recommends a fishing effort of 7 days per sampling area."

    The comment is noted. Reasons for capturing less than the target number of fish include the following:

    - *There were a large number of ninespine stickleback in the tributaries that may have affected the number of Arctic grayling present during the field survey;*
    - *As this is a mine in care and maintenance, the camp is not open year-round, and the camp was closing at the end of August; as such, there was no opportunity to extend the field program.*

18. "p. 37. The Phase 3 study design indicated that Dam 1 a would be sampled for fish as in Phases 1 and 2, however the interpretative report indicates that all fish were collected downstream near the Seep Creek Ponds. Given that the Dam 1a pond is adjacent to the tailings impoundment area and has historically had higher metal concentrations in water and sediment compared to downstream

sites, please discuss how its exclusion from the fish survey might confound the comparison of Phase 3 results to Phases 1 and 2."

Correct, the focus of the fishing survey was on the creeks in all three areas. Electrofishing with a Smith-Root LR-24 Backpack Electrofisher was the only fishing method used in Cycle 3 as it was found to be the most successful method in previous years. In the Cycle 2 study, minnow traps and gill nets were used in Dam 1a and near the Seep Creek Ponds, but electrofishing was not used (see Appendix D, Table D-3 from the Cycle 2 study report). In Cycle 2, no fish were caught in Dam 1a.Rather, all fish were caught in Seep Creek and Seep Creek Ponds. Thus, data from Cycle 3 is comparable to data from Cycle 2.

19. "p. 40. Please describe the QA/QC protocols for the fish ageing analyses: were ageing data independently verified , as recommended in Section 3.9.6 of the guidance document?"

We were not able to determine whether the ages assigned from otoliths was independently verified. There is nonetheless strong corroborative evidence for the age of collected fish based on the fact that the study focussed on 0+ and 1+ year classes of arctic grayling, and that there was a clear differentiation between these two year classes (and between the 1+ and older year classes) based on fork length observations alone. The earlier year classes clearly fall within distinct modes relative to the overall size distribution, and can be readily distinguished even in the absence of fish ageing using otoliths or scales. Figure 2, herein, provides a clear example of this.

20. "p. 40. How many fish were combined for each composite sample for tissue analysis?".

Instructions from the lab were that at least 10 grams of fish tissue were required for each analysis. Ideally, one fish would be submitted per sample, where the fish were too small, more than one fish was included in the tissue sample. The summary of number of fish that made up each tissue sample was included in Appendix C Table C-7 in the sample ID. These data have been included below (Table 7). Sample E-C1 includes fish E-024. In Appendix C Table C-2, Fish ID E024 was an Arctic grayling, total weight 21.554 g, and was submitted for ageing analysis. In Appendix C Table C-5, Fish E024 was determined to be class age-1+.

Table 7: Fish samples submitted for tissue analysis

Exposure Area		Reference Area 1		Reference Area 2	
Sample ID	**# Fish**	**Sample ID**	**# Fish**	**Sample ID**	**# Fish**
E-C1 (INCL.E-024)	1	R1-C1 (INCL.RI-024)	1	R2-C1 (INCL.R2-035)	1
E-C2 (INCL.E-097,E-025)	2	R1-C2 (INCL.R1-041)	1	R2-C2 (INCL.R2-036)	1
E-C3 (INCL.E-053)	1	R1-C3 (INCL.R1-042)	1	R2-C3 (INCL.R2-062)	1
E-C4 (INCL.E-052)	1	R1-C4 (INCL.R1-028)	1	R2-C4 (INCL.R12-063)	1
E-C5 (INCL.E-074,E-072,E-054,E-073,E-091)	5	R1-C5 (INCL.R1-023,R1-016)	2	R2-C5 (INCL.R2-064)	1
E-C6 (INCL.E-075,E-096,E-095,E-094,E-093,E-092)	6	R1-C6 (INCL.R1-052)	1	R2-C6 (INCL.R2-078)	1
E-C7 (INCL.E-100)	1	R1-C7 (INCL.R1-051)	1	R2-C7 (INCL.R2-079)	1
E-C8 (INCL.E-115,E-113,E-098,E-114,E-134,E-152,E-153)	7	R1-C8 (INCL.R1-085,R1-072,R1-079,R1-064,R1-111)	5	R2-C8 (INCL.R2-082)	1
E-C9 (INCL.E-101,E-154)	2	R1-C9 (INCL.R1-112,R1-110,R1-078,R1-086)	4	R2-C9 (INCL.R2-081)	1
E-C10 (INCL.E-156,E-155)	2	-	-	-	-
E-C11 (INCL.E-102)	1	-	-	-	-

7.0 EFFLUENT AND WATER QUALITY RESULTS

21. "p. 43. Please discuss possible causes of elevated conductivity in the immediate receiving area (Dam 1a pond, SCD1), given that there was no effluent discharge in 2010."

The ability of water to pass an electrical current is affected by the presence of ions that carry a negative charge such as inorganic dissolved solids (chloride, nitrate, sulfate, and phosphate anions) or ions that carry a positive charge (sodium, magnesium, calcium, iron, and aluminum cations). At a contaminated site the presence of metal ions in water could also potentially affect conductivity readings. Conductivity also increases with increasing temperature and therefore conductivity readings are reported as conductivity at 25°C.

Historical records indicate that the flow levels in Seep Creek decrease significantly over the summer period. During a summer with no effluent discharge the influx of water from Seep Creek could decrease by approximately 90%. The resulting low throughput for Dam 1a pond and SCD1 could lead to increased conductivity concentrations as the summer progresses. A decrease in throughput would also be expected to increase the level of internal cycling within Dam 1a pond and SCD1. With a longer residency time the internal cycling of ions introduced during effluent loading this may cause an increase in conductivity despite a co-occurring effluent release. The 10.7% increase in conductivity noted within Dam 1a pond and SCD1 between 2008 and 2010 could likely represent the temporal variation caused by influx rates and residency time but would *also be partially reflective of the contaminant loading from 2009 effluent discharge period (2,897,461 m^3).*

However, Table 2-3 of the Cycle 3 Report indicates that the average conductivity readings in 2008 and 2010 at location SNP 925-20 were nearly identical and an order of magnitude lower than those measured in 2000, 2002, and 2005.

8.0 SEDIMENT RESULTS

22. "p. 45. Please discuss how differences in sediment grain size between exposure and reference areas might influence the interpretation of the sediment metal concentrations."

Both grain size and total organic carbon (TOC) content of sediments have been shown to influence the sorption of contaminants onto sediments. There is no simple relationship for predicting or quantifying the distribution of a contaminant load based on the sediment grain-size fractions of study sites. In general, higher concentrations of metals tend to accumulate in the finer-grain-size fractions. This increased sorption has been attributed to a higher surface-area to grain-size ratio of the finer-grain sizes.

During Cycle 3 at the Lupin Mine, many metal parameters were higher in the exposure area as compared to the reference areas. Specifically, significant differences were identified in the sediment concentrations of arsenic, cobalt, copper, molybdenum, nickel, strontium and zinc. Between the two reference areas, Reference Area 2 generally had higher concentrations of metals/metalloids than Reference Area 1, but no significant differences were identified.

The Cycle 3 results also indicated that the predominant sediment type in each of the study areas was sand with the Exposure Area being classified as silty sand (Table 6-1: Summary of Sediment Textural Characteristics; Cycle 3 Report). There was a significantly greater proportion of clay in the exposure area samples than in the reference area samples. However, the relative percent composition of clay particles in each area was less than 5% and no other statistical differences were identified. Average TOC was highest in the exposure area (2.3%) compared to Reference Area 1 (1.33%) and Reference Area 2 (1.73%) but the small differences identified are not expected to have a significant impact on contaminant concentrations between sampling areas.

Overall, the differences in grain size and TOC are valuable when comparing sites from the same treatment area but are unlikely to be significant factors influencing the differences between the study areas in this project (contaminant differences for the elements noted above ranged from 2-10 times greater in the exposure area). Alternatively the use of the Sediment Quality Triad approach may be considered as an effects-based approach that describes sediment quality and *provides strong, complementary evidence for the degree of contamination-induced degradation in aquatic communities.*

23. "p. 46. Identical values were reported in each of the sampling areas for many of the trace elements {e.g., Sb, Be, Cd, Pb, Hg, Se, Ag, Sn, U). Were the concentrations of these elements below detection levels?"

    The sample size in each area was relatively small (n = 5). The identical values represent metals at their respective detection limits and therefore the values would be similarly low in both the reference and exposure areas.

24. "p. 47. The report identifies several trace elements that were significantly higher in concentration in the exposure sediments compared to reference areas (e.g., As, Co, Cu, Mo, Ni, Sr, Zn). Were there any exceedances of sediment quality guidelines?"

    We have prepared Table 8, below, which indicates the maximum and average sediment concentrations for the trace elements above in comparison to available CCME Interim Sediment Quality Guidelines and Probable Effect Levels.

Table 8: Comparison of target metals with CCME ISQG and PEL sediment standards

Metals	Exposure Area		Reference Area 1		Reference Area 2		CCME Sediment Quality Guidelines	
	Max	Average	Max	Average	Max	Average	ISQG's (mg/kg)	***PELs (mg/kg)***
As	**196**	**92.7**	**24.7**	12	**17.8**	7.6	5.9	**17**
Co	143	49.8	5.5	5.88	13.3	6.92	NA	NA
Cu	46.8	33.3	27.1	11.4	45.3	16.5	35.7	**197**
Mo	3.4	1.74	1.0	1	1.7	1.14	NA	NA
Ni	109	67.7	27.9	15.0	65.1	29.3	NA	NA
Sr	14.6	10.2	9.6	4.92	10.7	5.72	NA	NA
Zn	121	85.4	50.0	24.8	68.0	37.2	123	**315**

Note: values in yellow-highlighted cells exceed their respective ISQG, while bolded numbers exceed the PEL.

The results indicate exceedances for As and copper which are highlighted below:

- *The maximum As concentrations exceeded the CCME ISQGs and PELs in all three areas.*
- *The average As concentrations exceeded the CCME ISQGs in all three areas, but only exceeded the PEL in the exposure area.*

- *The maximum Cu concentrations exceed the CCME ISQG's for the exposure area and the reference area.*
- *No guidelines were published by CCME for cobalt, molybdenum, nickel, and strontium.*

9.0 FISH SURVEY

25. "p. 49. The fish habitat data in Appendix C, Table C-6 show considerably higher pH values for each of the study areas as compared to the water quality data reported in Tables 5-2 and 5.3 (p. 43-44). Please discuss possible sources of error for the pH measurement,"

The data from Appendix C, Table C-6, and Tables 5-2 and 5-3 have been compiled for comparison in Table 9 and 10 below. The field pH values for the reference areas and exposure area are approximately 8 to 12% and 32% higher (respectively) than the historical readings from the previous investigations. The most likely reasons for the difference between the readings are from inter-annual variation of the local pH and the potential for inaccurate field readings during the 2010 fish sampling event. These may have occurred due to improper calibration or issues with the pH probe membrane causing an inaccurate reading. These readings were not accompanied by supporting information such as calibration records, GPS coordinates or at what depth the pH readings were collected which might aid in determining why these differences occurred.

Table 9. Comparison of pH between historical laboratory pH readings and 2010 field readings from the Reference Areas.

			Fingers Lake – Reference Area 1					Fingers Creek – Reference Area 1				Reference Area 2
Parameter	**Units**	**CCME Aquatic Life**	**Fingers Lake (2005)**	**FL1**	**FL5**	**FL5**	**% Change (FL5)**	**Fingers Creek (2005)**	**FC2**	**FC2**	**% Change (FC2)**	**Reference Area 2 -Av (2010)**
				2008	**- 2008**	**-2010**			**- 2008**	**-2010**		
Historical Laboratory pH Values	pH unit	6.5-9.0	6.5	6.6	6.6	6.75	1.10%	**6.3**	6.6	6.92	2.40%	6.62
2010 Fish Survey Field pH Values	pH unit	6.5-9.0	-	-	-	-	NA	-	7.5		NA	7.2
								% Change	**8-12%**		**NA**	**8%**

Table 10. Comparison of pH between historical laboratory pH readings and 2010 field readings from the exposure area.

Parameter				Lupin Mine Tailings Containment Area (Dam 1A Lake Area)						Seep Creek	
	Units	**CCME Aquatic Life**	**Dam 1A (2005)**	**SCD1 (2008)**	**SCD1 (2010)**	**% Change (SCD1)**	**SCP1 (2008)**	**SCP1 (2010)**	**% Change (SPC1)**	**Seep Creek Ponds 1&2 (2005)**	**SCP5 (2008)**
Historical Laboratory pH Values	pH unit	6.5-9.0	5.8	4.9	6.89	+16.9%	5.5	6.7	+9.8%	6.1	5.6
2010 Fish Survey Field pH Values	pH unit	6.5-9.0	-	-	-	-	-	-		8.95	
									% Change	**32-37%**	

There may also be differences between field measured and laboratory measured pH due to microbial sulphate-reduction or nitrogen reactions within the sample bottle that lowered the pH between the moment of collection and when it was analysed at the lab. Microbial reduction of sulfate by metal-reducing bacteria, have the ability to precipitate sulfide minerals, and raise the pH of water. This process is most commonly observed at circumneutral pH. As the pH drops below 5 most sulfate-reducing bacteria have been shown to be inactive. The potential for pH changes due to sulphur or nitrogen cycling mechanisms cannot be ruled out but there is no direct evidence in the projects records to support this hypothesis.

26. "p. 51. Fish tissue concentrations of As and Co were found to be higher in the exposure area than in reference area 1 (Table 7-2). It is noted that sediment concentrations of As and Co were also considerably higher in the exposure area compared to the reference (i.e., ~7-8 fold). Please discuss possible pathways for the transfer of contaminants from sediments to YOY fish."

The primary pathways of contaminant uptake or transfer by YOY fish is via dietary uptake and or maternal transfer. The dietary uptake of contaminants by fish leads to excretion or assimilation in tissues. With respect to maternal transfer, a fish's parental investment is limited to the nutrients and energy invested in eggs that will support embryonic development. There are many examples in the scientific literature of accumulation and maternal transfer of contaminants (typically essential elements such as Cu, Se, and Zn) to eggs, often as organic compounds used for embryo development. There is limited information on the maternal transfer of As and Co in fish. However, recent research conducted on birds (Kubota et al., 2002[1]) identified arsenobetaine as

[1] Kubota, R., Kunito, T., Tanabe, S., Ogi, H. and Shibata, Y. (2002), Maternal transfer of arsenic to eggs of black-tailed gull (*Larus crassirostris*) from Rishiri Island, Japan. Appl. Organometal. Chem., 16: 463–468. doi: 10.1002/aoc.322

the major arsenic compound present in both adult tissue and the resulting eggs. This is a good example of the transfer of contaminants between parent and offspring via an organic complex.

27. "p. 51. Please confirm that trace metal concentrations in fish were reported as dry weight, as suggested by the second column header in Table 7-2."

    We appreciate TAP pointing out this discrepancy. Trace metals analysis in fish tissue by ICPMS were analyzed by ALS in Edmonton, AB using EPA method "200.3/200.8-ICPMS" and reported on a wet weight basis.

28. "p. 58. Why were only 14 exposure fish included in the analysis of YOY condition? According to the fish data provided in Appendix C2, it would appear that there were 21 grayling in the YOY size class as defined by size ranges in Figures 7-5 and 7-6. Similarly, it would appear that 13 YOY grayling were collected from reference area 1, however only 7 fish were included in the analysis. Please discuss."

    The subset of results used were for fish with confirmed ages based on successful collection and aging of otoliths. For the Exposure Area, otoliths were obtained during field work from only 16 of 21 YOY collected, and in Reference Area 1, otoliths were successfully obtained from 8 of 13 YOY fish collected. Per Appendix C, Table C5 of the report, ages from otolith examination were reported for 14 YOY from the Exposure Area and 7 YOY from Reference Area 1. Overall, the numbers used in the ANCOVA and condition analysis reflect a decision to include only those fish for which the age was independently verified through otolith aging.

    As indicated in our response to Comment 17, above, the YOY grayling could be confidently differentiated from the 1+ and subsequent age classes based on fork length alone, so the exclusion of fish that did not have accompanying otolith age data was likely not necessary. <u>Therefore, the ANCOVA results presented herein under our response to comments #7 are based on the larger YOY and 1+ data set</u>.

29. "p. 60. Please calculate the magnitude of the effect on condition as the difference in adjusted mean weight between exposure and reference areas, expressed as a percentage of the reference adjusted mean (refer to Table A2-3 in Chapter 8 of the guidance document)."

    Please refer to our response to TAP comment 7.

30. "p. 62. Please note that the weight-length relationship is log-linear and thus analysis of condition is typically conducted on log-transformed data (as in Phase 1). The relationship may appear linear within cohorts, but is unlikely to be linear over a larger age range (e.g., Figure 7-8)."

We concur and the re-analysis of the log transformed data was conducted as part of the response to comment #7. For the 2+ age category, only 1 individual was sampled from the Exposure Area. Therefore, as per the approach provided in the EEM technical guidance document, an ANCOVA is inappropriate for this portion of the fish data and only means and sample sizes have been provide for two year old fish.

31. "p. 63. The data in Figure 7-9 indicate that age-0+ fish from 2010 were larger than age-1+ fish. Please clarify, and provide a corrected version of the figure."

The legend of Figure 7-9 was mistakenly mislabelled, and the 0+ and 1+ identifiers were switched. Figure 1 shows the body condition effect endpoint for YoY (0+) Arctic grayling from the 2008 and 2010 collections for both the Exposure Areas and Reference Area 1. The updated figure clearly identifies that Reference Area 1 YOY grayling are larger than Exposure Area YOY grayling.

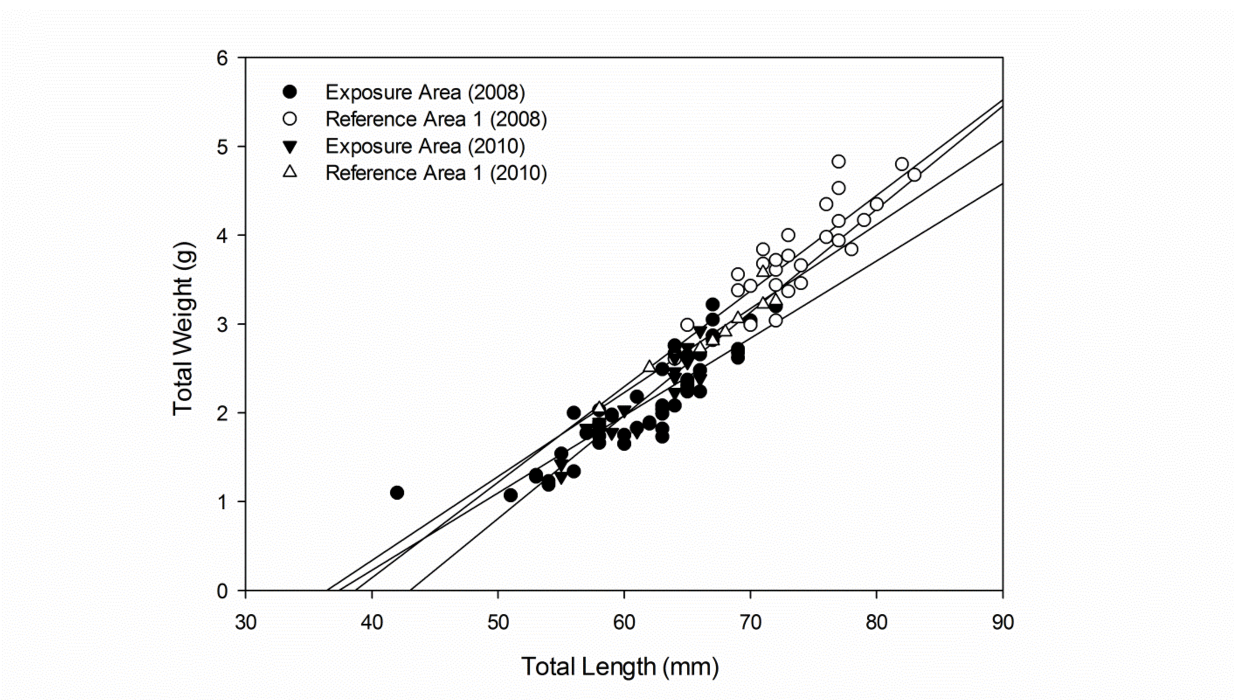

Figure 3. Comparison of the Total Weight to Fork Length (Condition) Relationship for both the 2008 and 2010 YoY Arctic Grayling Sampling Seasons.

32. "p. 67. The summary suggests that differences in intercepts provide information on condition at hatching or emergence from the egg. Please note that the weight-to-length regressions should not be extrapolated back to zero. ANCOVA assumes a common slope for the weight-to-length relationship in both areas, and the difference in the y-intercepts of these regressions is used to compare weight between areas at a given length."

Please see Figure 1 above. While the slope of the mass-length relationships for the 0+ age class are not significantly different between reference area 1 and the exposure area (α = 0.05), the slopes of the least-squares best fit are clearly visually different, and we also need to consider the power to detect a difference in slope of the two sub-populations. We were simply advancing a hypothesis that maternal energy transfers via the egg and yolk sac may have a role at very early post-hatch life stages in the realized mass at length. We would expect the effect of condition at emergence to have lesser influence relative to juvenile exposure to decrease with the age of the 0+, 1+ and 2+ age classes.

33. "p. 70. The proponent is recommended to consider the data compiled in the Lupin Gold Mine EEM Program Historical Information Report, which includes pre-disturbance studies on sediments, water/benthos and fish dating back to 1981, prior to the commencement of effluent discharge in 1985. Fish sampling at the site was historically conducted in late June/early July, precluding direct comparison to the YOY and age-1+ results from the EEM studies, however the historical studies suggest that older age classes of grayling were more predominant in Seep Creek early In the summer, likely moving downstream as flow decreased in later months."

Interpretations in the Cycle 3 report are consistent with interpretations in the review comments. Relevant comparisons are discussed below:

- *The report indicated that arctic grayling showed a decreased growth rate from 1983 to 1990. The proposed hypotheses for this decrease included metals exposure, thermal variation, and inconsistent sampling window. Sampling was historically conducted in late June/early July and as such many spawning adults would have moved out of the system and the condition factor of post spawning adults may have been changed significantly. This also precludes the comparison of the YOY and 1+ age categories from the EEM studies.*
- *The Cycle 3 interpretations regarding the timing of YOY migration out of the system prior to freeze-up and adult arctic grayling movement into the system from Contwoyto Lake post ice out are consistent with the detailed information provided in the historical information document.*
- *The Cycle 3 report indicated that "differences in recruitment could have been caused by differences in the timing of spawning grounds accessibility. These differences may have occurred based on localized differences in spring thaw rates (i.e. related to stream morphology, depth, width, etc) and spawning area entrance limitations (i.e. ice jams)." The historical report also indicates that the movement of spawning adults out of Seep Creek will also be dependent on the flow levels. This is an important parallel argument to our discussion of spring ice out timing which would affect the arrival of spawning adults*

and the two variables seem to be important factors in defining the spawning window for adult arctic grayling in Seep Creek.

The historical information also raises an interesting counter point to our discussion on fish position within the surveyed streams. The influences of stream position on the morphometrics analyzed in this study are valid. However, the historical report indicates that the movement of spawning adults out of Seep Creek is also heavily dependent on the flow levels. This information may be helpful in calibrating future field sampling programs within the EEM framework to account for the effect of low flow periods on the search for target age classes of arctic grayling.

34. "p. 70. The report refers to differences in recruitment between areas, however it is not apparent that recruitment was measured in this study; please clarify."

The subject of the study was younger, sub-adult age classes of arctic grayling, and of the YOY age class in particular. The reference to recruitment was simply intended to convey the role of the YOY in renewing fish populations within the catchment area of interest.

Furthermore, the report makes no factual claims about differences in the seasonal timing of recruitment into the Exposure Area versus Reference Areas, but does nonetheless speculate that such studies on YOY could be influenced by the timing of emergence of fry.

If further cycles focus on YOY grayling, it may be useful to more directly consider windows of fry emergence or swim up relative to the sampling periods.

35. "p. 70. Does the proponent have any references to support the statement: "This would be consistent with observations by various researchers that condition increases through the growing season"?

It is well understood within the research community that especially arctic and sub-arctic fish undergo appreciable depletion of energy resources during non-feeding or limited feeding periods in winter-time under-ice conditions, followed by a rapid re-acquisition of lipid and other energy reserves in the spring. A small sampling of scientific references is provided below.

- J.R. Brett, 1971. *Energetic* responses of salmon to temperature. A study of some thermal relations in the physiology and freshwater ecology of sockeye salmon (*O. nerka*). Am. Zool., 11: 99–113.

- Valtonen, T. 1974. Seasonal and sex-bound variation in carbohydrate metabolism of the liver of whitefish. Comparative Biochemistry and Physiology 47A: 713 – 727.

- Berg, O.K. and Bremset, G. 1998. Seasonal changes in the body composition of young riverine Atlantic salmon and brown trout. Journal of Fish Biology 52: 1272 – 1288.
- Finstad, A. G; Berg, O. K; Lohrmann, A., 2003. Seasonal variation in body composition of Arctic char, Salvelinus alpinus, from an ultraoligotrophic alpine lake. Ecology of Freshwater Fish 12: 228 – 235.
- Pyle, G., Busby, P., Gauthier, C. *et al.,* 2008. Seasonal and Regional Variations in Metal Contamination and Condition Indicators in Yellow Perch (*Perca flavescens*) along Two Polymetallic Gradients. II. Growth Patterns, Longevity, and Condition. Human and Ecological Risk Assessment: 14: 126 – 145.

The following figures are excerpted from Berg and Bremsett (1998), based on studies of energetic reserves in young riverine Atlantic salmon and brown trout.

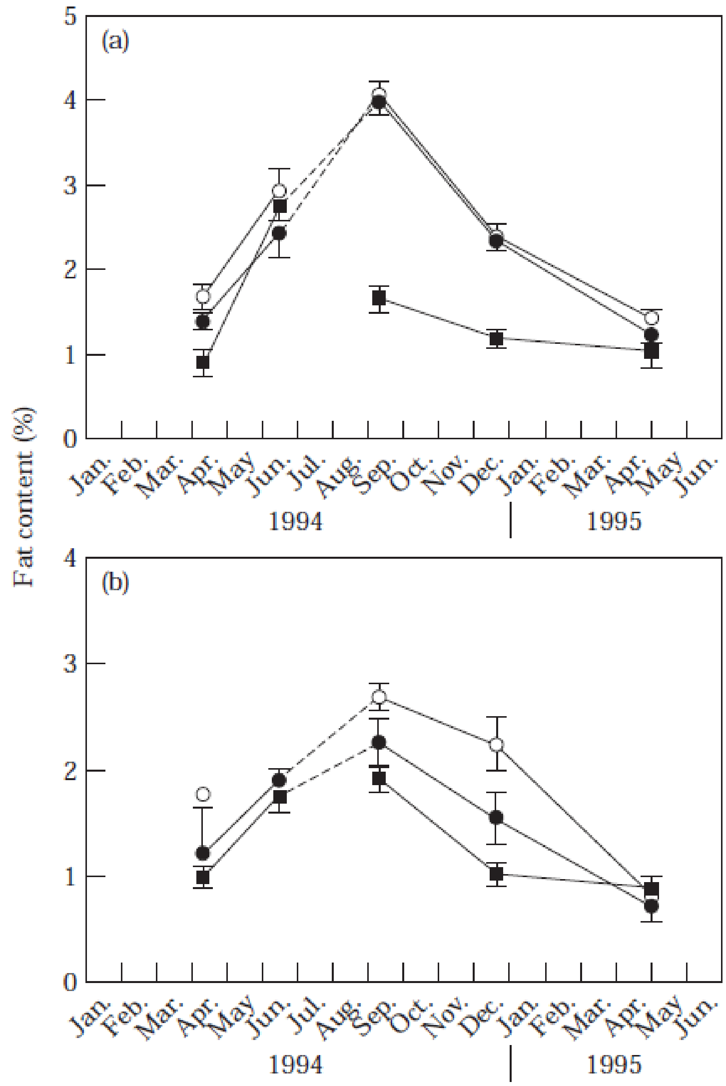

FIG. 3. Mean fat content of (a) Atlantic salmon and (b) brown trout in accordance with seasonal sampling periods (April 1994–April 1995). The break in lines from June to September accord to the change in age status during the early summer period. S.E. bars are indicated for each mean value, and sample size is given in Table I. (a), ■, Body mass <2·0 g; ●, 2·0–5·0 g; ○, >5·0 g. (b), ■, Body mass <3·2 g; ●, 3·2–7·5 g; ○, >7·5 g.

36. “p. 72. The TAP appreciated the summary of threshold concentrations for trace metal toxicity in fish.”

No response required.

10.0 MINOR COMMENTS AND ERRATA

“p. iv. Please clarify the final sentence in the second paragraph under Conclusions: "...we speculate that the standing stock biomass between the exposure areas and reference areas would be sufficiently similar to impact the growth of sub-adult Arctic char in the exposure area."

To clarify we provide the following modification to the text:

Given the similar average numerical abundance between the two areas, we speculate that the invertebrate standing stock biomass between the Exposure Area and reference areas would be sufficiently similar to provide similar feeding and energetic uptake opportunities for sub-adult Arctic char.

"p. 2. Regarding the last sentence in the second paragraph: "...the channels and small ponds within the Fingers Creek system are slightly deeper on average than the *reference* area." Should this refer to the *exposure* area?"

Agreed, this paragraph was modified with the following text to indicate the sentence should be referring to the exposure area.

Various biological and chemical characteristics of the Lupin Mine exposure area were compared to those a similar reference area. The Fingers Creek drainage system, to the immediate southeast of the mine site, was investigated as a potentially suitable reference area. As noted in the Cycle 1 and 2 interpretive reports, the channels and small ponds within the Fingers Creek system are slightly deeper on average than the exposure area.

"p. 3. Please note that there was a statistically significant difference in benthic density In Phase 2 (exposure area density was 3.1 standard deviations higher than the reference area)."

Agreed. The text in this section has been updated to identify this significant difference.

The Benthic Invertebrate Community (BIC) assessment conducted during the Cycle 1 study was repeated for the Cycle 2 study, using the previously used sample locations and methods. The Cycle 2 BIC assessment results are as follows:

- **There was significantly greater benthic invertebrate density for the exposure area compared to the reference area during Phase 2 ,**

- **There were no statistically significant differences between the Exposure Area samples and Fingers Creek Reference Area samples for total taxon richness, family richness, Simpson's Diversity, or Simpson's Evenness.**

An important point, nonetheless, is that a statistically significantly greater density of benthic invertebrates in the exposure area in comparison with the reference area is not necessarily an adverse effect that would be expected from metal mine effluent discharge per se. Given the lack *of evidence for impoverished biodiversity in the exposure area relative to the reference area, the increased density does not appear to be associated with an ecotoxicological response similar to the Pearson et al. "Peak of Opportunists". The most simple explanation for the observations, therefore, is in association with greater secondary productivity within the exposure area.*

"p. 4. The last line refers to a significant difference in the *ratio* of liver weight to total length for ninespine stickleback. Please note that it was not ratios that were compared but rather the y-intercepts of liver weight to total length regressions, as per ANCOVA."

Agreed. The text in this section has been updated to eliminate the reference to the term ratio.

The major results from the Cycle 2 study on juvenile Arctic grayling and ninespine stickleback were as follows:

- **Average fork length and average body weight of 0+ Arctic grayling was significantly higher in the Reference Area than the Exposure Area. The 0+ grayling were on average 44% heavier and 16% longer in the Reference Area in comparison with the Exposure Area.**
- **An ANCOVA of weight (as the independent variable) versus fork length (as the dependent variable) was completed to assess spatial differences in condition of 0+ grayling. Condition differed between areas but the slope of the relationship was the same in both areas. Condition was 18% higher in the reference over the exposure area.**
- **There was no significant difference in the relationship of liver weight to carcass weight for young-of-year Arctic grayling by area.**
- **Body weight and length of ninespine stickleback in the exposure area were significantly heavier and longer, respectively, than reference area individuals. The slope of the length to weight relationship, however, did not differ significantly between areas.**
- **The liver weight to total length relationship was significantly different between areas for ninespine stickleback (for a given length, livers were heavier from exposure area versus individuals from the reference area). As determined from the y-intercepts of the regressions as per (liver weight to total length ANCOVA).**

"p. 17. The text under Figure 2-3 refers to the CCME standard range (hardness dependent) for aqueous *cadmium;* this should refer to copper."

Agreed, the sentence has been updated to reflect this change.

The copper concentration of the effluent discharge from Lupin Mine in 2009 was generally constant over the course of the discharge period except for one spike that occurred in October, and was consistently below the MMER guideline for a single sample set at 0.6

mg/L. The majority of the effluent samples and downgradient water samples in Seep Creek were greater than the CCME standard range (hardness dependent) for aqueous copper set at 0.002 to 0.004 mg/L. However, the concentrations were generally below the CCME standard for samples collected in Contwoyto Lake.

"p. 47. The first sentence under 'Sediment Quality Highlights' states that "Reference Area 1 and 2 sediment predominantly sandy and was more silty with significantly more clay in the Exposure Area." However, it is noted on p. 45 that the exposure area had relatively higher silt content than the reference areas, Please clarify."

Agreed, the first bullet of Sediment Quality Highlights has been updated to clarify this.

Sediment Quality Highlights:

- Sediment concentration of arsenic, cobalt, copper, molybdenum, nickel, strontium and zinc were significantly higher in the exposure area in comparison with the reference areas.
- Sediment concentration of arsenic, cobalt, copper, molybdenum, nickel, strontium and zinc were significantly higher in the exposure area in comparison with the reference areas.
- Many of the other metal parameters did not differ significantly between the areas but concentrations were higher in the exposure area as compared to the reference areas.
- The majority of the sediment concentrations did not differ between the two reference areas; however, Reference Area 2 generally had higher concentrations of metals/metalloids.

"p. 49. The text indicates that 30 grayling were collected from the exposure area, however Table 7-1 indicates a sample size of 28, and Table 7-4 indicates 29; please clarify. Also, the total number of grayling collected from the exposure area is indicated as 223 in Table 7-1, however the text on p. 49 indicates that 308 fish were collected."

Agreed, the capture results have been confirmed and they should read as follows:

- **Capture results for the sentinel target species indicate that 29 Arctic grayling were captured in the Exposure Area, 25 were caught in Reference Area 1 and 33 were captured in Reference Area 2. This clarification does not affect the CPUE statistics which were calculated based on n=29.**
- **Sampling of the creeks and ponds was conducted by backpack electrofishing. In total, 223 fish representing three species were captured in the Exposure Area (Appendix C Table C-2), 161 fish representing six species were captured in Reference Area 1 (Appendix C Table C-3) and 301 fish representing seven species were captured in Reference Area 2 (Appendix C Table C-4). Table 7-1 shows that the same amount of effort was needed to**

catch fish in the Exposure Area and Reference Area 2. It also indicates that it was much more difficult to catch fish in Reference Area 1.

"p. 54. The sample sizes for grayling reported in Figures 7-2,7-3, and 7-4 do not appear to match those reported in Tables 7-1 and 7-4; please clarify."

In the Cycle 3 report Table 7-4 represents summary statistics for all fish collected and thus all age classes. Table 7-5 summarises only the YOY fish that were confirmed using otolith examination. Figures 7-2 and 7-3 represent frequency distributions for all of the age classes of the fish collected (i.e. Table 7-4). The data summarised in Table 7-5 are illustrated in Figures 7-5 and 7-6.

"p. 58. The report states that "...0+ fish in the reference area weighed 30% more and were 9% longer than individuals in the Exposure area." Please note that according to the data in Table 7-5, YOY grayling in the exposure had 28% lower length, and 7% lower weight than reference fish."

We interpret this TAP comment to indicate that we are in agreement that reference area fish are longer and heavier than exposure area fish. The difference between the two statements is the order in which the two populations are being compared. Re-stated, it indicates that 0+ exposure area fish had 28% lower length and 7% lower weight than the 0+ reference fish.

"p. 61. Was the linear relationship reported the for 2010 age-2+ arctic grayling actually based on fish collected from reference area 2, rather than from reference area 1 as indicated in text on p. 61 and Figure 7-8?"

Agreed, we have updated the title line below to reflect this clarification.

In addition to YoY (0+) Arctic grayling, weight to fork length relationships were compared for age 1+ and 2+ Arctic grayling collected in 2010. Linear least-square estimates of the weight-length relationships are shown below.

<u>2010 age 1+ Arctic grayling</u>

Reference Area 1: Total weight (g) = 0.4403 x Fork length (mm) – 36.0430; r^2=0.96

Exposure Area: Total weight (g) = 0.5163 x Fork length (mm) – 41.8910; r^2=0.97

<u>2010 age 2+ Arctic grayling</u>

Reference Area 2 only : Total weight (g) = 0.7583 x Fork length (mm) – 75.876; r^2=0.91

p. 63. The data in Figure 7-9 indicates that age 0+ fish from 2010 were larger than age 1+ fish. Please clarify.

Updated. Please see our response to Comment 31, above.

p. 78. Please provide units for Table 8-3."

Units have been added for 96 h LC_{50} values (µg/L) to Table 11.

Table 11. Toxicological thresholds of sub-adult arctic grayling for arsenite, cadmium, mercury and nickel (adapted from Buhl and Hamilton, 1991).

Substance	Alevin		Juvenile		Lupin Exposure Area 2010 Range (µg/L)
	96 h LC_{50} (µg/L)	95% Confidence Range	96 h LC_{50} (µg/L)	95% Confidence Range	
Arsenite	27,700	23,500-32,700	13,700	11,600-16,100	4.1-8.2*
Cadmium	6.1	4.7-7.8	4.0	1.5-9.7	0.014-0.060
Mercury	124	106-146	218	186-256	<0.020-0.073
Nickel	8,200	5,600-12,000	8,700	6,700-11,400	18-35

* as total measurable dissolved arsenic.

11.0 SIGN-OFF AND CLOSURE

We trust that the responses meet Elgin's needs and will have in turn assisted the EEM Technical Advisory Panel (TAP) in carrying out their work. We have appreciated the opportunity to complete this work on behalf of Elgin.

We have appreciated the opportunity to work with you on this project, and trust that this report is satisfactory to your requirements. Please feel free to contact the undersigned regarding any questions or further information that you may require.

Report prepared by:
Hemmera

Doug Bright, Ph.D., RPBio (BC)
Business Leader – Environmental Risk Assessment

604.669.0424 (606)
dbright@hemmera.com

12.0 STATEMENT OF LIMITATIONS

This report was prepared by Hemmera for the sole benefit and exclusive use of Elgin Mining Ltd. The material in it reflects Hemmera's best judgment in light of the information available to it at the time of preparing this Report. Any use that a third party makes of this Report, or any reliance on or decision made based on it, is the responsibility of such third parties. Hemmera accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this Report.

Hemmera has performed the work as described above and made the findings and conclusions set out in this Report in a manner consistent with the level of care and skill normally exercised by members of the environmental science profession practicing under similar conditions at the time the work was performed.

This Report represents a reasonable review of the information available to Hemmera within the established Scope, work schedule and budgetary constraints. It is possible that the levels of contamination or hazardous materials may vary across the Site, and hence currently unrecognised contamination or potentially hazardous materials may exist at the Site. No warranty, expressed or implied, is given concerning the presence or level of contamination on the Site, except as specifically noted in this Report. The conclusions and recommendations contained in this Report are based upon applicable legislation existing at the time the Report was drafted. Any changes in the legislation may alter the conclusions and/or recommendations contained in the Report. Regulatory implications discussed in this Report were based on the applicable legislation existing at the time this Report was written.

In preparing this Report, Hemmera has relied in good faith on information provided by others as noted in this Report, and has assumed that the information provided by those individuals is both factual and accurate. Hemmera accepts no responsibility for any deficiency, misstatement or inaccuracy in this Report resulting from the information provided by those individuals.

The liability of Hemmera to Elgin shall be limited to injury or loss caused by the negligent acts of Hemmera. The total aggregate liability of Hemmera related to this agreement shall not exceed the lesser of the actual damages incurred, or the total fee of Hemmera for services rendered on this project.