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Our File #: TC-03-01

April 3, 2013

Mr. Bruce Donald
Teck Metals
PO Box 2000
Kimberley BC V1A 3C1

Dear Mr. Donald:

RE: Implications of Sublethal Toxicity Testing Results at Polaris Mine

At the request of Teck Metals (Teck), Azimuth has prepared this brief summary of results of sublethal toxicity test results at the Polaris Mine, Little Cornwallis Island and implications of failures of sublethal toxicity testing on future monitoring and/or requirements, based on Environment Canada guidance within the Metal Mining Effluent (MMER) regulations. The impetus for this technical letter is to review the most recent results of sublethal toxicity testing and discuss implications, if any, on future long-term monitoring requirements at the Polaris Mine.

Tables 1 and **2** provide a summary of acute and sublethal toxicity data respectively between 2003 and 2011. Results of these tests have been discussed within other submissions, however, the consequences of toxicity in acute and sublethal tests has not.

No acute lethality to rainbow trout (*Oncorhynchus mykiss*) and the waterflea (*Daphia magna*) have been recorded in two or three times annual toxicity testing since 2003, save a single event in 2007 when testing was conducted by a different laboratory. Given the lack of acute toxicity, there is no requirement within the MMER to conduct any further testing (e.g., a toxicity identification evaluation) nor follow up assessment of effluent quality.

There has been consistent sublethal toxicity since 2003 for two of three species tested. Because the effluent from Garrow Lake is slightly brackish, effluent has been salinity adjusted to allow testing of marine organisms. A brief summary of most recent 2010 and 2011 results (Table 2) is as follows:

- No effect to topsmelt (*Atherinops affinis*) survival or growth rate at full strength effluent
- In the 2011 Echinoderm (*Dendraster ecentricus*) fertilization test, only the full strength effluent concentration produced a significantly lower fertilization ratio relative to the

control group. The IC25 was 41% and the IC50 was >53%. Similar results were observed in 2010, with slightly lower IC25 and IC50 values (67% and >100%).

- In the 2011 algal reproduction test (*Champia parvula*), there was 43% impairment to cystocarp production at the IC25 level. In 2010, there was 68% impairment to cystocarp production, but only at the highest effluent concentration (66%). The IC25 was estimated at 41% effluent.

With respect to the implications of sublethal toxicity of effluent, Environment Canada MMER guidelines specifically address this in a recent March 1, 2012 update to the MMER. The link to the test specifically relating to sublethal toxicity of effluent can be found at http://canadagazette.gc.ca/rp-pr/p2/2012/2012-03-14/html/sor-dors22-eng.html . A summary of the specific text within this update is as follows:

> *4. The Amendments remove the requirement in Schedule 5, paragraph 17(g) and referred to in paragraphs 21(1)(a) and 25(a) to compare the results of sublethal toxicity testing with results of biological monitoring studies to determine if there is a correlation. These comparisons did not lead to meaningful results on a consistent basis.*
>
> *In place of the previous requirement in paragraph 17(g), the Amendments introduce a new requirement to include, as part of each interpretive report for biological monitoring studies, a summary of the results of effluent characterization, water quality monitoring and sublethal toxicity testing. (see footnote 4) Prior to the Amendments, many mines voluntarily included such a summary in each interpretive report, but this requirement will ensure that this summary is provided in all cases, aiding in the interpretation of the results of biological monitoring studies.*

This text clearly states that there is no specific requirement to conduct follow up testing in the receiving environment, nor have such studies attempting to do so found any correlation. Notwithstanding this, Azimuth did undertake a receiving environment effects assessment in 2003 on nearshore water quality, plume delineation and dispersion and metals concentrations in benthic clams offshore of Garrow Creek. No effects and no potential effects was found because of rapid dilution and dispersion of the slightly brackish plume within the upper few cm of the water column as it entered the marine environment of Garrow Bay.

In summary, there are no follow up procedures or studies that are required in the event that sublethal toxicity is found in effluent. The trigger for follow up investigations lies in consecutive failures in acute toxicity tests, which have never been observed at Polaris Mine. Thus, there is no requirement to pursue any incidences of sublethal toxicity as part of a long-term monitoring program of discharge from Garrow Lake

Please let me know if you required any further information.

Sincerely,
Azimuth Consulting Group Partnership

Randy Baker, MSc, RPBio.

Table 1. Summary of Polaris Mine acute toxicity tests, 2003 - 2011.

Test Date	Species Tested	Test Type	Sample Method	Consultant Laboratory	LC50 (% effluent)	LC50 Lower Confidence Limit (% effluent)	LC50 Upper Confidence Limit (% effluent)
Rainbow Trout 96-hr LC50							
29-Jul-03	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
19-Aug-03	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
16-Sep-03	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
7-Jul-04	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
27-Jul-04	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
24-Aug-04	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
16-Jul-05	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
6-Aug-05	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
15-Jul-06	*Oncorhynchus mykiss*	Survival	Grab	Golder Associates, North Vancouver, BC	> 100	-	-
23-Aug-06	*Oncorhynchus mykiss*	Survival	Grab	Golder Associates, North Vancouver, BC	> 100	-	-
9-Sep-06	Sample lost due to laboratory error						
26-Jul-07	*Oncorhynchus mykiss*	Survival	Grab	ALS Environmental, Winnipeg, MB	PASS	-	-
23-Aug-07	*Oncorhynchus mykiss*	Survival	Grab	ALS Environmental, Winnipeg, MB	> 100	-	-
6-Sep-07	*Oncorhynchus mykiss*	Survival	Grab	ALS Environmental, Winnipeg, MB	> 100	-	-
30-Aug-08	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
9-Sep-08	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
18-Jul-09	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
16-Jul-10	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
23-Aug-10	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
23-Jul-11	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
7-Sep-11	*Oncorhynchus mykiss*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
***Daphnia magna* 48-hr LC50**							
29-Jul-03	*Daphnia magna*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
19-Aug-03	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
16-Sep-03	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
7-Jul-04	*Daphnia magna*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
27-Jul-04	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
24-Aug-04	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
16-Jul-05	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
6-Aug-05	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
15-Jul-06	*Daphnia magna*	Survival	Grab	Golder Associates, North Vancouver, BC	> 100	-	-
23-Aug-06	*Daphnia magna*	Survival	Grab	Golder Associates, North Vancouver, BC	> 100	-	-
9-Sep-06	*Daphnia magna*	Survival	Grab	Golder Associates, North Vancouver, BC	> 100	-	-
26-Jul-07	*Daphnia magna*	Survival	Grab	ALS Environmental, Winnipeg, MB	PASS	-	-
23-Aug-07	*Daphnia magna*	Survival	Grab	ALS Environmental, Winnipeg, MB	67.4	59.7	76.1
6-Sep-07	*Daphnia magna*	Survival	Grab	ALS Environmental, Winnipeg, MB	86.6	-	-
30-Aug-08	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
9-Sep-08	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
18-Jul-09	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
16-Jul-10	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
23-Aug-10	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
23-Jul-11	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-
7-Sep-11	*Daphnia magna*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100	-	-

Table 2. Summary of Polaris Mine sublethal toxicity tests 2003 - 2011.

Test Date	Species Tested	Test Type	Sample Method	Consultant Laboratory	EC25 or IC25 (% effluent)	EC25 or IC25 Lower Confidence Limit (% effluent)	EC25 or IC25 Upper Confidence Limit (% effluent)
Topsmelt (*Atherinops affinis*) 7-d Growth and Survival Toxicity Test - Growth Endpoint							
19-Aug-03	*Atherinops affinis*	Growth	Grab	EVS Consultants, North Vancouver, BC	> 72.3	-	-
7-Jul-04	*Atherinops affinis*	Growth	Grab	EVS Consultants, North Vancouver, BC	> 72.6	-	-
27-Jul-04	*Atherinops affinis*	Growth	Grab	EVS Consultants, North Vancouver, BC	> 69.0	-	-
24-Aug-04	*Atherinops affinis*	Growth	Grab	EVS Consultants North Vancouver, BC	> 71.0	-	-
16-Jul-05	*Atherinops affinis*	Growth	Grab	EVS Consultants North Vancouver, BC	> 71.4	-	-
6-Aug-05	*Atherinops affinis*	Growth	Grab	EVS Consultants North Vancouver, BC	> 67.4	-	-
16-Jul-10	*Atherinops affinis*	Growth	Grab	Nautilus Environmental, Burnaby, BC	> 100		
Topsmelt (*Atherinops affinis*) 7-d Growth and Survival Toxicity Test - Survival Endpoint					**LC50 (% effluent) for survival endpoint only**		
19-Aug-03	*Atherinops affinis*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 72.3	-	-
7-Jul-04	*Atherinops affinis*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 72.6	-	-
27-Jul-04	*Atherinops affinis*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 69.0	-	-
24-Aug-04	*Atherinops affinis*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 71.0	-	-
16-Jul-05	*Atherinops affinis*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 71.4	-	-
6-Aug-05	*Atherinops affinis*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 67.4	-	-
16-Jul-10	*Atherinops affinis*	Survival	Grab	Nautilus Environmental, Burnaby, BC	> 100		
Sandollar Echinoderm (*Dendraster excentricus*) 92-h Echinoderm Fertilization Test							
19-Aug-03	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	3.8	1.1	7.2
27-Jul-04	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	8.7	7.6	9.9
24-Aug-04	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	17.5	11.6	22.6
16-Jul-05	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	5.2	4.4	6.0
6-Aug-05	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	15.6	13.6	18.3
16-Jul-10	*Dendraster excentricus*	Reproduction	Grab	Nautilus Environmental, Burnaby, BC	66.6	42.6	83.1
Red Algae (*Champia parvula*) 7-d Sublethal Algal Toxicity Test							
19-Aug-03	*Champia parvula*	Reproduction	Grab	Saskatchewan Research Council (SRC), Saskatoon, SK	13.6	9.0	16.0
27-Jul-04	*Champia parvula*	Reproduction	Grab	SRC, Saskatoon, SK	26.6	20.8	31.5
24-Aug-04	*Champia parvula*	Reproduction	Grab	SRC, Saskatoon, SK	45.3	36.3	58.1
16-Jul-05	*Champia parvula*	Reproduction	Grab	Stantec Inc, Guelph,ON	24.6	22.2	27.2
6-Aug-05	*Champia parvula*	Reproduction	Grab	SRC, Saskatoon, SK	45.3	27.5	52.4
Red Algae (*Champia parvula*) 48-hr Sexual Reproduction Test							
23-Aug-10	*Champia parvula*	Reproduction	Grab	Nautilus Environmental, Burnaby, BC	41.1	37.3	43.9