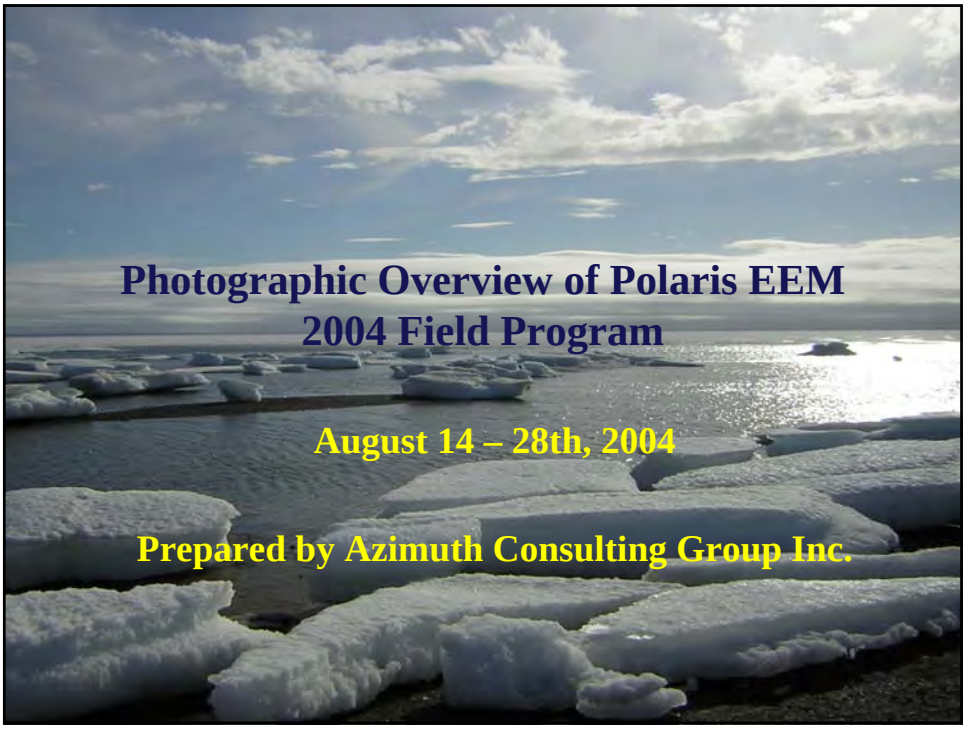
APPENDIX C

PHOTOGRAPHIC OVERVIEW OF POLARIS EEM
2004 FIELD PROGRAM (AZIMUTH, 2004b)



Photographic Overview of Polaris EEM 2004 Field Program

August 14 – 28th, 2004

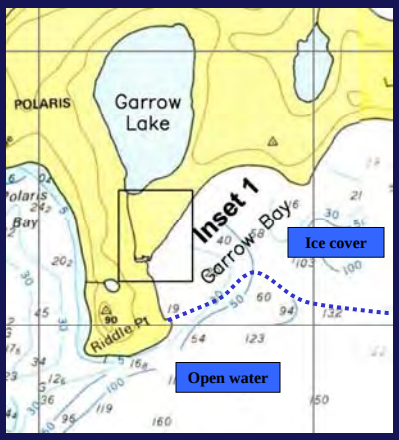
Prepared by Azimuth Consulting Group Inc.

Polaris EEM – 2004 Field Program Highlights

- Six field crew and all equipment arrived at mine site on August 14th.
- Garrow Bay sampling areas inaccessible from shore or by boat due to large ice floes covering entire bay and most of offshore Pullen Strait.
- Diving equipment, compressor, two boats, and beach camp operational within two days of arrival to ensure readiness in the event that ice conditions changed.
- Conducted survey of fish habitat near former dock area using seabed imaging and mapping system (SIMS) on August 16th and 19th. This work fulfilled mine closure requirements by Fisheries and Oceans Canada.
- Conducted additional underwater survey of former dock area using divers on August 20th.
- Documented ice conditions on Garrow Bay throughout duration of the two-week field program – overall the bay remained completely inaccessible due to ice conditions.
- Weekly verbal updates were provided to Sandra Blenkinsopp (Environment Canada).

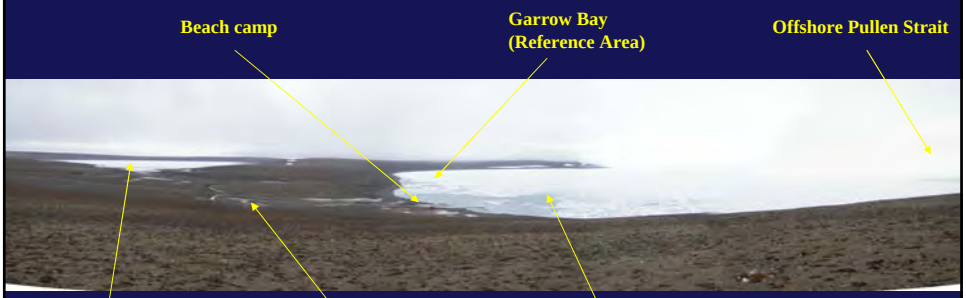
Polaris EEM – Overview of Study Design for Biological Monitoring Studies (including overlay of ice conditions during field program)

Study Area



Inset 1

Polaris EEM Field 2004 Photos – Panorama (Aug 16)



Polaris EEM Field 2004 Photos

Garrow Bay		Offshore Pullen Strait
	Aug 14	
	Aug 15	

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay		Offshore Pullen Strait
	Aug 16	
	Aug 17	

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay (Reference Area) Aug 17

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay **Offshore Pullen Strait**

Aug 18

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 19

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 20

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 21

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 22

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 22 (late afternoon)

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 23

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 23

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Offshore Pullen Strait

Aug 24

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 24

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay (Reference Area) Aug 24

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Offshore Pullen Strait

Aug 25

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 25

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 26

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 26

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Offshore Pullen Strait

Aug 27

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 27

Polaris EEM Field 2004 Photos – Panorama (Aug 27)

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 28

Bruce J. Donald
Reclamation Manager

August 8, 2005

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Sir;

Re: Polaris Mine – 2005 2nd Quarter Metal Mining Effluent Regulations Report

Please find attached the Metal Mining Effluent Report for the Polaris Mine for the 2nd Quarter of 2005. Flow initiated at the end of June (approximately June 25th, 2005), thus only one sample was collected during the 2nd quarter. This first MMER routine monitoring sample was collected on Wednesday June 29, 2005. All MMER routine parameters, plus additional EEM water quality parameters were analyzed on this sample. However, only the final discharge point (i.e., Garrow Creek station) was accessible at this time due to ice conditions in Garrow Bay precluding sample collection from the receiving and reference stations. An oversight by the ALS lab resulted in mercury, nitrate, and alkalinity analysis being conducted slightly after the holding times. A written explanation of this oversight is attached as APPENDIX E. Concentrations of all deleterious substances were well within Schedule 4 limits.

While a toxicity program (acute and sublethal) was considered for this event, EVS and Stantec laboratories were not able to accommodate sample receiving or testing at this time, due to the statutory holiday (i.e., Friday July 1, 2005). Toxicity sample shipment to meet holding times would also have been problematic due to the holiday. Thus, toxicity testing was attempted at the earliest possible timing, which was in July, and will be discussed in the 3rd quarter report.

2005 2nd quarter MMER regulatory data has been submitted electronically through the online RISS system, on August 8, 2005. I will forward a paper copy of this report by mail. Please contact me if there are any questions related to enclosed information.

Yours truly,
Original signed by B Donald

Bruce Donald

Attachments: 2nd Quarterly Monitoring Report

cc:

Walter Kuit (Teck Cominco Limited)
Randy Baker (Azimuth Consulting Group)
Cheryl Mackintosh (Azimuth Consulting Group)

POLARIS MINE – MMER MONITORING REPORT

2nd QUARTER 2005

APPENDIX A (96-hour Rainbow Trout Toxicity Test)

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test

APPENDIX B (72-hour Daphnia Magna Toxicity Test)

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test

APPENDIX C (Mass Loadings)

i. Concentration & monthly mean concentrations of each deleterious substance of Schedule 4
ii. pH of the effluents samples as required by subsection 12(1)
iii. Description of sample collection method
iv. Total volume of effluent deposited during each month of the quarter as per section 19
v. Mass loading of the deleterious substances set out in Schedule 4 and as per section 20

APPENDIX D (Effluent Characterization Results)

i. Results of the effluent characterization as per paragraph 4(1) of Schedule 5

APPENDIX E (Letter regarding monthly parameter holding times)

i. Letter from ALS Environmental

APPENDIX A

96-h Acute Rainbow Trout Toxicity Test

Reporting Requirements for Reference Method EPS 1/RM/13

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - No sampling conducted as effluent discharge began in the final days of June, and the EVS laboratory could not accommodate testing due to the July 1 statutory holiday. The statutory holiday also precluded sample shipment within toxicity testing holding times. Testing was conducted at the next possible time, which was July and will be discussed in the 3rd quarter report.

iii. Type of sample
   - No toxicity sampling conducted, see ii.

iv. Brief description of sampling point
   - Discharge point of siphon at Garrow Lake dam

v. Sampling method
   - No toxicity sampling conducted, see ii.

vi. Name of person submitting samples
   - No toxicity sampling conducted, see ii.

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - No testing conducted during the quarter

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations to report as there was no testing conducted during the quarter

iii. Name and city of testing laboratory
   - No laboratory used during the quarter

iv. Percent mortality of fish in stock tank(s)
   - None to report. There were no tests conducted during the period

v. Species of test organism
   - None to report as there were no tests conducted during the period

vi. Date and time for start of definitive test
   - None to report as there were no tests conducted during the period

vii. Person(s) performing the test and verifying the results
   - No tests performed during the quarter

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - No data to report as there were no tests conducted during the period

ix. Confirmation that no adjustment of sample or solution pH occurred
   - No adjustment to report as there were no tests conducted during the period

x. Indication of aeration of test solutions before introduction of fish
   - None to report as there were no tests conducted during the period

xi. Concentrations and volumes tested
   - No data to report as there were no tests conducted during the period

xii. Measurements of dissolved oxygen, pH and temperature
   - No data to report as there were no tests conducted during the period

xiii. Number of fish added to each test vessel
   - No fish added as there were no tests conducted during the period

xiv. Mean and range of fork length of control fish at end of test
   - No data to report as there were no tests conducted during the period

xv. Mean wet weight of individual control fish at end of the test
   - No data to report as there were no tests conducted during the period

Reporting Requirements for Reference Method EPS 1/RM/13

xvi. Estimated loading density of fish in test solutions
- No data to report as there were no tests conducted during the period

Section 8.1.3 Results

i. Number of mortalities of fish in each test solution
- None to report. No tests conducted during the period

ii. Number of control fish showing atypical/stressed behaviour
- None to report. No tests conducted.

iii. Mean mortality rate in solutions of effluent and control water
- None to report. No tests conducted

iv. Estimate of 96-h LC50 in multi-concentration tests
- No data to report. No tests conducted

v. Most recent 96-h LC50 for reference toxicity test(s)
- No data to report. No tests conducted

APPENDIX B

72-h Acute *Daphnia magna* Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - No sampling conducted as effluent discharge began in the final days of June, and the EVS laboratory could not accommodate testing due to the July 1 statutory holiday. The statutory holiday also precluded sample shipment within toxicity testing holding times. Testing was conducted at the next possible time, which was July and will be discussed in the 3rd quarter report.

iii. Type of sample
   - No toxicity sampling conducted, see ii.

iv. Brief description of sampling point
   - Discharge point of siphon at Garrow Lake dam

v. Sampling method
   - No toxicity sampling conducted, see ii.

vi. Name of person submitting samples
   - No toxicity sampling conducted, see ii.

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - No testing conducted during the quarter

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations to report as there was no testing conducted during the quarter

iii. Name and city of testing laboratory
   - No laboratory used during the quarter

iv. Species of test organism
   - None to report as there were no tests conducted during the period

v. Date and time for start of definitive test
   - None to report as there were no tests conducted during the period

vi. Person(s) performing the test and verifying the results
   - No tests performed during the quarter

vii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - No data to report as there were no tests conducted during the period

viii. Confirmation that no adjustment of sample or solution pH occurred
   - No adjustment to report as there were no tests conducted during the period

ix. Indication of any adjustment of hardness of effluent sample
   - No adjustment to report as there were no tests conducted during the period

x. Indication of any aeration of sample
   - No indication to report as there were no tests conducted during the period

xi. Concentrations and volumes tested
   - No data to report as there were no tests conducted during the period

xii. Measurements of dissolved oxygen, pH and temperature
   - No data to report as there were no tests conducted during the period

xiii. Estimates of time to first brood, average number of neonates per brood, and percent mortality during the seven-day period prior to the test
   - No data to report as there were no tests conducted during the period

xiv. Number of neonates per test vessel and milliliters of solution per daphnid
   - No data to report as there were no tests conducted during the period

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

Section 8.1.3 Results

i. Number of dead and/or immobile daphnids in each test solution including controls
   - No data to report. No tests conducted during the period.

ii. For single-concentration test the number of daphnids dead in each of three replicate effluent solutions and in each of three replicate control solutions at end of test. Also report the mean value.
   - No data to report. No tests conducted during the period.

iii. Estimate of 48-h LC50 and 95% confidence limits in multi-concentration tests, 48-h EC50 for immobilization and 95% confidence limits, indication of statistical method on which results are based.
   - No data to report. No tests conducted during the period

iv. Most recent 48-h LC50 for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC50 and warning limits.
   - No data to report. No tests conducted during the period.

APPENDIX C

Effluent Metals Concentrations and Loadings

2005 2nd QUARTER MMER REPORT

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	pH[1]	Collection Method
3-Apr-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
10-Apr-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
17-Apr-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
24-Apr-05	nd[3]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
1-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
8-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
15-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
22-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
29-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
5-Jun-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
12-Jun-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
19-Jun-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
26-Jun-05	29-Jun-05	*0.00020*	*0.00050*	*0.0050*	0.00037	0.00075	0.0137	*3.0*	*0.0050*	7.98	Grab

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "nd" refers to no effluent discharge to sample

MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[3] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
April/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
May/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
June/05	0.0002	0.0005	0.005	0.000368	0.000754	0.0137	3	0.005

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note [2] - "nd" refers to no effluent discharge to sample

Note[3] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
3-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
10-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
17-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
24-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
1-May-05	nd[2]	0	0	0	0	0	0	0	0	0
8-May-05	nd[2]	0	0	0	0	0	0	0	0	0
15-May-05	nd[2]	0	0	0	0	0	0	0	0	0
22-May-05	nd[2]	0	0	0	0	0	0	0	0	0
29-May-05	nd[2]	0	0	0	0	0	0	0	0	0
5-Jun-05	nd[2]	0	0	0	0	0	0	0	0	0
12-Jun-05	nd[2]	0	0	0	0	0	0	0	0	0
19-Jun-05	nd[2]	0	0	0	0	0	0	0	0	0
26-Jun-05	29-Jun-05	0.002	0.005	0.048	0.004	0.007	0.133	29.030	0.048	9,677

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note [2] - "nd" refers to no effluent discharge to sample

MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
April/05	-	-	-	-	-	-	-	-	-	-
May/05	-	-	-	-	-	-	-	-	-	-
June/05	0.015	0.036	0.363	0.027	0.055	0.994	217.728	0.363	16,934	58,061

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the week of June 26, 2005 x 6 days of flow

APPENDIX D

Results of Effluent Characterization

RESULTS OF EFFLUENT CHARACTERIZATION

AS PER PARAGRAPH 4(1) in Schedule 5

The final discharge point on Garrow creek began to thaw and flow on approximately June 25, 2005. An MMER routine monitoring sample was collected at the first opportunity, which was on Wednesday June 29, 2005. For this sample, the suite of routine weekly parameters plus additional quarterly EEM parameters were analyzed. EEM effluent characterization parameters for this sample are presented in Table 1. Due to an oversight by ALS, mercury, nitrate and alkalinity were analyzed slightly after the holding times (see attached letter in Appendix E). At this time, only the effluent station (i.e., Garrow Creek) was accessible due to unsafe ice conditions in Garrow Bay, which precluded collection of receiving (exposure) or reference water samples.

While a toxicity program (both sublethal and acute) was considered for this event, the labs were not able to accommodate sample receiving and testing at this time, due to the statutory holiday (i.e., Friday July 1, 2005). Shipment during the holiday would also have been problematic and would have resulted in missed holding times for the samples. Thus, a toxicity program (acute and sublethal) was attempted at the first suitable time, which was in July. This program and the results will be discussed in the 3rd quarter report.

Concentrations of deleterious substances in effluent water from the June 29, 2005 sample were all below Schedule 4 limits. Zinc is the primary contaminant of potential concern (COPC) identified in mine effluent and was only slightly above BC Ambient Water Quality Guidelines (BC AWQG) of 10µg/L in the effluent sample collected on June 29, 2005 (i.e., concentration was 13.7µg/L), and well below the MMER effluent limit of 500µg/L.

Appendix D - Table 1. Effluent Characterization Results - June 29, 2005.

Facility Name	FDP Name	Effluent Characterization Date	Sample Method	Hardness	Alkalinity	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Ammonia	Nitrate
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	6/29/2005	Grab	132	30.7	< 0.1	0.000035	0.024	< 0.00001	< 0.005	0.089	0.0382

Notes:
Only the effluent sample was collected during this event, as the receiving (exposure) and reference stations were frozen. No toxicity samples were collected as the labs (EVS and Stantec) could not receive samples and accommodate testing at this time due to the July 1 holiday, followed by the weekend. Holding times for Hg, alkalinity and nitrate were slightly exceeded due to an oversight by the lab (ALS). A letter explaining this oversight is presented in Appendix E.

APPENDIX E

Letter from ALS Regarding Monthly Parameter Holding Times

2005 POLARIS MINE MMER 3RD QUARTER REPORT

Bruce J. Donald
Reclamation Manager

November 10, 2005

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB, T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Peter Blackall;

Re: Polaris Mine 2005 3rd Quarter MMER Report

Please find attached the Metal Mining Effluent Regulation (MMER) Report for Polaris Mine for the 3rd Quarter of 2005. As Polaris is a remote mine and operations on the site have ceased, collection of MMER and Environmental Effects Monitoring (EEM) data for this year was conducted by small field crews stationed onsite for the first part of the season, and then by flying scientists/ technicians to site on a weekly basis for the latter part of the season. Field crews were onsite when flow initiated in Garrow Creek on approximately June 25, 2005. Flow continued through July and August, and Garrow Creek was observed to be frozen on September 13, 2005.

The MMER effluent characterization monitoring, bioassay testing, and environmental effects monitoring were conducted throughout the quarter. Due to the short season of flow, two sets of acute and sublethal toxicity tests were conducted within the quarter on July 16 and August 9, 2005, corresponding to the dates of EEM quarterly water quality monitoring samples collected at effluent, exposure and reference stations. A quarterly effluent sample plus acute and sublethal toxicity samples were also collected on July 6, 2005, but due to fog conditions at the mine, the toxicity samples did not make it to the labs within holding times are were discarded. The effluent sample was analyzed for the MMER and EEM parameters. No exposure or reference samples were collected on July 6, 2005, since Garrow Bay was still ice-covered.

MMER water quality monitoring was conducted on a weekly basis throughout most of the season. Between August 20 – 23 and after August 27, 2005, access to the site was not possible due to weather conditions. Ken Russell and Jenny Ferone were informed of failed sampling attempts and were updated with weather and safety conditions at the site on a regular basis. On September 13, 2005, a quarterly event with acute toxicity testing was planned. However, upon arrival onsite, it was observed that Garrow Creek (final discharge point) was frozen. A chronology of the 2005 sampling season is presented in Appendix I.

There were no exceedances of MMER Schedule 4 Limits for the 2005 season, and there was no acute toxicity in Rainbow trout and *Daphnia* tests. Holding times for nitrate and alkalinity were exceeded in the July 6, 2005 sample due to an oversight by the ALS lab. This situation is explained in a letter from ALS provided in Appendix J, and is not likely to influence the results.

The following information is included in our 2005 3rd Quarter MMER Report:

- Table 1a – Concentrations Of Effluent For MMER Schedule 4 Sampled Weekly
- Table 1b – Monthly Mean Concentrations Of Effluent For MMER Schedule 4
- Table 1c – Mass Loading Of Deleterious Substance For Each Day Sampled
- Table 1d – Mass Loading Per Calendar Month For Each Deleterious Substance
- Table 2 – Results of Acute Lethality Tests and Daphnia Magna Monitoring Tests
- Table 3 – Effluent Characterization Water Quality Results (studies conducted under Part 1, Section 4) (Effluent Characterization) (Table 3, Table 5)
- Table 4 – Water Quality Monitoring in Exposure and Reference Stations (Results of studies conducted under Part 1, Section 7)
- Table 5 – QAQC of Effluent and Water Quality Data

Additional Appendices

- Appendix A – Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test
- Appendix B – Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test
- Appendix C – 7-d Topsmelt Growth and Survival Sublethal Toxicity Test
- Appendix D – 92-h Echinoderm Fertilization Sublethal Toxicity Test
- Appendix E – 7-d Sublethal Champia (Algae) Sublethal Toxicity Test
- Appendix F – Results of Effluent Characterization, as per Paragraph 15(1)(a)
- Appendix G – Acute Toxicity Testing Reports
- Appendix H – Sublethal Toxicity Testing Reports
- Appendix I – Polaris 2005 Sampling Event Chronology
- Appendix J – Letter from ALS explaining missed holding times of alkalinity and nitrate for July 6,2005 sample

The MMER and EEM data required to be reported in electronic format were submitted electronically through the RISS online system on November 10 2005. In addition to this hardcopy report, an electronic pdf version of this report is being emailed to you (e-mailed November 10, 2005).

If you have any questions regarding the annual report or aspects of the application of the MMER to the Polaris Mine, please feel free to contact me.

Yours truly,

Original signed by B. Donald
Bruce Donald

Attachments: 2005 3rd Quarter Regulatory Data Tables
cc: Randy Baker (Azimuth Consulting Group)
Ken Russell (Environment Canada)
Jenny Ferone (Environment Canada)

Polaris Mine 2005 3rd Quarter MMER Report

Prepared for

Environment Canada, Prairie & Northern Region
Room 200, 4999 98th Ave.
Edmonton, AB, T6B 2X3

November 10, 2005

Teck Cominco
Bag 2000
Kimberley, BC, Canada
V1A 3E1

2005 3rd QUARTER MMER REPORT

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

Table 1a. CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	pH[1]	Collection Method
3-Jul-05	6-Jul-05	*0.00020*	0.00024	*0.0050*	0.00017	0.00060	0.0127	4	0.0050	7.49	Grab
10-Jul-05	13-Jul-05	*0.00020*	0.00061	*0.0050*	0.00230	0.00088	0.0205	*3.0*	*0.0050*	7.48	Grab
10-Jul-05	16-Jul-05	*0.00020*	0.00042	0.0444	0.00042	0.00081	0.0179	*3.0*	0.0090	7.59	Grab
17-Jul-05	23-Jul-05	*0.00020*	0.00047	*0.0050*	0.00024	0.00105	0.0325	*3.0*	*0.0050*	7.56	Grab
24-Jul-05	30-Jul-05	0.00021	0.00050	*0.0050*	0.00020	0.00141	0.0405	*3.0*	*0.0050*	7.70	Grab
31-Jul-05	6-Aug-05	*0.00020*	0.00052	*0.0050*	0.00047	0.00166	0.0356	*3.0*	*0.0050*	7.65	Grab
7-Aug-05	13-Aug-05	*0.00020*	0.00052	*0.0050*	0.00111	0.00149	0.0310	*3.0*	0.0080	7.79	Grab
14-Aug-05	24-Aug-05[3]	*0.00020*	0.00101	*0.0050*	0.00093	0.00474	0.0905	4.8	0.0090	8.13	Grab
21-Aug-05	27-Aug-05	*0.00020*	0.00079	*0.0050*	0.00076	0.00356	0.0680	3.7	0.0100	7.92	Grab
28-Aug-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
4-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
11-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
18-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
25-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "nd" refers to no effluent discharge to sample

Note [3] - due to weather conditions samples could not be collected the week of August 14th, two sets were collected the following week.

Concentrations in italicized font are less than the detection limit shown.

Table 1b. MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[3] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
July/04	0.0002	0.00045	0.0129	0.00066	0.00095	0.0248	3	0.0058
August/04	0.0002	0.00071	0.00500	0.00082	0.00286	0.0563	3.6	0.0080
September/04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note [2] - "nd" refers to no effluent discharge to sample

Note[3] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

Table 1c. MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)[4]
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
3-Jul-05	6-Jul-05	0.002	0.002	0.042	0.001	0.005	0.108	34	42,353	8,471
10-Jul-05	13-Jul-05	0.001	0.002	0.018	0.008	0.003	0.075	11	18,178	3,636
10-Jul-05	16-Jul-05	0.001	0.001	0.148	0.001	0.003	0.060	10	30,086	3,343
17-Jul-05	23-Jul-05	0.001	0.003	0.027	0.001	0.006	0.177	16	27,214	5,443
24-Jul-05	30-Jul-05	0.000	0.001	0.011	0.000	0.003	0.092	7	11,299	2,260
31-Jul-05	6-Aug-05	0.001	0.003	0.034	0.003	0.011	0.240	20	33,734	6,747
7-Aug-05	13-Aug-05	0.002	0.006	0.056	0.012	0.017	0.348	34	89,872	11,234
14-Aug-05	24-Aug-05[3]	0.004	0.018	0.089	0.017	0.084	1.604	85	159,501	17,722
21-Aug-05	27-Aug-05	0.003	0.010	0.063	0.010	0.045	0.856	47	125,830	12,583
28-Aug-05	nd[2]	0	0	0	0	0	0	0	0	0
4-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0
11-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0
18-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0
25-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note [2] - "nd" refers to no effluent discharge to sample

Note [3] - August 24 data are presented in the week of the August 14th

Note [4] - Discharge for August 6 is an estimate pending verification by Teck Cominco.

Table 1d. MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
July/04	0.03	0.06	1.53	0.08	0.12	3.16	483.14	800,602	32,412	143,540
August/04	0.07	0.29	1.87	0.32	1.21	23.62	1,438.14	3,169,267	84,501	374,218
September/04	0	0	0	0	0	0	0	0	0	0

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the month x days in month

Table 2

RESULTS OF ACUTE LETHALITY TESTS AND
DAPHNIA MAGNA MONITORING TESTS

Date Sample Collected	Effluent Acutely Lethal to Rainbow Trout (yes or no)	Effluent Acutely Lethal to *Daphnia magna* (yes or no)
16-Jul-05	No	No
6-Aug-05	No	No

Non-compliance Information

If effluent was non-compliant with the aurthorized limits set out in Schedule4, indicate the cause(s) of non-compliance and remedial measures planned or implemented. Also indicate remedial meaures planned or implemented in response to the failure of acute lethality tests.

There were no non-compliant concentrations, and no failed acute lethality toxicity tests during 2005 3rd Quarter for Polaris Mine.

Table 3. 2005 3rd Quarter Polaris Mine Effluent Characterization Results (Part 1, Section 4)

Effluent Characterization from Final Discharge Point - Garrow Lake Former Dam / Syphons
Northing: 75°22'32"
Easting: 96°48'37"

Facility Name:	Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)					
FDP Name:	Garrow Lake Syphons					
Sample ID:	G Creek	G-Creek	G-Creek			
Sampling Date:	6-Jul-05	16-Jul-05	6-Aug-05			
Sample Method:	Grab	Grab	Grab			
Parameter	**Units**				***Detection Limit***	**Methods[1]**
Hardness	mg/L	149	184	375	*0.54 - 5.4*	Calculation - EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity, Total	mg/L	28.1	29.2	52.5	*2.0*	Colourimetry - APHA Method 2320 (potentiometric titration)
Aluminum, Total	mg/L	<0.20	0.0085	<0.20	*0.001 - 0.2*	ICPMS[3]
Cadmium, Total	mg/L	0.000034	0.000044	0.000097	*0.000020*	SPR-IDA[2], ICPMS[3]
Iron, Total	mg/L	0.012	0.043	0.014	*0.010*	SPR-IDA[2], ICPMS[3]
Mercury, Total	mg/L	<0.000010	<0.000010	<0.000010	*0.000010*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum, Total	mg/L	<0.0050	<0.0050	<0.0050	*0.0050*	ICPMS[3]
Ammonia Nitrogen	mg/L	0.036	0.037	<0.020	*0.020*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate Nitrogen	mg/L	0.032	<0.050	0.072	*0.025 - 0.050*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic, Total	mg/L	<0.00020	<0.00020	<0.00020	*0.00020*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper, Total	mg/L	0.000240	0.000424	0.000516	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Cyanide, Total	mg/L	<0.0050	0.0444	<0.0050	*0.0050*	Colourimetry - APHA Method 4500-CN (cynate hydrolosis using an ammonia selective electrode
Lead, Total	mg/L	0.000166	0.000415	0.000467	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Nickel, Total	mg/L	0.000601	0.000807	0.00166	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Zinc, Total	mg/L	0.0127	0.0179	0.0356	*0.00050*	Chelation SPR-IDA[2], ICPMS[3]
Total Suspended Solids	mg/L	4.0	<3.0	<3.0	*3.0*	Gravimetry - APHA Method 2540 (filtration through glass fibre filter)
Radium-226 (a)	Bq/L	0.0050	0.009	<0.0050	*0.0050*	Radio Chemistry[5]
pH	pH units	7.49	7.59	7.65	*0.010*	APHA Method 4500-H (pH electrode meter)

Notes:

< = Less than the detection limit indicated.

(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.

[1]Original data reports are available upon request

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

Table 4. 2005 3rd Quarter Polaris Mine Water Quality Monitoring Results (Part 1, Section 7)

Station:		Exposure Area		Reference Area			
Description:		Garrow Bay at Mouth of Garrow Creek Confluence		Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek).			
Northing:		75°22'15"		75°22'40"			
Easting:		96°48'30"		96°47'12"			
Facility Name:		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)			
FDP Name:		Garrow Lake Syphons		Garrow Lake Syphons			
Area Name:		Garrow Bay Exposure		Garrow Bay Reference			
Sample ID:		G-BAY	G-Bay (b)	T-BAY REF	Ref		
Sampling Date:		16-Jul-05	6-Aug-05	16-Jul-05	6-Aug-05		
Sample Method:		Grab	Grab	Grab	Grab		
Parameters	**Units**					***Detection Limit***	**Methods[1]**
Hardness	mg/L	215	385	271	840	*0.54-5.4*	Calculation - EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity, Total	mg/L	44.2	63.2	23.0	53.5	*2.0*	Colourimetry - APHA Method 2320 (potentiometric titration)
Aluminum, Total	mg/L	0.0519	<0.10	0.0619	<0.10	*0.001-0.2*	ICPMS[3]
Cadmium, Total	mg/L	0.000051	0.000081	<0.000020	<0.000020	*0.000020*	SPR-IDA[2], ICPMS[3]
Iron, Total	mg/L	0.207	0.015	0.217	0.011	*0.010*	SPR-IDA[2], ICPMS[3]
Mercury, Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	*0.000010*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	*0.0050*	ICPMS[3]
Ammonia Nitrogen	mg/L	0.048	<0.020	<0.020	<0.020	*0.020*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate Nitrogen	mg/L	<0.050	0.092	<0.050	0.0261	*0.025*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic, Total	mg/L	<0.00020	<0.00020	0.00050	0.00024	*0.00020*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper, Total	mg/L	0.000748	0.000608	0.000563	0.000305	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	*0.0050*	Colourimetry - APHA Method 4500-CN (cynate hydrolosis using an ammonia selective electrode
Lead, Total	mg/L	0.00147	0.000517	0.000690	0.000078	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Nickel, Total	mg/L	0.00126	0.00188	0.000554	0.000412	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Zinc, Total	mg/L	0.0154	0.0224	0.00323	0.00122	*0.00050*	Chelation SPR-IDA[2], ICPMS[3]
Total Suspended Solids	mg/L	16.7	<3.0	<3.0	<3.0	*3.0*	Gravimetry - APHA Method 2540 (filtration through glass fibre filter)
Radium-226 (a,b)	Bq/L	0.010	n/a	<0.0050	<0.0050	*0.0050*	Radio Chemistry[5]
pH	pH units	7.64	7.96	7.40	7.89	*0.010*	APHA Method 4500-H (pH electrode meter)
Water Temperature[6]	°C	0.2	0.6	-0.1	0.2	*n/a*	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85
Dissolved Oxygen[6]	mg/L	13.2	11.6	15.2	13.9	*n/a*	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85

Notes

The Garrow Bay exposure area (mouth of the creek), and Garrow Bay reference area were frozen during the July 6, 2005 sampling event.

< = Less than the detection limit indicated.

(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.

(b) n/a for August 6, 2005 sample = not available, the sample was lost during analysis by SRC with no additional sample remaining to repeat the analysis.

[1]Original data reports are available upon request

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

[6]Temperature and dissolved oxygen data are estimated pending verification by Teck Cominco.

Table 5. 2005 3rd Quarter Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Duplicate	Original Sample		Field Duplicate	Original Sample	
Sample ID:		Dup	G Creek		DUP	G-Creek		Dup	Ref	
Location:		Garrow Lake Syphons			Garrow Lake Syphons			Garrow Bay Reference		
Description:		Final Discharge Point		RPD[2]	Final Discharge Point		RPD[2]	~1km NE of confluence with Garrow Creek		RPD[2]
Sampling Date:		6-Jul-05		(%)	16-Jul-05		(%)	6-Aug-05		(%)
Parameters	**Parameter Units**									
Hardness	mg/L	140	149	6.0	187	184	1.6	852	840	1.4
Alkalinity, Total	mg/L	28.0	28.1	0.4	29.0	29.2	0.7	53.8	53.5	0.6
Aluminum, Total	mg/L	<0.10	<0.20	n/a	0.0087	0.0085	2.4	<0.10	<0.10	n/a
Cadmium, Total	mg/L	0.000040	0.000034	17.6	0.000049	0.000044	11.4	<0.000020	<0.000020	n/a
Iron, Total	mg/L	0.013	0.012	8.3	0.043	0.043	0.0	0.011	0.011	0.0
Mercury, Total	mg/L	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum, Total	mg/L	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Ammonia Nitrogen	mg/L	0.032	0.036	11.1	0.044	0.037	18.9	<0.020	<0.020	n/a
Nitrate Nitrogen	mg/L	0.028	0.032	12.5	<0.050	<0.050	n/a	0.0348	0.0261	33.3
Arsenic, Total	mg/L	0.00021	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	0.00024	n/a
Copper, Total	mg/L	0.000295	0.000240	22.9	0.000376	0.000424	11.3	0.000321	0.000305	5.2
Cyanide, Total	mg/L	<0.0050	<0.0050	n/a	0.0058	0.0444	86.9	<0.0050	<0.0050	n/a
Lead, Total	mg/L	0.000241	0.000166	45.2	0.000409	0.000415	1.4	0.000062	0.000078	20.5
Nickel, Total	mg/L	0.000673	0.000601	12.0	0.000819	0.000807	1.5	0.000460	0.000412	11.7
Zinc, Total	mg/L	0.0136	0.0127	7.1	0.0185	0.0179	3.4	0.00165	0.00122	35.2
Total Suspended Solids	mg/L	<3.0	4.0	n/a	<3.0	<3.0	n/a	<3.0	<3.0	n/a
Radium-226 (a,b)	Bq/L	<0.0050	0.0050	n/a	<0.0050	0.009	n/a	0.0060	<0.0050	n/a
pH	pH units	7.62	7.49	1.7	7.58	7.59	0.1	7.80	7.89	1.1
Salinity	o/oo	<1.0	<1.0	n/a	<1.0	<1.0	n/a	4.6	4.6	0.0
Calcium, Total	mg/L	16.5	19.1	13.6	21.4	21.1	1.4	58.1	57.6	0.9
Magnesium, Total	mg/L	24.0	24.6	2.4	32.3	31.9	1.3	172	169	1.8

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller, stored for 1 year in jerry cans onsite.

[4]Commercial distilled water transported to mine site.

QAQC Results

A total of 3 duplicate samples and 5 blank samples were collected during the 2005 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of cyanide on July 16, 2005. Cyanide is not used in the process and is typically measured at less than the detection limit. With the exception of the aforementioned cyanide measurement, which is questionable, the data generally indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples from the on-site distilled water that had been stored indicated relatively high levels of zinc, copper, and lead. This contamination was considered to be a result of the storage procedure and metal leaching from the metal jerry cans that the water was stored in for the year. The transport blanks using commmercial distilled water indicated low concentrations of all paramters (i.e., typically less than, or slightly higher than detection limits), which reveals no background contamination issues with the analysis.

Table 5. 2005 3rd Quarter Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Blank	Field Blank	Field Blank	ALS Travel Blank	ALS Travel Blank
Sample ID:						
Location:		n/a	n/a	n/a	n/a	n/a
Description:		Distilled Water[3]	Distilled Water[3]	Distilled Water[3]	Distilled Water[4]	Distilled Water[5]
Sampling Date:		6-Jul-05	16-Jul-05	6-Aug-05	24-Aug-05	24-Aug-05
	Parameter					
Parameters	**Units**					
Hardness	mg/L	3.07	<0.54	0.85	<0.50	<0.50
Alkalinity, Total	mg/L	3.2	<2.0	<2.0	<2.0	<2.0
Aluminum, Total	mg/L	<0.0010	<0.0050	<0.10	<0.0010	<0.0010
Cadmium, Total	mg/L	<0.000050	<0.000020	<0.000050	<0.000020	<0.000050
Iron, Total	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury, Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum, Total	mg/L	<0.000050	<0.0050	<0.0050	<0.000050	<0.000050
Ammonia Nitrogen	mg/L	<0.020	<0.020	<0.020	-	-
Nitrate Nitrogen	mg/L	<0.0050	<0.0050	<0.0050	-	-
Arsenic, Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Copper, Total	mg/L	0.00484	0.00167	0.0244	<0.000050	<0.00010
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	-	-
Lead, Total	mg/L	0.00212	0.00607	0.0445	<0.000050	<0.000050
Nickel, Total	mg/L	<0.00010	<0.000050	<0.00050	<0.000050	<0.00010
Zinc, Total	mg/L	0.0080	0.00440	0.0040	<0.00050	<0.0010
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	<3.0	<3.0
Radium-226 (a,b)	Bq/L	<0.0050	<0.0050	<0.0050	-	-
pH	pH units	6.27	5.59	6.17	5.51	5.53
Salinity	o/oo	<1.0	<1.0	<1.0	<1.0	<1.0
Calcium, Total	mg/L	1.23	0.084	0.341	<0.050	<0.050
Magnesium, Total	mg/L	<0.10	<0.10	<0.10	<0.050	<0.050

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APPENDIX A

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test

APPENDIX B

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test

APPENDIX C

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPAW 95-EPA West Coast: 7-day Topsmelt Survival and Growth Tests.

APPENDIX D

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPS 1/Rm/27-EC: 92 hr Echinoderm (sand dollar) Fertilization Test

APPENDIX E

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPA/600/4-91-003, Method 1009.0: Algae (*Champia parvula*) 7-day Sublethal Growth Tests

APPENDIX F

i. Results of Effluent Characterization, as per Paragraph 15(1)(a)

APPENDIX G

ii. Acute toxicity testing laboratory reports

APPENDIX H

i. Sublethal toxicity testing laboratory reports

APPENDIX I

i. Polaris 2005 Sampling Event Chronology

APPENDIX J

i. Letter from ALS explaining missed holding times for July 6, 2005 sample

APPENDIX A

96-h Acute Rainbow Trout Toxicity Test

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for monthly acute toxicity testing were collected
   - Test 1: Saturday July 16, 2005 – 0900h
   - Test 2: Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method

- Water was collected from at least 15cm below the surface using a water pump with silicon tubing
- Water was collected from the upstream direction
- The pump was flushed with site water for at least one minute prior to sample collection
- 2 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Test 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Acute_071605
   - Test 2 – Garrow Creek

viii. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

ix. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - 96-hour Rainbow Trout LC_{50}

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations from requirements

iii. Name and city of testing laboratory

- EVS Environment Consultants, North Vancouver, BC

iv. Source of test species
   - Sun Valley

v. Percent mortality of fish in stock tank(s)
   - Test 1: 0.1%
   - Test 2: 0.1%

vi. Species of test organism
   - Rainbow Trout (*Oncorhynchus mykiss*)

vii. Date and time for start of definitive test
   - Test 1: July 21, 2005 – 1035h
   - Test 2: August 11, 2005 – 1500h

viii. Person(s) performing the test and verifying the results

- Test 1: Marriah Grey, Robert Harrison, Julianna Kalocai
- Test 2: Anja Fouche, Robert Harrison, Julianna Kalocai

ix. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
- Test 1: pH - 7.3, T - 15.0 °C, DO - 10.4 mg/L, C – 1445 µmhos/cm
- Test 2: pH - 7.4, T - 15.0 °C, DO - 10.1 mg/L, C – 2510 µmhos/cm

x. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment

xi. Indication of aeration of test solutions before introduction of fish
- Test 1: 6.5 ± 1 mL/min/L for 30mins
- Test 2: 6.5 ± 1 mL/min/L for 30mins

xii. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (0%) - 10 L (test 1&2)
- 6.25% - 10 L (test 1&2)
- 12.5% - 10 L (test 1&2)
- 25% - 10 L (test 1&2)
- 50% - 10 L (test 1&2)
- 100% - 10 L (test 1&2)

xiii. Measurements of dissolved oxygen, pH and temperature

Sample Collection Date	Test Concentration (% v/v)	Temperature (0hr) (°C)	Temperture (48 hr) (°C)	Dissolved Oxygen (0hr) (mg/L)	Dissolved Oxygen (48hr) (mg/L)	pH (0hr) pH units	pH (48hr) pH units	Conductivity (0hr) umhos/cm
Test 1	0 (Control)	15	15	10.1	9.7	7	6.7	37
16-Jul-05	6.25	15	15	10.1	9.5	7.1	6.8	194
	12.5	15	15	10.1	9.8	7.1	6.8	301
	25	15	15	10.1	9.8	7.1	6.8	418
	50	15	15	10.1	9.8	7.2	6.9	775
	100	15	15	10.2	9.8	7.3	7	1445
Test 2	0 (Control)	15	15	10.1	9.3	7	7	40
19-Aug-05	6.25	15	15	10.1	9.4	7	7	323
	12.5	15	15	10.1	9.4	7	7.1	535
	25	15	15	10.1	9.6	7	7.1	827
	50	15	15	10.1	9.6	7.2	7.2	1373
	100	15	15	10.1	9.7	7.4	7.3	2510

xiv. Number of fish added to each test vessel
- 10 fish/ 10 L vessel (Test 1 & 2)

xv. Mean and range of fork length of control fish at end of test
- Test 1: 30 mm (25 – 33)
- Test 2: 31 mm (27 – 35)

xvi. Mean wet weight of individual control fish at end of the test
- Test 1: 0.29 g (0.20 – 0.37)
- Test 2: 0.33 g (0.22 – 0.46)

xvii. Estimated loading density of fish in test solutions
- Test 1: 0.29 g/L
- Test 2: 0.33 g/L

Section 8.1.3 Results

i. Number of mortalities of fish in each test solution
   - Results were the same for Test 1, and Test 2, except where noted
   - Control (0%) - 0
   - 6.25% - 0
   - 12.5% - 0
   - 25% - 0
   - 50% - 0
   - 100% - 0

ii. Number of control fish showing atypical/stressed behaviour
   - None in Test 1 or Test 2

iii. Mean mortality rate in solutions of effluent and control water
   - Results were the same for Test 1 and Test 2
   - Control (0%) - 0%
   - 6.25% - 0%
   - 12.5% - 0%
   - 25% - 0%
   - 50% - 0%
   - 100% - 0%

iv. Estimate of 96-h LC50 in multi-concentration tests
   - Results were the same for Test 1 and Test 2
   - 96hr LC_{50} concentration > 100% effluent

v. Most recent 96-h LC50 for reference toxicity test(s)
   - Reference toxicity tests for Toxicant: SDS
   - Test 1 & 2: (Jul-12-03) 96-h LC_{50} = 24mg/L SDS, 95% CL = 18-32mg/L

vi. Reference toxicant warning limits (mean +/- 2SD)
   - Reference toxicity tests for Toxicant: SDS
   - Test 1 & 2: 96-h LC_{50} = 29 +/- 12 mg/L SDS

APPENDIX B

72-h Acute *Daphnia magna* Toxicity Test

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for monthly acute toxicity testing were collected
   - Test 1: Saturday July 16, 2005 – 0900h
   - Test 2: Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 2 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Test 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Acute_071605
   - Test 2 – Garrow Creek

viii. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

ix. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Section 8.1.2 Test Facilities and Conditions

ii. Test type & method
   - 48-hour *Daphnia magna* LC_{50}

iii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations from requirements

iv. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

v. Species of test organism
   - *Daphnia magna*

vi. Date and time for start of definitive test
   - Test 1: July 19, 2005 – 1600h
   - Test 2: August 11, 2005 – 1030h

vii. Person(s) performing the test and verifying the results
   - Test 1: Shiva Behnia, Julianna Kalocai
   - Test 2: Shiva Behnia, Julianna Kalocai

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - Test 1: pH - 7.3, T – 21.0 °C, DO - 10.8 mg/L, C – 1566 µmhos/cm
   - Test 2: pH - 7.5, T - 21.0 °C, DO - 10.8 mg/L, C – 2850 µmhos/cm

ix. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment

x. Indication of any adjustment of hardness of effluent sample
- Test 1: No hardness adjustment (initial hardness = 160 mg/L)
- Test 2: No hardness adjustment (initial hardness = 300 mg/L)

xi. Indication of any aeration of sample
- Test 1: 25-50 mL/min/L for 12mins
- Test 2: 25-50 mL/min/L for 15mins

xii. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used for both Test 1 and Test 2 were:
- Control (0%) - 200 mL
- 6.25% - 200 mL
- 12.5% - 200 mL
- 25% - 200 mL
- 50% - 200 mL
- 100% - 200 mL

xiii. Measurements of dissolved oxygen, pH and temperature

Sample Collection Date	Test Concentration (% v/v)	Temperature (0hr) (°C)	Temperture (48 hr) (°C)	Dissolved Oxygen (0hr) (mg/L)	Dissolved Oxygen (48hr) (mg/L)	pH (0hr) pH units	pH (48hr) pH units	Conductivity (0hr) umhos/cm	Hardness (0hr) (mg/L)
Test 1	0 (Control)	20	21	9.1	8.7	7.6	7.6	344	94
16-Jul-05	6.25	20	21	9.1	8.7	7.6	7.6	426	
	12.5	20	21.5	9	8.7	7.6	7.7	505	
	25	20.5	21.5	9	8.7	7.6	7.7	648	
	50	20.5	21	9	8.7	7.4	7.7	954	
	100	21	21.5	8.9	8.7	7.4	7.5	1566	160
Test 2	0 (Control)	20	21	9.1	8.6	7.4	7.6	354	94
19-Aug-05	6.25	20	21	9	8.5	7.4	7.7	505	
	12.5	20.5	21	9	8.5	7.5	7.7	654	
	25	20.5	21	8.9	8.5	7.5	7.7	990	
	50	21	21	8.9	8.5	7.5	7.6	1582	
	100	21	21	8.9	8.5	7.6	7.6	2850	300

xiv. Estimates of time to first brood, average number of neonates per brood, and percent mortality during the seven-day period prior to the test
- Test 1: 8 days to brood, >34 neonates/brood, 0% mortality in 7d prior to test
- Test 2: 7 days to brood, >29 neonates/brood, 0% mortality in 7d prior to test

xv. Number of neonates per test vessel and milliliters of solution per daphnid
- Methods for all tests and dilution series were the same:
- 10 neonates per vessel
- 200 mL of solution per vessel
- 20 mL of solution per daphnid

Section 8.1.3 Results

i. Number of dead and/or immobile daphnids in each test solution including controls
   - Results were the same for Test 1 and Test 2
   - Control (0%) - 0 dead / immobile
   - 6.25% - 0 dead / immobile
   - 12.5% - 0 dead / immobile
   - 25% - 0 dead / immobile
   - 50% - 0 dead / immobile
   - 100% - 0 dead / immobile

ii. For single-concentration test the number of daphnids dead in each of three replicate effluent solutions and in each of three replicate control solutions at end of test. Also report the mean value.
   - Single concentration test was not conducted, dilution series tests were conducted

iii. Estimate of 48-h LC50 and 95% confidence limits in multi-concentration tests, 48-h EC50 for immobilization and 95% confidence limits, indication of statistical method on which results are based.
   - Test 1: 48-h LC_{50} = > 100% effluent
   - Test 2: 48-h LC_{50} = > 100% effluent

iv. Most recent 48-h LC50 for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC50 and warning limits.
   - Reference toxicity tests for Toxicant: Zinc
   - Test 1: (Jul-19-05) 96-h LC_{50} = 426µg/L Zinc, 95% CL = 362 – 504 µg/L
   - Test 2: (Aug-15-05) 96-h LC_{50} = 481µg/L Zinc, 95% CL = 388 – 597 µg/L

v. Reference toxicant warning limits (mean +/- 2 SD)
   - Reference toxicity tests for Toxicant: Zinc
   - Test 1: 96-h LC_{50} = 445 (+/- 280) µg/L Zinc
   - Test 2: 96-h LC_{50} = 445 (+/- 280) µg/L Zinc

APPENDIX C

7-d Topsmelt Growth and Survival Toxicity Test

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75^{o} 22' 32" N, 97^{o} 48' 37" W.

ii. Date & time of sampling
   - Samples for sublethal toxicity testing were collected:
     Test 1 – Saturday July 16, 2005 – 0900h
     Test 2 – Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water from final discharge point

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 3 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Tests 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Sublethal_071605
   - Test 2 – Garrow Creek

viii. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

ix. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Test Organisms Imported from External Supplier

i. Species of test organism
   - Topsmelt (*Atherinops affinis*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Aquatic Bio Systems (ABS), Fort Collins, Colorado

iv. Date test species acquired on
   - Test 1 – July 19, 2005
   - Test 2 – August 9, 2005

v. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

vi. Percent mortality of fish in 24-hour period preceding the test
   - Test 1 - <10% mortality in approximately 450 fish upon receipt
   - Test 2 - <10% mortality in approximately 450 fish upon receipt

vii. Age at start of test
   - Test 1 – 10 days post-hatch
   - Test 2 – 10 days post-hatch

viii. Unusual appearance, behaviour, or treatment of larvae before their use in the test
- Nothing unusual noted for any test

ix. Confirmation that larvae are actively feeding and swimbladders are not inflated
- All tests - Larvae actively feeding and swimbladders not inflated

x. Confirmation that temperature change was <3°C and dissolved oxygen was maintained at >6mg/L during transport
- Temperature change was <2°C and dissolved oxygen supersaturated mg/L during transport

xi. Test organism acclimation rate at the testing laboratory
- For both tests: Organisms were received on the day of set-up
- Organisms were received in holding water conditions of DO=supersaturated, pH = 7.3, T = 21°C, salinity = 33ppt
- Organisms were acclimated to EVS water holding conditions of DO = 7.5 mg/L, pH = 7.8, T=20°C salinity = 28-29ppt,
- Acclimation was conducted in the lab on the day of the test by adding lab seawater at approximately 30 min. intervals. The differences between the water quality upon receipt and EVS holding conditions were minor.

Test Facilities and Conditions

i. Test type & method
- 7-day Topsmelt (*Atherinops affinis*) Survival and Growth Toxicity Test
- Static renewal
- Sample water was renewed daily
- Reference Method - EPA/600/R-95/136 (EPAW 95-EPA West Coast)

ii. Dates or test days during test when subsamples or multiple samples were renewed
- Samples were renewed daily for all tests (Test Day 1,2,3,4,5,6)
- Three subsamples were used on days i) 0-1; ii) 2-3; and iii) 4-5-6-7

iii. Indications of deviations from requirements in Sections 11 of Method EPA/600/R-95/136 (EPAW 95-EPA West Coast)
- No deviations from requirements
- Salinity controls were run
- Sample water salinity for
    - Test 1 was 6 ppt
    - Test 2 was 1.0 ppt

iv. Date and time for start of definitive test
- Test 1 Tuesday July 19, 2005 – 1430h
- Test 2 Tuesday August 9, 2005 – 1500h

v. Date for test completion
- Test 1 July 26, 2005
- Test 2 August 16, 2005

vi. Test vessel description
- For all tests was a 600mL beaker

vii. Person(s) performing the test and verifying the results
- Test 1: Testing and overall setup conducted by: Jenny Shao and QA/QC by: Julianna Kalokai
- Test 2: Testing and overall setup conducted by: Jenny Shao and QA/QC by: Julianna Kalokai

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
- Test 1: pH 7.7, T 20.0 °C, DO 11.1 mg/L, C 1520 µmhos/cm
- Test 2: pH 7.7, T 20.0 °C, DO 9.8 mg/L, C 2700 µmhos/cm

ix. Confirmation that no adjustment of sample or solution pH occurred
- For both tests, no pH adjustment

x. Indication of aeration of test solutions before introduction of fish
- For both tests, no pre-aeration was conducted, none was required

xi. Indication that EC guidance document for salinity adjustment was followed
- The following was done for all 3 tests:
    - No deviations from EC guidance document on preparation of hypersaline brine (HSB)
    - HSB prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
    - No deviations from EC guidance document for salinity adjustment of sample
    - HSB was added to samples to salinity adjust them to ~30ppt
    - For a 200mL volume the concentrations were prepared by adding:
        - Test 1: 143mL of effluent + 57mL of HSB for the highest concentration. This solution was then diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).
        - Test 2: 135mL of effluent + 65mL of HSB for the highest concentration. This solution was then diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).

xii. Type and source of control/dilution water
- For all 3 tests, control/dilution water was UV-sterilized, 0.45μm-filtered natural seawater from the Vancouver Aquarium

xiii. Concentrations and volumes tested:
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- For Test 1:
    - Control (0%) - 200 mL
    - Salinity Control (0%) - 200 mL
    - 4.5% - 200mL
    - 8.9% - 200mL
    - 17.9% - 200mL
    - 35.7% - 200mL
    - 71.4% - 200mL
- For Test 2:
    - Control (0%) - 200 mL
    - Salinity Control (0%) - 200 mL
    - 4.2% - 200mL
    - 8.4% - 200mL
    - 16.9% - 200mL
    - 33.7% - 200mL
    - 67.4% - 200mL

xiv. Number of replicated per concentration
- For both tests: 5 replicates per concentration

xv. Number of organisms added to each test vessel
- For both tests: 5 fish per vessel

xvi. Manner and rate of exchange of test solutions
- For both tests: Daily renewal

xvii. Measurements of dissolved oxygen, pH and temperature, and salinity for each 24 hr period

- Test 1: See attached photocopied pages 1 and 2 of original laboratory report
- Test 2: See attached photocopied pages 3 and 4 of original laboratory report

Results

i. Number and % of mortalities of fish in each test solution. Note that this data is presented in units of number of SURVIVORS and % MORTLITY. (Data is entered from original handwritten tables in lab reports)

- Test 1: Totals from all 5 replicates are presented:

Concentration		Number of Survivors - Day of Test							% Mortality on the Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Brine	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Control	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
4.5%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
8.9%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20
17.9%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
35.7%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
71.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0

- Test 2: Totals from all 5 replicates are presented:

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
	B	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20
Brine	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Control	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	E	5	5	4	4	4	4	3	0	0	20	0	0	0	20
4.2%	A	5	5	4	4	4	4	4	0	0	20	0	0	0	20
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	4	4	4	4	4	4	0	20	0	0	0	0	0
	E	5	4	4	4	4	4	4	0	20	0	0	0	0	0
8.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
16.9%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	4	4	4	4	4	0	0	20	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	4	4	4	4	3	0	0	20	0	0	0	20
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20
33.7%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	4	4	4	4	4	0	0	20	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
67.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	4	4	4	4	4	4	0	20	0	0	0	0	0
	C	5	5	5	5	5	5	3	0	0	0	0	0	0	40
	D	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20

ii. Average dry weight (mg) per original fish in test vessel. No preservation of fish was used. Fish were dried and then weighed.

- Test 1: Mean dry weight (mg) of each replicate and overall means are presented:

Concentration	Replicate					Overall Mean	Standard Deviation
(% effluent v/v)	1	2	3	4	5		
D-Control	0.9600	1.0480	0.7560	1.0100	0.8060	0.9160	0.1284
B-Control	1.0780	1.1300	1.0720	0.9420	0.6900	0.9824	0.1775
4.5	0.7320	0.6840	0.9000	0.5200	1.0080	0.7688	0.1903
8.9	1.0120	1.1320	0.9960	0.5400	0.3960	0.8152	0.3253
17.9	0.9600	1.0280	0.9220	1.2440	0.9020	1.0112	0.1387
35.7	0.8420	1.2900	1.2400	0.9640	0.9900	1.0652	0.1916
71.4	1.2300	0.6620	0.9660	1.1000	0.5680	0.9052	0.2828

- Test 2: Mean dry weight (mg) of each replicate are presented:

Concentration	Replicate						
(% effluent v/v)	1	2	3	4	5	Overall Mean	Standard Deviation
D-Control	0.8000	0.6080	1.0980	0.7760	0.5640	0.7692	0.2105
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620	0.9140	0.1155
4.2	0.8120	0.9280	0.9700	1.0420	0.5720	0.8648	0.1837
8.4	0.8980	0.8560	0.7120	1.0200	1.0200	0.9012	0.1285
16.9	0.9820	0.8880	0.6860	0.5780	0.6420	0.7552	0.1718
33.7	0.7260	0.9700	0.7060	0.6300	0.7240	0.7512	0.1284
67.4	1.0340	0.8380	0.6120	0.8640	0.7040	0.8104	0.1615

iii. Estimate of 7-d LC_{50} (95% CL)

- Test 1: 7-d LC_{50} concentration > 71.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d LC_{50} concentration > 67.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

iv. Estimate of 7-d IC_{25} (95% CL) for growth

- Test 1: 7-d IC_{25} concentration > 71.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d IC_{25} concentration > 67.4% effluent (highest concentration tested due to dilution for salinity adjustment)

v. Current reference toxicity tests (95% CL) for 7-d LC_{50} for survival and 7-d IC_{50} for growth

- Test 1 :Reference toxicity tests for Toxicant: Copper
    - Test conducted on July 19, 2005, same day as effluent test
    - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
    - 7-d LC_{50} survival = 117 mg/L Cu, 95% CL = 100-136 mg/L
    - 7-d IC_{50} growth = 116 mg/L Cu, 95% CL = 81-156 mg/L
- Test 2 :Reference toxicity tests for Toxicant: Copper
    - Test conducted on August 9, 2005, same day as effluent test
    - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
    - 7-d LC_{50} survival = 103 mg/L Cu, 95% CL = 91-118 mg/L
    - 7-d IC_{50} growth = 95 mg/L Cu, 95% CL = 75-127 mg/L

vi. Reference toxicity warning limits (+/- SD) for 7-d LC_{50} for survival and 7-d IC_{50} for growth

- Test 1: Reference toxicity tests for Toxicant: Copper
    - 7-d LC_{50} survival = 133 ± 39mg/L Cu
    - 7-d IC_{50} growth = 132 ± 46mg/L Cu
- Test 2: Reference toxicity tests for Toxicant: Copper
    - 7-d LC_{50} survival = 132 ± 40mg/L Cu,
    - 7-d IC_{50} growth = 133 ± 40mg/L Cu

APPENDIX D

92-h Echinoderm Fertilization Test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75^{o} 22' 32" N, 97^{o} 48' 37" W.

ii. Date & time of sampling
   - Samples for sublethal toxicity testing were collected:
     Test 1 – Saturday July 16, 2005 – 0900h
     Test 2 – Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Tests 1
   - Brenda Bolton (Gartner Lee) Test 2

x. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Sublethal_071605
   - Test 2 – Garrow Creek

xi. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

xii. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Test Organisms

i. Species of test organism
   - Sandollar Echinoid (*Dendraster excentricus*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Westwind Sealab, Victoria BC
   - All adults providing gametes are from the same population and source
   - Gametes are spawned in-house at EVS

iv. Date test species acquired on
   - Test 1: July 19, 2005
   - Test 2: August 9, 2005

v. Holding time and conditions for adults
   - Test 1: Adults received at the testing laboratory the day of the test.
   - Test 2: Adults received at the testing laboratory the day of the test.

vi. Indications of deviations from EC guidance on the importation of test organisms
   - Test 1: No deviations from EC requirements
   - Test 2: No deviations from EC requirements

vii. Weekly percent mortality of adults being held over 7d preceding test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- Test 1: <2% per day over the 7 days preceding the test
- Test 2: <2% per day over the 7 days preceding the test

viii. Age of test organisms
- Test 1: < 4 hours after spawning
- Test 3: < 4 hours after spawning

ix. Unusual appearance, behaviour, or treatment of adults or gametes before test start, or anything unusual about the test
- Test 1: Organisms appear healthy, in good condition, nothing unusual about test organisms or test
- Test 2: Organisms appear healthy, in good condition, nothing unusual about test organisms or test

Test Facilities and Conditions

i. Test type & method
- Echinoderm (*Dendraster excentricus*) Fertilization Toxicity Test
- Static
- Reference Method – EPS/1/RM/27 with 1997 amendments

ii. Test duration
- Test 1: 10:10 min (10min sperm + 10min sperm & egg)
- Test 2: 10:10 min (10min sperm + 10min sperm & egg)

iii. Date and time for start of definitive test
- Test 1: Tuesday July 19, 2005 – 1514h
- Test 2: Tuesday August 9, 2005 – 1723h

iv. Test vessel description
- Test 1: 16 x 125mm test tubes
- Test 2: 16 x 125mm test tubes

v. Person(s) performing the test and verifying the results
- Test 1: Testing by Shawn Seguin; QA/QC reviewed by Julianna Kalokai.
- Test 2: Testing by Shawn Seguin; QA/QC reviewed by Julianna Kalokai.

vi. Indication of rate and duration of pre-aeration of test solutions before initiation of test
- Test 1: No pre-aeration
- Test 2: No pre-aeration

vii. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment

viii. Procedure for sample filtration
- Test 1: No sample filtration
- Test 2: No sample filtration

ix. Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997

- Test 1: Hypersaline brine (HSB) was prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine). HSB was added to samples to salinity adjust them to 30ppt. For a 10mL volume the concentrations were prepared by adding 7.28mL of effluent + 2.72mL of HSB for the highest concentration. This solution was diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions). No deviations from EC guidance document (July 1997) for salinity adjustment of sample.
- Test 2: Hypersaline brine (HSB) was prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine). HSB was added to samples to salinity adjust them to 30ppt. For a 10mL volume the concentrations were prepared by adding 7.13mL of effluent + 2.87mL of HSB for

the highest concentration. This solution was diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions). No deviations from EC guidance document (July 1997) for salinity adjustment of sample.

x. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment
- Test 1: salinity adjusted from 3.0 to 28 ppt
- Test 2: salinity adjusted from 1.0 to 29 ppt

xi. Type and source of control/dilution water
- Test 1: UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium
- Test 2: UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xii. Concentrations and volumes tested
- Test 1: Concentrations (% effluent volume / total volume) tested and total volumes used were:
    - Control (0%) - 10mL
    - Salinity Control (0%) - 10mL
    - 4.6% - 10mL
    - 9.1% - 10mL
    - 18.2% - 10mL
    - 36.4% - 10mL
    - 72.8% - 10mL
- Test 2: Concentrations (% effluent volume / total volume) tested and total volumes used were:
    - Control (0%) - 10mL
    - Salinity Control (0%) - 10mL
    - 4.5% - 10mL
    - 8.9% - 10mL
    - 17.8% - 10mL
    - 35.6% - 10mL
    - 71.3% - 10mL

xiii. Number of replicated per concentration
- Test 1: 4 replicates per treatment concentration
- Test 2: 4 replicates per treatment concentration

xiv. Number of organisms per container
- Test 1: 2000 eggs per vessel (100 counted)
- Test 2: 2000 eggs per vessel (100 counted)

xv. Measurements of pH and dissolved oxygen in sample water before use
- Test 1: pH 8.2, DO 8.5
- Test 3: pH 8.3, DO 8.5

xvi. Measurements of pH, temperature, dissolved oxygen, and salinity during test
- Test 1: pH – 7.9 – 8.3, T - 15.0°C, DO - 8.5mg/L, salinity - 28ppt
- Test 2: pH – 7.5 – 8.4, T - 15.0°C, DO – 7.8 – 8.5mg/L, salinity - 29ppt

Results

i. Number and % of fertilized eggs in each test concentration
- Test 1: (Number is equal to percent since totals were 100)
    - Control (0%): # Fert = 64, 60, 66, 69
    - 4.6%: # Fert = 56, 51, 52, 53
    - 9.1%: # Fert = 39, 37, 37, 36
    - 18.2%: # Fert = 33, 28, 29, 30
    - 36.4%: # Fert = 39, 39, 37, 36

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- 72.8%: # Fert = 20, 16, 21, 21

- Test 2: (Number is equal to percent since totals were 100)
  - Control (0%): # Fert = 88, 81, 85, 86
  - Salinity Control: # Fert = 91, 86, 85, 87
  - 4.5%: # Fert = 82, 80, 79,78
  - 8.9%: # Fert = 76, 77, 77, 76
  - 17.8%: # Fert = 64, 59, 63, 61
  - 35.6%: # Fert = 50, 54, 54, 53
  - 71.3%: # Fert = 37, 40, 37,35

ii. Estimate of IC_{25} (95% CL) for fertilization success

- Test 1: IC_{25} concentration = 5.2 (4.4 – 6.0)% v/v effluent
- Test 2: IC_{25} concentration = 15.6 (13.6 – 18.3)% v/v effluent
- Quantitative statistic used to generate IC_{25} values was log-linear interpolation (200 resamples) calculated in ToxCalc v5.0.23 (for both Test 1 and Test 2)

iii. Current reference toxicity tests (95% CL) for IC_{50} for fertilization

- Test 1: Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on July 19, 2005, same day as effluent test
  - Reference test conducted under same conditions
  - IC_{50} for fertilization = 5.8 mg/L SDS, 95% CL = (5.2 – 6.5)mg/L
- Test 2: Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on August 9, 2005, same day as effluent test
  - Reference test conducted under same conditions
  - IC_{50} for fertilization = 3.9 mg/L SDS, 95% CL = (3.6 – 4.1) mg/L

iv. Reference toxicant warning limits (+/- 2SD) for IC_{50} for fertilization

- Test 1: 3.6 +/- 4.4 mg/L SDS
- Test 2: 3.9 +/- 4.3 mg/L SDS

APPENDIX E

7-d Sublethal *Champia* (Algae) Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Test 1 – Saturday July 16, 2005 – 0900h
     Test 2 – Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 1 x 4L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Tests 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Temperature of water upon receipt at lab
   - Test 1: 18°C
   - Test 2: 22°C

xiii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek Sublethal 071605
   - Test 2 – Garrow Creek

xiv. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1300h
     Test 2 – Tuesday August 9, 2005 – 0900h

Test Organisms

i. Species of test organism
   - Algae (*Champia parvula*)

ii. Name and city of testing laboratory
   - Test 1: Stantec Consulting Ltd, Guelph Ontario
   - Saskatchewan Research Council [SRC], Saskatoon, SK

iii. Source of test species and health of organisms
   - Test 1
     - Source was Stantec in-house culture
     - Batch number CH05-07
     - Sexually mature male and female branches
     - Females have trichogynes, males have sori with spermatia
     - No organisms exhibiting unusual appearance, behaviour or undergoing unusual treatment were used in the test
   - Test 2
     - Sexually mature male and female branches
     - Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995
     - Appear in excellent health, nothing unusual

- Females have trichogynes, males have sori with spermatia

iv. Any unusual appearance, behaviour, or treatment of test organisms, before their use in test
- Test 1 and Test 2
  - Nothing unusual about the appearance, behaviour, or treatment of test organisms, before their use in test; everything is normal
  - Nothing unusual about the tests

Test Facilities and Conditions

i. Test type & method
- Test 1:
- Test of Sexual Reproduction using the Red Macroalga *Champia parvula*, EPA-821-R-02-014, October 2002 Method 1009.0, with Canadian adaptations (Environment Canada 1998, 1999)
- Static, non-renewal
- 48-hour exposure, followed by 7 day recovery period for cystocarp development
- Test 2:
- Test of Sexual Reproduction using the Red Macroalga *Champia parvula*, Reference Method - EPA/600/4-91/003, Method 1009.0
- Static, non-renewal
- 2 day exposure, followed by 5-7 day recovery period for cystocarp development

ii. Date and time for start of definitive test
- Test 1: Tuesday July 19, 2005 17:45h
- Test 3: Tuesday August 9, 2005 – time not noted but lab notes state tests started within 72 hrs of collection

xviii. Date for test completion
- Test 1 – July 28, 2005
- Test 2 – August 16, 2005

iii. Test vessel description
- Test 1: 270mL transparent polystyrene cups with polystyrene lids
- Test 2: 270mL transparent polystyrene cups with polystyrene lids

iv. Person(s) performing the test and verifying the results
- Test 1: E. Jonczyk/ K. Johnson
- Tests 2: Mary Moody

v. Indication of pre-aeration of test solutions
- Test 1: No pre-aeration
- Test 2: No pre-aeration

vi. Confirmation that no pH adjustment of sample or solution occurred
- Test 1: No pH adjustment
- Test 2: - No pH adjustment

vii. Indication that EC guidance document for salinity adjustment was followed
- Test 1:
  - No deviations from EC guidance document on preparation of hypersaline brine (Environment Canada Salinity Adjustment Guidance Document, revised Dec. 2001)
  - HSB prepared from natural seawater at 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
  - No deviations from EC guidance document for salinity adjustment of sample
  - Salinity adjustment (for a 1000mL volume): 660mL effluent + 330mL HSB + 10mL test nutrient solution

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

- Salinity of samples adjusted from 0ppt to 32ppt
- Test 2:
  - No deviations from EC guidance document on preparation of hypersaline brine (May 2001)
  - HSB prepared from natural seawater at 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
  - No deviations from EC guidance document for salinity adjustment of sample
  - Salinity adjustment: 600mL effluent + 260mL HSB + 8.6 ml test nutrient solution

Salinity of samples adjusted from 2ppt to 30ppt

viii. Type and source of control/dilution water

- Test 1:
  - Natural seawater collected from Pointe-du-Chene in Shediac Bay, New Brunswick.
  - No chemicals added.
  - Filtered to 0.45μm prior to use
- Test 2
  - Natural seawater collected at the Pacific Environmental Center, Environment Canada, North Vancouver, BC
  - Filtered to 0.2μm and autoclaved prior to use
  - Salinity adjusted as per EC guidance document to 30ppt with HSB from the same source

ix. Type and quantity of any chemicals added to the control dilution water

- Test 1: No chemicals added to dilution water. 10 mL of test nutrients.
- Test 3: No chemicals added. Test nutrients as described in Test Method USEPA/600/4-91/003, Method 1009.0 were added at concentration of 10mL/L, analytical grade, 8.6 mL added

x. Concentrations and volumes of test solutions

- Concentrations (% effluent volume / total volume) tested and total volumes used were:

- Tests 1:
  - Control (Natural Seawater) (0%) - 100mL
  - Salinity Control Brine (0%) - 100mL
  - 2.1% - 100mL
  - 4.4% - 100mL
  - 8.3% - 100mL
  - 16.5% - 100mL
  - 33% - 100mL
  - 66% - 100mL
- Tests 2:
  - Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
  - Salinity Control Brine (0%) - 100mL, 4.5cm depth
  - 4.38% - 100mL, 4.5cm depth
  - 8.75% - 100mL, 4.5cm depth
  - 17.5% - 100mL, 4.5cm depth
  - 35% - 100mL, 4.5cm depth
  - 70% - 100mL, 4.5cm depth

xi. Number of replicates per concentration

- Tests 1& 2: 3 replicates per concentration

xii. Number of organisms per test chamber

- Tests 1 & 2: 5 female branches + 2 male branches per chamber

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

xiii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample before use
- Test 1 (unadjusted effluent): pH – 8.0, T – 22.0 °C, DO – 10.2mg/L, salinity - 0ppt
- Test 1 (before use): pH – 8.0, T – 22.5 °C, DO – 7.0mg/L, salinity - 32ppt
- Test 2 (unadjusted sample): pH - 7.75, T – 23.0 °C, DO – 8.6mg/L, salinity - 2ppt
- Test 2 (before use): pH – 8.35, T – 23.0 °C, DO – 7.6mg/L, salinity - 30ppt

xiv. Measurements of pH, temperature, dissolved oxygen, and salinity of test solution and controls at 0hr, 48hr, and the beginning and end of recovery period
- Test 1: See attached photocopied page 5 of original laboratory report
- Test 2: See attached photocopied pages 6 of original laboratory report

Results

i. Number and % mortality of female plants after recovery in each test solution
- Totals from all 3 replicates are presented:
- Test 1:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 2.1%: 0 (0%) mortality
  - 4.4%: 0 (0%) mortality
  - 8.3%: 0 (0%) mortality
  - 16.5%: 0 (0%) mortality
  - 33%: 0 (0%) mortality
  - 66%: 0 (0%) mortality
- Test 2:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 4.38%: 0 (0%) mortality
  - 8.75%: 0 (0%) mortality
  - 17.5%: 0 (0%) mortality
  - 35%: 0 (0%) mortality
  - 70%: 0 (0%) mortality

ii. Mean number of cystocarps per plant in each replicate of each test concentration
- Test 1: (Replicates are A, B, and C)
  - Control (0%): A) 26.8, B) 27.2, C) 26.4
  - Salinity Control (0%): A) 27.6, B) 27.4, C) 28.4
  - 2.1%: A) 29.4, B) 29.0, C) 30.0
  - 4.4%: A) 26.2, B) 26.8, C) 27.4
  - 8.3%: A) 27.6, B) 27.2, C) 28.0
  - 16.5%: A) 25.4, B) 26.4, C) 26.6
  - 33%: A) 18.4, B) 15.0, C) 18.4
  - 66%: A) 0.4, B) 0.2, C) 0.2
- Test 2: (Replicates are A, B, and C)
  - Control (0%): A) 104.0, B) 74.2, C) 79.6
  - Salinity Control (0%): A) 103.8, B) 84.6, C) 99.0
  - 4.38%: A) 89.8, B) 70.0, C) 82.6
  - 8.75%: A) 86.6, B) 98.4, C) 93.6
  - 17.5%: A) 95.6, B) 94.0, C) 88.4
  - 35%: A) 91.8, B) 88.8, C) 67.2
  - 70%: A) 35.0, B) 36.6, C) 28.4

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

iii. Estimate of IC_{25} (95% CL) for cystocarp development

- Test 1: IC_{25} concentration = 24.6 (22.2 – 27.2)% effluent v/v
- Quantal statistic method was linear interpolation determined using ToxStat 3.5
- Test 2: IC_{25} concentration = 45.3 (27.5 – 52.4)% effluent v/v
- Quantal statistic method was linear interpolation (200 resamples) determined using ToxCalc v5.0.23

iv. Current reference toxicity tests (95% CL) for IC_{50} for cystocarp development

- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test 1: Test conducted on July 19, 2005, same day as effluent test
    - Reference toxicant test was conducted under the same experimental conditions as the effluent test
    - IC_{50} cystocarp development = 0.134 mg/L SDS, 95% CL = (0.123 – 0.143) mg/L
  - Test 2: Test conducted on August 17, 2005, within 30 days of effluent test
    - Reference toxicant test was conducted under the same experimental conditions as the effluent test
    - IC_{50} cystocarp development = 1.31mg/L SDS, 95% CL = (1.20 - 1.41) mg/L

v. Reference toxicant warning limits (+/- 2SD) for IC_{50} for cystocarp development

- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test 1: 0.155 (0.112 – 0.216) mg/L SDS
- Test 2: 1.41 (1.15 – 1.74) mg/L SDS

Pages 1 to 6 inclusive are included in the hardcopy sent in the mail. This data can also be found in the original lab reports in Appendix H.

APPENDIX F

Results of Effluent Characterization as per Paragraph 15(1)(a)

RESULTS OF EFFLUENT CHARACTERIZATION

AS PER PARAGRAPH 15(1)(a)

Nine MMER effluent samples were collected during the 3rd Quarter of 2005 between July 6, 2005 and August 27, 2005. "Quarterly" EEM samples were collected from the effluent, exposure, and reference stations on July 16, 2005 and August 6, 2005 and analyzed for a wider suite of elements, as per the guidance document. Monthly loadings of metals to Garrow Bay were calculated based on average weekly discharge volumes from Garrow Lake to Garrow Bay via the creek outflow. The August 6, 2005 effluent volume discharge is estimated and will be finalized by Teck Cominco.

Holding times for nitrate and alkalinity were missed during the July 6, 2005 event due to an oversight by the laboratory. The oversight is explained in Appendix I and is not likely to influence results. A quarterly event with toxicity testing was planned for this event; however, due to a delay in shipment because of weather conditions at the mine site, toxicity samples missed holding times and were discarded at the labs. The parameters that missed holding times were "quarterly" parameters, and additional measurements were taken on July 16, 2005, corresponding to acute and sublethal toxicity testing.

Due to the high Arctic, remote location of the mine, travel into or out of the mine site can be hazardous due to weather conditions such as fog and snow. As the mine has ceased operations and little infrastructure exists onsite, sampling this season was conducted by small field crews stationed onsite, or by flying technicians in on a weekly basis to collect the MMER samples. In August and September, several planned MMER sampling attempts did not proceed due to hazardous weather conditions that prevented flights from getting into the mine site or from departing Resolute Bay. MMER samples were collected at the next possible time, and Ken Russell and Jenny Ferone were kept informed of this situation. The 2005 sampling chronology is presented in Appendix I. The last sample was collected on August 27, 2005. After this event, the mine was inaccessible due to weather until September 13, 2005, when Garrow Creek (final discharge point) was frozen with no discharge.

There were no exceedances of any Schedule 4 discharge limits during the quarter.

Water samples for acute and sublethal toxicity testing were collected using a pump system from about 20 m downstream of the historic dam location on Garrow Lake, within the main flow of the creek. Acute Lethality Testing was conducted on samples collected July 16, 2005 and August 6, 2005. There were no adverse effects observed for either the 96-hr Rainbow Trout toxicity test, or the 48-hr *Daphnia magna* toxicity test. LC_{50} values were >100% effluent for both species in all testing events.

Sublethal Toxicity Testing was conducted on samples collected July 16, 2005 and August 6, 2005. As this is considered a marine discharge, marine species were used for sublethal testing following brine adjustment of the brackish effluent (as per EC test protocols). Testing for fish (7-d Topsmelt growth and survival) and invertebrates (Sand dollar) was conducted at EVS Environment Consultants, Vancouver, BC, while algae (48-h *Champia*) testing was undertaken at Stantec Guelph, ON, for the July test, and at the Saskatchewan Research Council, Saskatoon SK, for the August test.

There were no effects observed in the Topsmelt Survival and Growth Test at the highest concentrations tested (>71.4%, and >67.4% effluent v/v).

Sublethal effects were observed for the echinoid and algal species in both tests. In the echinoid *(Dendraster excentricus)* fertilization test,

- the IC_{25}'s were 5.2, and 15.6% v/v, and
- the IC_{50}'s were 13.2, and 55% v/v

In the *Champia parvula* sexual reproduction test

- the IC_{25}'s were 24.6, and 45.3% v/v,
- the IC_{50} was 61.4% v/v in the second test (not reported in the first test).

Zinc is the primary contaminant of potential concern (COPC) identified in mine effluent. Concentrations of zinc during 2005 averaged 39 μg/L and ranged between 13 and 91 μg/L, which are well below the MMER effluent limit of 500μg/L. These concentrations are also lower than those measured in 2003, 128μg/L (range 48 – 186μg/L), and in 2004, 72 μg/L (range 35 – 198 μg/L), and show a decreasing pattern over the last three years. Note the CCME guideline for zinc is 30 μg/L and the BC AWQG guidelines are 7.5 and 33 μg/L, for the chronic and acute guidelines, respectively. Concentrations of zinc in Polaris mine effluent were not substantially higher than these guidelines in 2005.

On July 16, 2004 and August 6, 2005, the concentrations of zinc in the effluent were 17.9 and 35.6 μg/L, respectively. The echinoid test endpoints converted into concentrations of zinc results in values of 0.93 and 5.5 μg Zn/L for the IC_{25}'s, and 2.4 and 19.6 μg Zn/L for the IC_{50}. Reference toxicity tests of zinc on *Dendraster* fertilization give mean EC_{50} concentrations of 8.5 – 60 μg Zn/L (Dinnel et al. 1983). The reported range of *Dendratster* EC_{50}'s correspond to the August 6, 2005 IC_{50} of 19.6 μg Zn/L. The IC_{50} zinc concentration in the July 16, 2005 sample is lower than the literature EC_{50}'s and may indicate that other substances in the effluent were contributing to the sublethal effects in this sample. The echinoid test is quite sensitive to zinc, with IC25 (converted) zinc concentrations being less than the BC AWQG chronic guideline of 7.5 μg/L.

Endpoints for the *Champia* test in terms of zinc concentrations were 4.4 and 16.1 μg Zn/L (IC_{25}'s), and 21.9 μg Zn/L (IC_{50} in the August 6, 2005 sample). The reference IC_{25} endpoint for zinc in the *Champia* test performed in-house at SRC, reported in 2003, was 27 μg Zn/L (95% confidence limits 16-42μg/L). This reference concentration is similar to the zinc concentrations corresponding to the IC25 an IC50 in the August 6, 2005 sample. Like the echinoid results, the IC25 converted zinc concentration in the July 16, 2005 sample was lower than reference endpoints and may indicate that other substances in this sample were contributing to toxicity. *Champia* also appears to be sensitive to zinc concentrations between the BC AWQG chronic guideline of 7.5 μg/L and maximum guideline of 33 μg/L.

Given the similarity between zinc concentrations in the effluent samples and the effects concentrations of zinc in reference tests, it is likely that zinc is responsible for the sublethal effects observed in both the *Dendraster* and *Champia* tests.

Reference: Dinnel, P.A., Q.J. Stober, J.M. Link, M.W. Letourneau, W.E. Roberts, S.P. Felton, and R.E. Nakatan. 1983. Methodology and Validation of a Sperm Cell Toxicity Test for Testing Toxic Substances in Marine Waters. Final Report, FRI-UW-8306, Fisheries Research Inst., School of Fisheries, University of Washington, Seattle, WA :208. Source: EPA EcoTox database.

APPENDIX G

Acute Toxicity Testing Laboratory Reports

EVS environment consultants

A member of the Golder group of companies

Golder Associates

Golder Associates Ltd.

195 Pemberton Avenue
North Vancouver, British Columbia, Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

E/05/0336
04-1424-044

August 17, 2005

Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Attention: Ms. Cheryl Mackintosh

RE: WORK ORDERS: 0500296, 297
TOXICITY TEST RESULTS ON THE SAMPLES COLLECTED JULY 16, 2005

Dear Ms. Mackintosh

We are pleased to provide you with the results of the toxicity tests performed on the effluent sample identified as G-Creek-acute-071605 collected July 16, 2005. The sample was tested with the 48-h *Daphnia magna* and the 96-h rainbow trout LC50 toxicity tests. The tests were performed according to the Environment Canada protocol for conducting acute toxicity tests using *D. magna* (EPS 1/RM/14, Second Edition, 2000) and rainbow trout (EPS 1/RM/13, Second Edition, 2000). An independent EVS/Golder QA/QC review confirmed that all acceptability criteria specified by the protocol were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Yours very truly,
EVS ENVIRONMENT CONSULTANTS
A Member of the Golder Group of Companies

for Jennifer Young, B.Sc.
Bioassay Team Leader – Cladoceran Team

Verified By:

QA/QC Committee:
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.

Attachment: Table 1
RH/clz
O:\Data\Final\2004\1424\04-1424-044\LET 0817 2005 Tox Test WO 0500296 297 1.doc

Table 1
Toxicity Test Results

SAMPLE ID	SAMPLE DATE	48h *Daphnia magna* LC50 (95% CL) % (v/v)	96-h Rainbow Trout - LC50 (95% CL) % (v/v)
G-Creek-Acute-071605	July 16, 2005	>100	>100

CL – confidence limits.

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500297
EVS Analysts: SXB
Test Type: 48h LC50
Test Initiation Date: 19 July 05

SAMPLE INFORMATION

Identification: G-Creek-Acute-071605
Amount Received: 1x2L Subsampled from 1x20L RBT
Date Collected: 16 July 05
Date Received: July 19, 2005
Temperature (°C): 21.0
pH: 7.3 ① 7.4
Dissolved Oxygen (mg/L): 10.8 ① 8.9
Conductivity (µmhos/cm): 1566
Hardness (mg/L as $CaCO_3$): 160
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

pH adjustment details: —
① Pre-aeration rate and duration: 12 min @ 25-50 mL/min/L

DILUTION/CONTROL WATER (initial water quality)

Water Type: moderately Hard water (July13B)
Temperature (°C): 20.0
pH: 7.6
Dissolved Oxygen (mg/L): 9.1
Conductivity (µS/cm): 344
Hardness (mg/L as $CaCO_3$): 94
Alkalinity (mg/L as $CaCO_3$): 64
Other: —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture): 05 July A/B
Age (on Day 0): < 24hr
Days to First Brood: 8
Avg. Young/Brood (after 1st brood): 34
% Mortality in 7 d Before Test: 0
Reference Toxicant: Zinc
Current Reference Toxicant Result
Reference Toxicant Test Date: July 19, 2005
48-h LC50 and 95% CL: 426 (362-504) mg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
445 ± 280 mg/L Zn ; CV = 31

TEST CONDITIONS

Temperature Range (°C): 20.0 - 21.0
pH Range: 7.4 - 7.7
Dissolved Oxygen Range (mg/L): ~~5~~ 8.7 - 9.1
Conductivity Range (µS/cm): 344 - 1566
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200ml
Other: —

TEST RESULTS The 48hr LC50 of G-Creek-Acute-071605 is >100% (V/V).

Data Verified By: [signature]
Date Verified: Aug. 16/05

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client: Azimuth
Sample ID: G-Greek-Acute-071605
EVS Project No.: 04-1424-044
Date Collected: 16 July 05
EVS Work Order No.: 0500297
Test Initiation Date/Time: 19 July 05 @ 16:00
Daphnid Broodstock Batch: 05 July A/B
No. Organisms/Volume: 10/200 ml

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
Control				10	10	9.1	8.7	8.7	20.0	21.0	21.0	7.6	7.5	7.6	344	344
6.25				10	10	9.1	8.8	8.7	20.0	21.0	21.0	7.6	7.5	7.6	426	425
12.5				10	10	9.0	8.8	8.7	20.0	21.0	21.5	7.6	7.5	7.7	505	506
25				10	10	9.0	8.7	8.7	20.5	21.0	21.5	7.6	7.5	7.7 SK2	648	647
50				10	10	~~8.8~~ 9.0	8.7	8.7	20.5	21.0	21.0	7.4	7.5	7.7	958	944
100				10	10	8.9	8.7	8.7	21.0	21.0	21.5	7.4	7.4	7.5	1566	1532
Technician Initials					TL	SXB	SXB	TL	SXB	SXB	TL	SXB	SXB	TL	SXB	TL

Sample Description: clear - colourless
WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-020501 DO II-A-011201 Cond. IIA-990901
Comments:

Test Set Up By: SXB Data Verified By: [signature] Date Verified: Aug. 16/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: Azimuth
Golder ~~EVS~~ RGH Project No.: 04-1424-044
EVS Work Order No.: OS00296

EVS Analysts: MJG, RGH
Test Type: 96-h LC50
Test Initiation Date: July 21/05 @ 1035

SAMPLE
Identification: G-Creek 071605 Acute
Amount Received: 2 x 20L
Date Collected: July 16/05
Date Received: July 19/05
Other:

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 15
pH: 7.0
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 37
Hardness (mg/L as $CaCO_3$): 14
Alkalinity (mg/L as $CaCO_3$): 8
Other: -

TEST SPECIES INFORMATION
Source: Sun Valley
Collection Date/Batch: 062205
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: July 25/05
Fork Length (mm): 30 ± 3 (25-33)
Wet Weight (g): 0.29 ± 0.07 (0.20-0.37)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: July 12/05
Duration of Acclimation (days): 20
96-h LC50 (and 95% CL): 24 (18 and 32)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 mg/L SDS CV: 21%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.5 - 10.2
Temperature Range (°C): 15
pH Range: 6.7 - 7.3
Conductivity Range (µS/cm): 37 - 1463
Aeration Provided? (give rate): 6.5 ± 1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/10L
Loading Density (g/L): 0.29
Acclimation Before Testing (days): 29
Mortality In Previous Week of Acclimation (%): 0.1
Other: ✓

TEST RESULTS The 96-h LC50 is estimated to be > 100% (v/v)

Data Verified By: Ralph K
Date Verified: Aug. 4/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	15		15
pH	7.3		7.3
DO (mg/L)	10.4		10.2
Cond. (µS/cm)	1445		1445

1. Document pH adjustment procedure (if used) under "Comments".

Client: Azimuth
Golder ~~EVS~~ Project No.: 04-1424-044
EVS Work Order No.: 05002296
Trout Batch No. and 7-d Acclimation Mortality: 062205/0.5%
No. Fish/Volume: 10/10L
Sample ID: G-Creek 071605 Acute
Date/Time Collected: July 16/05 @ 0900
Test Initiation Date/Time: July 21/05 @ 1035

Total Pre-Aeration Time: 30 min

Concentration % (v/v)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
control				10	10	10	10	10.5	9.8	9.6	9.5	9.7	15	15	15	15	15	7.0	6.8	6.9	7.0	6.7	37	41
6.25				10	10	10	10	10.1	10.0	9.8	9.6	9.5	15	15	15	15	15	7.1	6.9	6.9	6.9	6.8	194	197
12.5				10	10	10	10	10.1	9.9	9.8	9.6	9.8	15	15	15	15	15	7.1	6.9	6.9	6.9	6.8	301	305
25				10	10	10	10	10.1	9.9	9.9	9.6	9.8	15	15	15	15	15	7.1	7.0	7.1	7.0	6.8	418	423
50				10	10	10	10	10.1	9.7	9.8	9.6	9.8	15	15	15	15	15	7.2	7.0	7.1	7.0	6.9	775	784
100				10	10	10	10	10.2	10.0	9.6	9.8	9.8	15	15	15	15	15	7.3	7.1	7.2	7.2	7.0	1445	1463
Technician Initials				ROA	TTL	TTL	ROA	ROA	ROA	TTL	TTL	ROA	ROA	ROA	TTL	TTL	ROA	ROA	ROA	TTL	TTL	ROA	ROA	ROA

WQ Instruments Used: Temperature calibrated Hg thermometer pH II-A-030302 DO II-A-3 Conductivity II-A-030363
Sample Description: clear
Comments:

Test Set Up By: ROA
Data Verified By: [signature]
Date Verified: Aug. 4/05

CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

Client Name: Teck Cominco | Client Contact Name: Bruce Donald | Ship to: BILL TO AZIMUTH CONSULTING GROUP.

Address: Bag 2000 | Phone: (250)427-8405

Kimberley, BC | Fax: (250)427-5451

V1A 3E1 | Sampled By: Blake Hamer | Attn: Edmond Canuia

Shipping Date: July 16/05

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested: 96-hr LC50 Rainbow Trout	48-hr LC50 Daphnia Magna	7-Day Toxicity Test	20 min. Echinoderm Fertilization			3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Receipt Sample Temp. (°C)	4 Condition/Integrity
For composite sample record date & time starting and ending																
16/07/05	0900	G-Creek_Acute_071605	E		G	2×20	P	X	X					Effluent Water		
16/07/05	0900	G-Creek_Sublethal_071605	E		G	3×20	P			X	X			Effluent Water		

EVS Receipt Check List - SAP

EVS Project #: 04-1424-00049

EVS Workorder #: 0500296/7/879

Sample Storage Location: 4°C [X] Chemical [ ] Other

Supporting documentation/other information attached if applicable:

1.	Signatures & dates correct?	Y N
2.	Chain-of-custody fully completed?	Y N
3.	Containers arrived in good condition (unbroken)?	Y N
4.	Container labels completed (i.e., dates, ID's)?	Y N
5.	Container labels agreed with custody papers?	Y N
6.	Sample receipt temperature within acceptable range?	Y N
7a.	Sediment testing going to be initiated within 14 days?	Y N
7b.	If no, are samples under Nitrogen? If not, why?	Y N
8.	Chain-of-custody generated upon receipt.	[ ]
9.	Sample containers originate from EVS.	[ ]

PO/Reference No.:

Project Title: Polaris MMER -

Results Needed By: Routine Turn Around.

Comments/Instructions: Bill to: Azimuth Consulting Group. Temp: 12.7 C

Electronic Results to: Cheryl Mackintosh, Azimuth, cmackintosh@azimuthgroup.ca

Bruce Donald, Teck Cominco, ~~bdonald~~ bruce.donald@teckcominco.com.

A) Released By: Blake Hamer Date: July 16, 2005

Company: GLL Time: 1030

Courier name:

Shipping containers secured by: ~~Tape~~ Straps Lock Other (circle one)

Custody seals used? Yes No

B) Received by: SAP Date: 19 July 05

Company: Golder Time: 10:45

Shipping containers received secure? Yes No

Custody seals intact? Yes No N/A

C) Released By: Date:

Company: Time:

Courier name:

Shipping containers secured by: Tape Straps Lock Other (circle one)

Custody seals used? Yes No

D) Received by: Date:

Company: Time:

Shipping containers received secure? Yes No

Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies: White, yellow, pink - accompany the shipment
Orange - retained by consignor (e.g., shipper)
Yellow - retained by consignee (e.g., receiver)
Pink - for use as needed
White - returned to consignor by consignee

EVS environment consultants
A member of the Golder group of companies

Golder Associates

Golder Associates Ltd.

195 Pemberton Avenue
North Vancouver, British Columbia, Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

E/05/0341
04-1424-044

August 31, 2005

Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Attention: Ms. Cheryl Mackintosh

RE: WORK ORDERS: 0500334, 335
TOXICITY TEST RESULTS ON THE SAMPLES COLLECTED AUGUST 6, 2005

Dear Ms. Mackintosh

We are pleased to provide you with the results of the toxicity tests performed on the effluent sample identified as Garrow Creek collected August 6, 2005. The sample was tested with the 48-h *Daphnia magna* and the 96-h rainbow trout LC50 toxicity tests. The tests were performed according to the Environment Canada protocol for conducting acute toxicity tests using *D. magna* (EPS 1/RM/14, Second Edition, 2000) and rainbow trout (EPS 1/RM/13, Second Edition, 2000). An independent EVS/Golder QA/QC review confirmed that all acceptability criteria specified by the protocol were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Yours very truly,
EVS ENVIRONMENT CONSULTANTS
A Member of the Golder Group of Companies

Jennifer Young, B.Sc.
Bioassay Team Leader – Cladoceran Team

Verified By:

QA/QC Committee:
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.

Attachment: Table 1
RH/clz
O:\Data\Final\2004\1424\04-1424-044\LET 0831 2005 Tox Test 0500334 335 .doc

Table 1
Toxicity Test Results

SAMPLE ID	SAMPLE DATE	48h *Daphnia magna* LC50 (95% CL) % (v/v)	96-h Rainbow Trout - LC50 (95% CL) % (v/v)
Garrow Creek	August 6, 2005	>100	>100

CL – confidence limits.

Toxicity testing was carried out in accordance with applicable test methodologies and/or standards of practice. Our liability is limited solely to the cost of re-testing in the event of non-compliance with such test specifications or standards of practice. Golder/EVS accepts no responsibility or liability for the interpretation or use of these testing results by others, nor for any delay, loss, damage or interruptions of testing, collection, preparation, and delivery of samples or test results resulting from events or circumstances beyond our control.

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group
EVS Analysts: SXB
EVS Project No.: 04-1424-044
Test Type: 48h LC50
EVS Work Order No.: 0500335
Test Initiation Date: 11 Aug 05

SAMPLE INFORMATION

Identification: Garrow Creek
Amount Received: 5x20L
Date Collected: 06 Aug 05
Date Received: 09 Aug 05
Temperature (°C): 21.0 → 21.0
pH: 7.5 → 7.6
pH adjustment details: none
Dissolved Oxygen (mg/L): 10.8 → 8.9
Pre-aeration rate and duration: 15 Min @ 25 to 50 ml/L/min
Conductivity (µmhos/cm): 2850
Hardness (mg/L as $CaCO_3$): ~~300~~
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

DILUTION/CONTROL WATER (initial water quality)

Water Type: Moderately Hard water (July 30)
Temperature (°C): 20.0
pH: 7.4
Dissolved Oxygen (mg/L): 9.1
Conductivity (µS/cm): 354
Hardness (mg/L as $CaCO_3$): ~~300~~ 94
Alkalinity (mg/L as $CaCO_3$): ~~of~~ 70
Other: —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture): 18 July A/B/C
Age (on Day 0): <24hr
Days to First Brood: 7.0
Avg. Young/Brood (after 1st brood): ~~7~~ 29
% Mortality in 7 d Before Test: 0
Reference Toxicant: ZinC
Current Reference Toxicant Result
Reference Toxicant Test Date: Aug 15, 2005
48-h LC50 and 95% CL: 481 (388 - 597) mg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
445 ± 280 mg/L Zn ; CV = 31

TEST CONDITIONS

Temperature Range (°C): 20.0-21.0
pH Range: 7.4 - 7.7
Dissolved Oxygen Range (mg/L): 8.5 - 9.1
Conductivity Range (µS/cm): 350 - 2850
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200ml
Other: —

TEST RESULTS The 48hr LC50 of Garrow Creek is >100% (v)

Data Verified By: Ralph
Date Verified: Aug. 31/05

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client: Azimuth Consulting Group
Sample ID: ~~6 Creek~~ Garrow Creek
EVS Project No.: 04-1424-044
Date Collected: 06 Aug 05
EVS Work Order No.: 0500335
Test Initiation Date/Time: 11 Aug 05 @ 10:30
Daphnid Broodstock Batch: 18 July A/B/C
No. Organisms/Volume: 10/200 ml

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
Control				10	10	9.1	8.9	8.6	20.0	21.0	21.0	7.4	7.7	7.6	354	350
6.25				10	10	9.0	8.8	8.5	20.0	21.0	21.0	7.4	7.7	7.7	505	508
12.5				10	10	9.0	8.8	8.5	20.5	21.0	21.0	7.5	7.7	7.7	654	667
25				10	10	8.9	8.8	8.5	20.5	21.0	21.0	7.5	7.7	7.7	990	992
50				10	10	8.9	8.7	8.5	20.5	21.0	21.0	7.5	7.7	7.6	1458	1593
100				10	10	8.9	8.7	8.5	21.0	21.0	21.0	7.6	7.7	7.6	2850	2766
Technician Initials				SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB

Sample Description: clear - colourless
WQ Instruments Used: Temp: Calibrated Hg Thermometer pH II-A-020501 DO II-A-011201 Cond. IIA-990901
Comments:

Test Set Up By: SXB Data Verified By: [signature] Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: Azimuth
EVS Project No.: 04-1424-044 (Golder Ref)
EVS Work Order No.: 0500334

EVS Analysts: AXF, RCH
Test Type: 96-h LC50
Test Initiation Date: Aug 11/05 @ 1500

SAMPLE
Identification: Garrow Creek
Amount Received: 5 + 20L
Date Collected: Aug 6/05
Date Received: Aug 9/05
Other: —

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 15
pH: 7.0
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 40
Hardness (mg/L as $CaCO_3$): 14
Alkalinity (mg/L as $CaCO_3$): 8
Other: —

TEST SPECIES INFORMATION
Source: Sun Valley
Collection Date/Batch: 062205
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: Aug 15/05
Fork Length (mm): 31 ± 3 (27 and 35)
Wet Weight (g): 0.33 ± 0.08 (0.22 and 0.46)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: July 12/05
Duration of Acclimation (days): 20
96-h LC50 (and 95% CL): 24 (18 and 32)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 mg/L SDS CV: 21%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.0 – 10.1
Temperature Range (°C): 15
pH Range: 6.8 – 7.4
Conductivity Range (µS/cm): 40 – 2850
Aeration Provided? (give rate): 6.5 ± 1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10 / 10L
Loading Density (g/L): 0.33
Acclimation Before Testing (days): 50
Mortality In Previous Week of Acclimation (%): 0.1
Other: —

TEST RESULTS: The 96-h LC50 is estimated to be > 100% (v/v)

Data Verified By: [signature]
Date Verified: Aug. 30/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	15		15
pH	7.4		7.4
DO (mg/L)	10.1		10.1
Cond. (µS/cm)	2510		2510

1. Document pH adjustment procedure (if used) under "Comments".

Golder

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 05003334
Trout Batch No. and 7-d Acclimation Mortality: 060205/0.1%
No. Fish/Volume: 10 / 10L
Sample ID: Garrow Creek
Date/Time Collected: Aug 6/05 @ 1100
Test Initiation Date/Time: Aug 11/05 @ 1500

Total Pre-Aeration Time: 30 min

Concentration % (v/v)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
control				10	10	10	10	10.1	9.2	9.4	10.0 ~~10~~ AXF	9.3	15	15	15	15	15	7.0	7.1	6.8	6.9	7.0	40	51
6.25				10	10	10	10	10.1	9.0	10.0	10.0 ~~10.2~~	9.4	15	15	15	15	15	7.0	7.1	6.9	7.0	7.0	323	349
12.5				10	10	10	10	10.1	9.2	10.0	10.0 ~~10.2~~	9.4	15	15	15	15	15	7.0	7.1	6.9	7.1	7.1	535	571
25				10	10	10	10	10.1	9.4	10.0	10.0 ~~10.2~~	9.6	15	15	15	15	15	7.0	7.1	6.9	7.1	7.1	827	864
50				10	10	10	10	10.1	9.4	10.1 ~~10.4~~ AXF	10.1 ~~10.3~~ AXF	9.6	15	15	15	15	15	7.2	7.2	7.0	7.1	7.2	1373	1431
100				10	10	10	10	10.1	9.8	10.1 ~~10.8~~ AXF ①	10.1 ~~10.5~~ AXF ①	9.7	15	15	15	15	15	7.4	7.3	7.0	7.1	7.3	2510	2850
Technician Initials				RAH	AXF	AXF	RAH	RAH	RAH	AXF ①	AXF ①	RAH	RAH	RAH	AXF	AXF	RAH	RAH	RAH	AXF	AXF	RAH	RAH	RAH

WQ Instruments Used: Temperature calibrated thermometre pH II-A-030302 DO II-A-3 Conductivity II-A-030304

Sample Description: clear

Comments: ① Re-calibrated D.O. meter

Test Set Up By: RAH Data Verified By: [signature] Date Verified: Aug. 30/05

CHAIN-OF-CUSTODY / TEST REQUEST FORM

SRS 0743

Client Name: Teck Cominco
Client Contact: Bruce Donald
Ship to:

Address: Box 2000
Kimberley BC
V1A 3G1
Phone: 250-427-5405
Fax: 250-427-2451
Sampled by: B. Patton
Attn.: Edmund Canavia
Shipping Date: Aug 6/05

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Sublethal toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00 am	Garrow Creek	E		G	1x20L		X					Client is actually Azimuth Consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Patton Date: Aug 6/05
Company: Gartner Lee Ltd. Time: 14:00 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder Laboratory upon sample receipt.

Golder Project No.: 0500327 / 328 / 334 / 33
Golder Work Order No.: 04-1424-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, Yellow – accompany the shipment
Pink – kept by consignor (e.g. shipper)
Yellow – kept by consignee (e.g. receiver)
White – returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

APPENDIX H

Sublethal Toxicity Testing Laboratory Reports

Stantec Consulting Ltd.
11B Nicholas Beaver Road RR3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

stantec.com

Stantec

Work Order : 207782
Sample Number : 13103

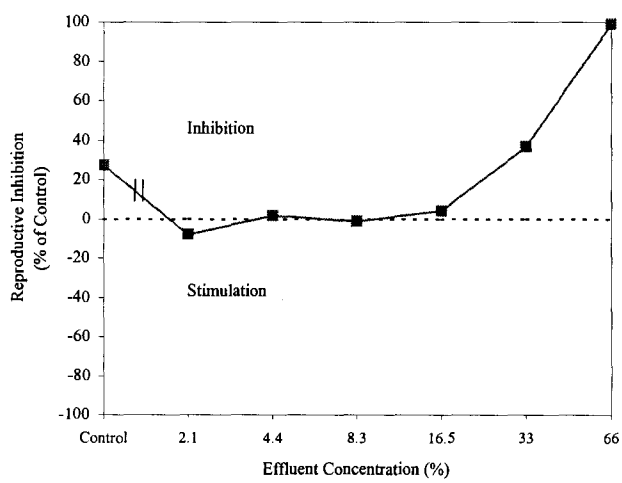
Sample Identification

Company :	Azimuth Consulting Group Inc.		
Location :	Vancouver, BC	Date Collected :	2005-07-16
Substance :	G-Creek Sublethal 071605	Time Collected :	09:00
Sampling Method :	Grab	Date Received :	2005-07-19
Sampled By :	B. Hamer	Time Received :	13:00
Shipped By:	Fed Ex/Rd	Date Tested :	2005-07-19
Temp. on arrival :	18.0°C	Lab Storage:	4±2 °C
Sample Description:	Clear, colourless, odourless.		

Test Results

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Reproduction)	24.6%	22.2-27.2	Linear Interpolation (Toxstat 3.5) b

Champia parvula Reproductive Inhibition



Note: Statistical analyses were performed using pooled control and salt control data.

Work Order Number: 207782
Sample Number: 13103

Test Conditions

Test Organism [a]	*Champia parvula*	Test Vessel	240 mL polystyrene cup
Organism Batch Number	CH05-07	Number of Replicates	3
Source	Stantec in-house culture	Number of Organisms per Replicate	5 females / 2 males
Life Stage [c]	Sexually mature	Test Volume (per replicate)	100 mL
Mean Organism Mortality	0% (7 days prior to testing)	Test Solution Depth	5 cm
Salinity Adjustment [d]	Yes	Recovery Volume (per replicate)	200 mL
pH Adjustment	None	Recovery Solution Depth	7 cm
Sample Filtration	None	Recovery Water Filtered (prior to dilution)	Yes (60µm)
Test Aeration (during exposure)	None	Date of Test Initiation	2005-07-19
Test Aeration (during recovery)	Yes (continuous, gentle aeration)	Time of Test Initiation	17:45
Photoperiod (h)	16 light / 8 dark	Date of Recovery Initiation	2005-07-21
Light Intensity	1000 - 1600 lux	Date of Test Completion	2005-07-28
Test Temperature (°C)	23.0 – 26.0	Test Duration	48 hours
Control/Dilution Water [e]	Natural seawater	Recovery Duration	7 days
Test Type	Static non-renewal	Analyst(s)	EJ/KJ

[a] Test Organism : No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test. All test organisms were from the same culture.

[c] Life Stage : Test organisms were sexually mature males having sori with spermatia and sexually mature females having trichogynes.

[d] Salinity Adjustment : Salinity adjustment was performed following the procedure for Hypersaline Brine Addition (Environment Canada Salinity Adjustment Guidance Document, revised December 2001).

[e] Control/Dilution Water : Filtered (0.45 µm) natural seawater from Pointe-du-Chene in Shediac Bay, New Brunswick. No chemicals added.

Test Method : Test of Sexual Reproduction using the Red Macroalga *Champia parvula*. EPA-821-R-02-014, October 2002, Method 1009.0, with Canadian adaptations (Environment Canada 1998, 1999).

Comments

Nutrient addition of 10 mls to the 100% salinity adjusted sample, prior to test initiation, reduced the maximum concentration tested from 66.7% to 66%.

Noted Deviation(s): The maximum test temperature of 24.0 °C, as specified by the test method, was exceeded on Day 4 of the recovery period. There were no other unusual conditions or deviations from the test protocol. The results reported relate only to the sample tested.

Reference Toxicant Data

Substance :	Sodium Dodecyl Sulphate (SDS)	Historical Mean IC50 :	0.155 mg/L
Test Date :	2005-07-19	Warning Limits (± 2 SD) :	0.112-0.216
Test Duration :	48 hrs exposure, 7 days recovery	Statistical Method :	Linear Interpolation (Toxstat 3.5)[b]
IC50 Reproduction	0.134 mg/L	Test Conducted By :	E. Jonczyk/K. Johnson
95% Confidence Limits:	0.123-0.143	Organism Batch :	CH05-07

The reference toxicant test was conducted under conditions identical to the test.

References

[b] West, Inc. and D. Gulley. 1996. Toxstat Release 3.5. Western Ecosystems Technology. Cheyenne, WY, U.S.A.

Date: 2005-08-25

Approved By: Project Manager

Work Order : 207782
Sample Number : 13103

Cystocarp Counts

Concentration (%)	Replicate	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Replicate Mean	Treatment Mean	Standard Deviation
Control	A	19	27	34	30	24	26.8	26.8	6.98
	B	32	21	36	25	22	27.2		
	C	23	42	29	21	17	26.4		
Salt Control	A	31	26	24	18	39	27.6	27.8	7.94
	B	24	29	32	37	15	27.4		
	C	17	22	28	35	40	28.4		
2.1	A	27	24	37	25	34	29.4	29.5	7.50
	B	33	19	39	28	26	29.0		
	C	24	31	42	16	37	30.0		
4.4	A	11	29	34	22	35	26.2	26.8	8.13
	B	27	24	38	15	30	26.8		
	C	28	31	22	38	18	27.4		
8.3	A	34	30	21	25	28	27.6	27.6	7.14
	B	16	24	32	29	35	27.2		
	C	39	34	25	13	29	28.0		
16.5	A	22	26	23	13	43	25.4	26.1	8.41
	B	29	19	31	29	24	26.4		
	C	15	24	32	41	21	26.6		
33	A	13	17	12	23	27	18.4	17.3	5.55
	B	16	20	15	13	11	15.0		
	C	10	18	26	24	14	18.4		
66	A	0	1	0	1	0	0.4	0.3	0.46
	B	0	0	1	0	0	0.2		
	C	1	0	0	0	0	0.2		

Plant Mortality Data

Exposure Period

	♂ 0 Hours		♀ 0 Hours		♂ 48 Hours		♀ 48 Hours		♀ Test Completion	
Concentration (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)
Control	0	0	0	0	0	0	0	0	0	0
Salt Control	0	0	0	0	0	0	0	0	0	0
2.1	0	0	0	0	0	0	0	0	0	0
4.4	0	0	0	0	0	0	0	0	0	0
8.3	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0

Test Data Reviewed By: [signature]
Date: 2005-08-11

Work Order : 207782
Sample : 13103

Water Chemistry Data

Initial Water Chemistry (100% Effluent)

	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	O2 Saturation (%)*	Salinity (‰)
Initial Parameters:	22.0	8.0	10.2	122	0
Parameters after Salinity Adjustment [1]:	22.5	8.0	7.0	98	32
Chemistry after Pre-Aeration [1,2]:	-	-	-	-	-

Exposure Period Water Chemistry

0 hours

Date & Time : 2005-07-19 17:45
Analyst(s) : EJ/KJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	7.8	7.8	106	32	22.5
33	7.7	7.3	102	32	22.5
16.5	7.7	7.2	100	32	22.5
8.3	7.7	7.1	100	32	22.5
4.4	7.7	7.3	103	32	22.5
2.1	7.7	7.0	99	32	23.0
Salt Control	7.7	5.9	83	30	24.0
Control	7.7	6.4	91	30	22.0

48 hours

Date & Time : 2005-07-21 16:00
Analyst(s) : KJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	8.8	7.7	99	31	23.0
33	8.9	7.0	98	31	23.0
16.5	8.7	6.9	98	31	23.0
8.3	9.1	6.9	97	31	22.0
4.4	8.7	6.8	96	30	22.5
2.1	8.9	6.6	94	30	22.0
Salt Control	9.0	6.2	91	30	22.0
Control	9.1	6.7	95	30	22.0

Initial Water Chemistry (Recovery Water)

	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	O2 Saturation (%)*	Salinity (‰)
Initial Parameters:	22.0	7.5	6.6	93	30

Recovery Period Water Chemistry

0 hours

Date & Time : 2005-07-21 16:00
Analyst(s) : KJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	7.5	6.6	93	30	22.0
33	7.5	6.6	93	30	22.0
16.5	7.5	6.6	93	30	22.0
8.3	7.5	6.6	93	30	22.0
4.4	7.5	6.6	93	30	22.0
2.1	7.5	6.6	93	30	22.0
Salt Control	7.5	6.6	93	30	22.0
Control	7.5	6.6	93	30	22.0

Test Completion

Date & Time : 2005-07-28 16:00
Analyst(s) : EJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	8.0	7.4	92	30	22.0
33	8.0	7.5	93	30	22.0
16.5	8.0	7.3	91	30	22.0
8.3	8.1	7.4	92	30	22.0
4.4	8.0	7.5	93	30	22.0
2.1	8.0	7.5	93	30	22.0
Salt Control	8.1	7.5	93	30	22.0
Control	7.8	7.6	95	30	22.0

Daily Temperature Monitoring

Date:	2005-07-19	2005-07-20	2005-07-21	2005-07-22	2005-07-23	2005-07-24	2005-07-25	2005-07-26	2005-07-27	2005-07-28
Temp. (°C):	23.0	24.0	24.0	24.0	23.0	24.0	26.0	24.0	23.0	23.0

[1] if applicable
[2] @ <100 bubbles/min
* adjusted for barometric pressure

August 2005

LABORATORY REPORT

Azimuth Consulting Group

POLARIS MINE

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

July 16, 2005 Sample

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

JULY 16, 2005 SAMPLE

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants (A Member of the Golder Group of Companies)
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

04-1424-044

August 2005

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

EVS Environment Consultants (a member of the Golder Group of Companies) conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as G Creek-071605, was collected from the Polaris Mine Site on July 16, 2005 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on July 19, 2005 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. Toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. The raw data and statistical analyses are provided in Appendices I and II respectively, and the chain-of-custody form is provided in Appendix III.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d survival and growth toxicity and reference toxicant tests using topsmelt (*A. affinis*) was conducted in accordance with U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was conducted in accordance with Environment Canada (1992 with 1997 amendments). Test conditions and methods are summarized in Table 2.

This fertilization test involves exposing echinoderm sperm to a series of test concentrations for ten minutes, echinoderm eggs are then added allowing fertilization to occur for ten minutes. Following the ten minutes exposure time, the eggs are preserved and the number of fertilized and unfertilized eggs in each replicate are counted. These observations are assessed in comparison to the pooled negative and brine controls.

2.3 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994).

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and

record-keeping, and use of standard operating procedures (SOPs). To ensure data and reporting meet quality standards, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Toxicity testing was carried out in accordance with applicable test methodologies and/or standards of practice. Our liability is limited solely to the cost of re-testing in the event of non-compliance with such test specifications or standards of practice. Golder/EVS accepts no responsibility or liability for the interpretation or use of these testing results by others, or for any delay, loss, damage or interruptions of testing, collection, preparation, and delivery of samples or test results resulting from events or circumstances beyond our control.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10 d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.5, 8.9, 17.9, 35.7, 71.4% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.6, 9.1, 18.3, 36.6, 72.8% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The test results are summarized in Table 1 and the raw statistical analyses are provided in Appendix I.

The highest concentration tested was approximately 71.4% due to salinity adjustment. The mean survival in both the negative and brine controls was 100%. Mean dry weight in the pooled controls was 0.95mg. The negative and brine controls were not significantly different for both the growth and survival endpoints ($p = 0.52$ and $p = 1.00$, respectively).

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). For the survival and growth endpoints the NOEC was 71.4, and the LOEC was >71.4% (v/v). The LC50 for survival was >71.4% (v/v). The IC50 and IC25 for growth were both >71.4% (v/v).

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The test results are summarized in Table 2 and the raw statistical analyses are provided in Appendix II.

The highest concentration tested was 72.8% due to salinity adjustment. Mean fertilization in the pooled controls was 66.9%. The negative and brine controls were not significantly different ($p = 0.09$).

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was <4.6 and LOEC was 4.6 % (v/v). The IC50 and IC25 (95% confidence limits) values were 13.2 (10.6 – 17.1) and 5.2 (4.4 – 6.0) % (v/v), respectively.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 3. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% V/V)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
D-Control	100.0 ± 0.0	0.92 ± 0.13
Brine Control	100.0 ± 0.0	0.98 ± 0.18
Pooled Controls	100.0 ± 0.0	0.95 ± 0.15
4.5	96.0 ± 8.9	0.77 ± 0.19
8.9	96.0 ± 8.9	0.82 ± 0.33
17.9	100.0 ± 0.0	1.01 ± 0.14
35.9	100.0 ± 0.0	1.07 ± 0.19
71.4	96.0 ± 8.9	0.91 ± 0.28
TEST ENDPOINT	**SURVIVAL (% V/V)**	**GROWTH (% V/V)**
NOEC	71.4	71.4
LOEC	>71.4	>71.4
LC50	>71.4	na
IC50	na	>71.4
IC25	na	>71.4

SD – Standard Deviation; na – not applicable.

Table 4. Summary of results for the Echinoderm (*Dendraster excentricus*) fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	64.8 ± 3.8
Brine Control	69.0 ± 1.8
Pooled Control	66.9 ± 3.6
4.6	53.0 ± 2.2*
9.1	37.2 ± 1.3*
18.2	30.0 ± 2.2*
36.5	23.5 ± 2.9*
72.8	19.5 ± 2.4*
TEST ENDPOINT	**PROPORTION FERTILIZED %(v/v)**
NOEC	<4.6
LOEC	4.6
IC50 (95% CL)	13.2 (10.6 – 17.1)
IC25 (95% CL)	5.2 (4.4 – 6.0)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

4. REFERENCES

Environment Canada. 1992. Biological test method: fertilization of echinoids (sea urchins and sand dollars). Environmental Protection Series, Report EPS 1/RM/27, December 1992. Environment Canada, Conservation and Protection, Ottawa, ON. 68 pp + appendices. Amended November 1997.

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US EPA (U.S. Environmental Protection Agency). 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 3rd edition. US Environmental Protection Agency, Office of Water (4303T). US Environmental Protection Agency, Washington, DC. EPA/821/R-02/014. 464 pp.

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Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX I

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Polaris
EVS Project No. 04-1424-0604
EVS Work Order No. 0500~~258~~[298] 298

EVS Analysts JxS, SxB, MJG, AxF
Test Initiation Date 19-July-05

Sample	Initial Sample	Refresh Samples	
	Day 0 Sublethal	Day 2	Day 4
Identification	G Creek ~~NO~~ 71605	G Creek	G Creek
Amount Received	1 ~~20~~ 30 x 20L	1x20L	1x20L
Date Collected	16Jul05	16Jul05	16Jul05
Date Received	19Jul05	19Jul05	19Jul05
Temperature (°C)	20.0	20.0	20.0
pH	7.7 ① → 8.2	7.8 ① → 8.2	7.7 ① → 8.3
DO (mg/L)	11.1 ① → 7.6	11.0 ① → 7.6	10.8 ① → 7.6
Conductivity (µmhos/cm)	1520	1520	1520
Salinity (ppt)	6 ① → 29	6 ① → 29	6 ① → 29
Ammonia (mg/L N)	-	-	-
Chlorine (mg/L Cl)	-	-	-
Other	① After Salinity Adjustment		

DILUTION/CONTROL WATER (initial water quality)
Water Type Filtered, UV sterilized seawater
Temperature (°C) 20.0
pH 7.8
Dissolved Oxygen (mg/L) 7.5
Salinity 28

TEST SPECIES INFORMATION
Source ABS
Date Received 19-July-05
Age (on Day 0) 10-d
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 19Jul05
7-d survival LC50 ~~122 (106-140)~~ [R5?] 117 (100-136) ug/L Cu
7-d growth IC50 ~~112 (80-149)~~ 116 (81-156) ug/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 133 ± 39 ug/L Cu CV=15%
7-d growth IC50 132 ± 46 ug/L Cu CV=17%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.7 - 8.3
Dissolved Oxygen Range (mg/L) 6.2 - 7.7
Salinity (ppt) 28 - ~~29~~ [R5?] 30
Photoperiod (L:D h) 16:8
Aeration Provided? No
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	71.4	>71.4	>71.4		
Growth		71.4	>71.4		>71.4	>71.4

Other

Data Verified By [signature] Date Verified Aug. 22/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client: Polaris | Sample ID: G-Creek Subtidal C7/16 05

EVS Project No.: 7-1424-044 | Test Initiation Date/Time: 19-July-05/1430

EVS Work Order No.: 0500298 | Source/Date Received: ABS / 19-July-05

~~%(v/v, mg/L~~ Concentration	Temperature (°C)													
	0	1		2		3		4		5		6		7
D-control	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
B-control	20.5	20.5	20.5	20.5	20.5	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
4.5	20.0	20.5	20.0	20.0 SXB 20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
8.9	20.0	20.5	20.0	20.0 SXB 20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
~~35.7~~ 17.9	20.0	20.5	20.0	20.0 SXB 20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
~~71.4~~ 35.7	20.0	20.5	20.0	20.0 SXB 20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
71.4	20.0	20.5	20.0	20.0 SXB 20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	MV	MV	MV	MV	MV	MV	TM

% (v/v) Concentration	pH													
	0	old 1 new		2		3		4		5		6 7.9		7
D-control	7.8	7.7	7.7	7.7	7.8	7.8	7.8 SXB 7.9	7.8	7.8	7.8	7.8	7.8	7.8	8.0
B-control	7.9	7.7	8.0	7.7	7.9	7.8	7.9	7.8	7.8	7.8	7.8	7.8	7.9	8.0
4.5	7.9	7.7	8.0	7.7	7.9	7.8	7.9	7.9	7.9	7.8	7.9	7.9	7.9	7.7
8.9	7.9	7.8	8.0	7.7	7.9	7.8	8.0	7.9	7.9	7.8	8.0	7.9	8.0	7.7
17.9	8.0	7.8	8.1	7.7	8.0	7.9	8.0	8.0	8.0	7.9	8.1	8.0	8.1	7.7
35.7	8.1	7.9	8.1	7.8	8.1	7.9	8.1	8.0	8.2	7.9	8.2	8.0	8.2	7.8
71.4	8.2	7.9 SXB 8.2		7.8	8.2	7.9	8.3	8.0	8.3	8.0	8.2	8.0	8.3	7.8
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	MV	MV	MV	MV	MV	MV	TM

WQ Instruments Used: Temp. Calibrated Hg thermometer pH I-A-03031

Comments: D used I-A-51

Test Set Up By: TM, SXB Data Verified By: [signature] Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Polaris

Sample ID G-Creek Sublethal C7160S

EVS Project No. 04-1424-044

Test Initiation Date/Time 19-July-05 /1430

EVS Work Order No. 0500~~28~~298

Source/Date Received ABS /19-July-05

% (v/v) Concentration	Salinity (ppt)													
	0	1		2		3		4		5		6		7
D-control	28	28	28	28	28	28	28	28	28	28	28	28	28	28
B-control	30	30	30	30	30	30	30	30	30	30	30	30	30	30
4.5	28	28	28	28	28	28	28	28	28	28	28	28	28	28
8.9	28	28	28	28	28	28	28	28	28	28	28	28	28	28
17.9	28	28	28	28	28	28	28	28	28	28	28	28	28	28
35.7	28	28	28	28	28	28	28	28	28	28	28	28	28	28
71.4	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	SXB	ML	SXB	ML	SXB	ML	TM

% (v/v) Concentration	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
D-control	7.5	6.6	7.5	6.7	7.5	6.5	7.5	6.5	7.7	6.6	7.7	6.6	7.7	6.4
B-control	7.5	6.6	7.5	6.7	7.5	6.5	7.5	6.5	7.7	6.7	7.7	6.6	7.6	6.2
4.5	7.5	6.5	7.5	6.7	7.5	6.5	7.5	6.5	7.7	6.6	7.7	6.5	7.7	6.6
8.9	7.5	6.5	7.5	6.8	7.6	6.6	7.5	6.4	7.6	6.6	7.7	6.6	7.7	6.7
17.9	7.6	6.5	7.5	6.7	7.6	6.7	7.5	6.4	7.6	6.5	7.7	6.6	7.7	6.6
35.7	7.6	6.6	7.5	6.8	7.6	6.6	7.6	6.5	7.6	6.5	7.6	6.6	7.6	6.2
71.4	7.6	6.5	7.5	6.7	7.6	6.6	7.6	6.5	7.6	6.6	7.6	6.6	7.6	6.4
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	TM

WQ Instruments Used: Salinity II-A-030303 DO II-A-14

Comments

Test Set Up By TM. SXB Data Verified By [signature] Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Polaris
EVS Project No. 04-1424-044
EVS Work Order No. 0500 ~~358~~ 398

Sample ID G-Creek Sublethal 071605
Test Species/Batch A affinis / 19-July-05
Test Initiation Date/Time 19-July-05 / 1430h
No. of Organisms/Volume 5 / 200 ml

Concentration % V/V	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
D-control	A	T1	5	5	5	5	5	5	5	
	B	T2	5	5	5	5	5	5	5	
	C	T3	5	5	5	5	5	5	5	
	D	T4	5	5	5	5	5	5	5	
	E	T5	5	5	5	5	5	5	5	
B-control	A	T6	5	5	5	5	5	5	5	
	B	T7	5	5	5	5	5	5	5	
	C	T8	5	5	5	5	5	5	5	
	D	T9	5	5	5	5	5	5	5	
	E	T10	5	5	5	5	5	5	5	
4.5	A	T11	5	5	5	5	5	5	5	
	B	T12	5	5	5	5	5	5	5	
	C	T13	5	5	5	5	5	5	5	
	D	T14	5	5	5	5	5	5	4	
	E	T15	5	5	5	5	5	5	5	
8.9	A	T16	5	5	5	5	5	5	5	
	B	T17	5	5	5	5	5	5	5	
	C	T18	5	5	5	5	5	5	5	
	D	T19	5	5	5	5	5	5	5	
	E	T20	5	5	5	5	5	5	4	
Technician Initials		TM	SKB	SKL	SKB	MML	MML	MH	TM	

Sample Description colorless, clear.
Data Verified By [signature] Date Verified Aug 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Polaris
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~858~~398

Sample ID G-Creek 071605 Sublethal
Test Species/Batch 4 affinis / 19-July-05
Test Initiation Date/Time 19-July-05 / 1430h
No. of Organisms/Volume 5/200ml

% (v/v) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
17.9	A	T21	5	5	5	5	5	5	5	
	B	T22	5	5	5	5	5	5	5	
	C	T23	5	5	5	5	5	5	5	
	D	T24	5	5	5	5	5	5	5	
	E	T25	5	5	5	5	5	5	5	
~~35.9~~ (RS) 35.7	A	T26	5	5	5	5	5	5	5	
	B	T27	5	5	5	5	5	5	5	
	C	T28	5	5	5	5	5	5	5	
	D	T29	5	5	5	5	5	5	5	
	E	T30	5	5	5	5	5	5	5	
71.4	A	T31	5	5	5	5	5	5	5	
	B	T32	5	5	5	5	5	5	4	
	C	T33	5	5	5	5	5	5	5	
	D	T34	5	5	5	5	5	5	5	
	E	T35	5	5	5	5	5	5	5	
	A									
	B									
	C									
	D									
	E									
Technician Initials		TM	SNB	SNB	SNB	MM	MM	MM	MM	

Sample Description colorless clear.
Data Verified By Gail Fink Date Verified Aug. 18/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Polaris

EVS Project No.: 04-1424-044

EVS Work Order No.: 0500288

Start Date (Day 0): 19-July-05 071605 sublethal

Sample ID: G-Creek

Balance Type/Serial Number: Sartorius / BP-211D

Sample ID (%)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
D-CTL	A	T1	1237.86	1242.66	5	5		AXF/
	B	T2	1223.60	1228.84	5	5		
	C	T3	1234.30	1238.08	5	5		
	D	T4	1221.57	1226.62	5	5	confirmed 1226.58 mg ✓	
	E	T5	1215.08	1219.11	5	5		
B-CTL	A	T6	1236.55	1241.94	5	5		
	B	T7	1230.84	1236.489	5	5		
	C	T8	1223.70	1229.06	5	5		
	D	T9	1242.73	1247.44	5	5		
	E	T10	1228.47	1231.92	5	5		
4.5	A	T11	1221.11	1224.77	5	5	confirmed 1224.75 mg ✓	
	B	T12	1237.55	1240.97	5	5		
	C	T13	1221.54	1226.04	5	5		
	D	T14	1229.99	1232.59	4	4		
	E	T15	1220.96	1226.00	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Qalpi

Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Polaris

EVS Project No. 04-1424-044

EVS Work Order No. 0500788

Start Date (Day 0) 19-July-05

Sample ID G-Creek ~~07605~~ 07605 Sublethal 07/605

Balance Type/Serial Number Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
8.9	A	T16	1221.54	1226.60	5	5		AXF 1-2-3
	B	T17	1235.48	1241.14	5	5		
	C	T18	1237.41	1242.39	5	5		
	D	T19	1236.28	1238.98	5	5	Confirmed 1238.99 mg ✓	
	E	T20	1219.90	1221.88	4	4		
17.9	A	T21	1227.04	1231.84	5	5		
	B	T22	1246.60	1251.74	5	5		
	C	T23	1239.07	1243.68	5	5		
	D	T24	1231.19	1237.41	5	5		
	E	T25	AXF 1229.72	1234.23	5	5		
~~35.9~~ 35.7	A	T26	1230.92	1235.13	5	5	Confirmed 1235.14 mg ✓	
	B	T27	1228.42	1234.87	5	5		
	C	T28	1231.53	1237.73	5	5		
	D	T29	1235.66	1240.48	5	5		
	E	T30	1228.20	1233.15	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By Ralph K

Date Verified Aug. 18/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Polaris

EVS Project No. 04-1424-044

EVS Work Order No. 05008

Start Date (Day 0) 19-July-05

Sample ID G-Creek ~~07605~~ Sublethal 07/605

Balance Type/Serial Number Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
71.4	A	T31	1227.99	1234.14	5	5		AXH 7..
	B	T32	1230.90	1234.21	4	4		
	C	T33	1234.94	1239.77	5	5		
	D	T34	1230.30	1235.80	5	5		
	E	T35	1232.19	1234.5~~4~~.03	5	5		
	A							
	B							
	C							
	D							
	E							
	A							
	B							
	C							
	D							
	E							

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By Qacji 4

Date Verified Aug. 17/05

Test: LF-Larval Fish Growth and Survival Test — Test ID: 0500298
Species: AA-Atherinops affinis — Protocol: EPAW 95-EPA West Coast
Sample ID: G_CREEK_Sublethal_071605 — Sample Type: EFF2-Industrial
Start Date: 7/19/2005 End Date: 7/26/2005 — Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1237.86	1242.66
	2	2	D-Control	5							5	5	1223.6	1228.84
	3	3	D-Control	5							5	5	1234.3	1238.08
	4	4	D-Control	5							5	5	1221.57	1226.62
	5	5	D-Control	5							5	5	1215.08	1219.11
	6	1	B-Control	5							5	5	1236.55	1241.94
	7	2	B-Control	5							5	5	1230.84	1236.49
	8	3	B-Control	5							5	5	1223.7	1229.06
	9	4	B-Control	5							5	5	1242.73	1247.44
	10	5	B-Control	5							5	5	1228.47	1231.92
	11	1	4.5	5							5	5	1221.11	1224.77
	12	2	4.5	5							5	5	1237.55	1240.97
	13	3	4.5	5							5	5	1221.54	1226.04
	14	4	4.5	5							4	4	1229.99	1232.59
	15	5	4.5	5							5	5	1220.96	1226
	16	1	8.9	5							5	5	1221.54	1226.6
	17	2	8.9	5							5	5	1235.48	1241.14
	18	3	8.9	5							5	5	1237.41	1242.39
	19	4	8.9	5							5	5	1236.28	1238.98
	20	5	8.9	5							4	4	1219.9	1221.88
	21	1	17.9	5							5	5	1227.04	1231.84
	22	2	17.9	5							5	5	1246.6	1251.74
	23	3	17.9	5							5	5	1239.07	1243.68
	24	4	17.9	5							5	5	1231.19	1237.41
	25	5	17.9	5							5	5	1229.72	1234.23
	26	1	35.7	5							5	5	1230.92	1235.13
	27	2	35.7	5							5	5	1228.42	1234.87
	28	3	35.7	5							5	5	1231.53	1237.73
	29	4	35.7	5							5	5	1235.66	1240.48
	30	5	35.7	5							5	5	1228.2	1233.15
	31	1	71.4	5							5	5	1227.99	1234.14
	32	2	71.4	5							4	4	1230.9	1234.21
	33	3	71.4	5							5	5	1234.94	1239.77
	34	4	71.4	5							5	5	1230.3	1235.8
	35	5	71.4	5							5	5	1232.19	1235.03

Comments: Azimuth(Polaris) 04-1424-044

Reviewed by Aug. 18/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

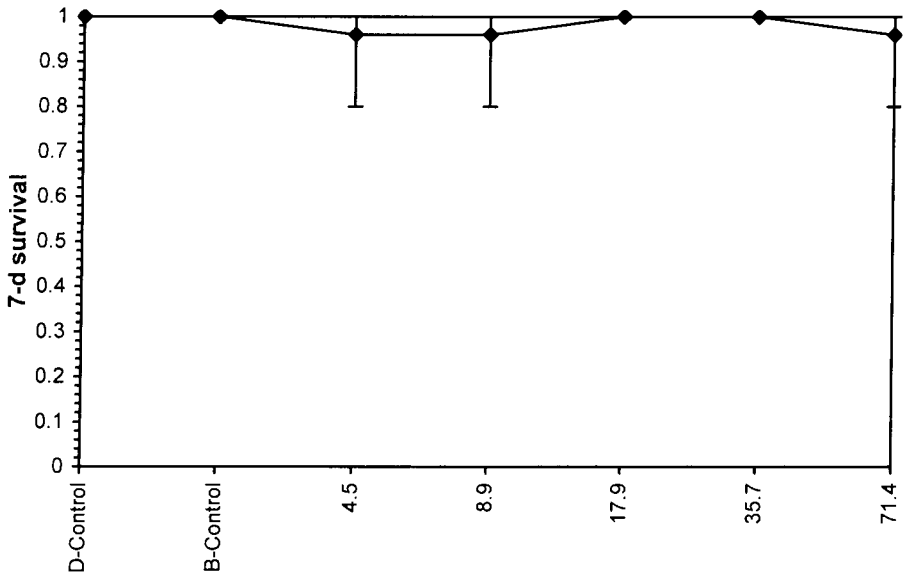
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
B-Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	0.8000	1.0000
8.9	1.0000	1.0000	1.0000	1.0000	0.8000
17.9	1.0000	1.0000	1.0000	1.0000	1.0000
35.7	1.0000	1.0000	1.0000	1.0000	1.0000
71.4	1.0000	0.8000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
B-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
4.5	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
8.9	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
17.9	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
35.7	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
71.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.59678	0.9	-2.2346	4.3922
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	71.4	>71.4		1.40056

Dose-Response Plot



Statistical comparisons were against the negative control.

Larval Fish Growth and Survival Test-7-d survival

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

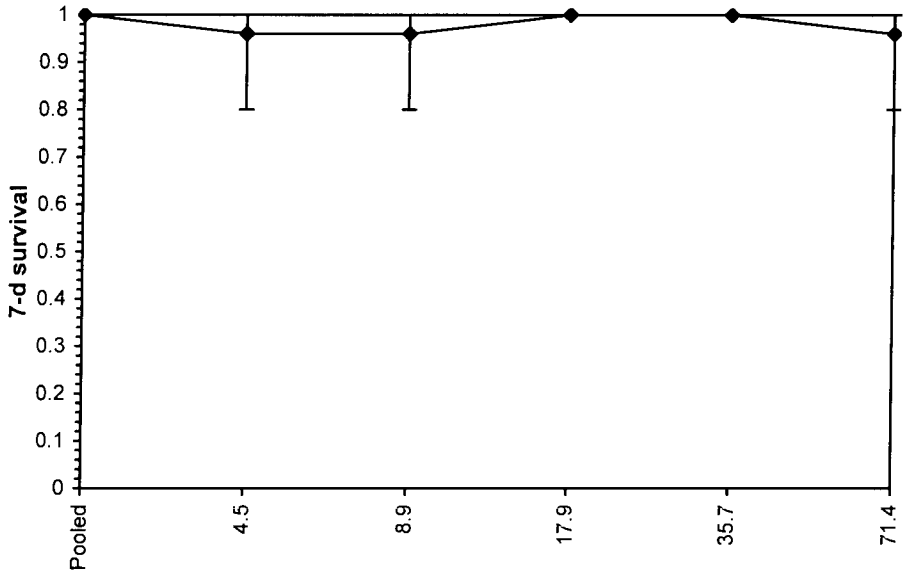
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
B-Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	0.8000	1.0000
8.9	1.0000	1.0000	1.0000	1.0000	0.8000
17.9	1.0000	1.0000	1.0000	1.0000	1.0000
35.7	1.0000	1.0000	1.0000	1.0000	1.0000
71.4	1.0000	0.8000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	10		
4.5	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
8.9	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
17.9	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
35.7	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
71.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.58129	0.91	-2.3952	5.50568
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	71.4	>71.4		1.40056

Dose-Response Plot



Statistical comparisons were agianst the pooled controls.

Reviewed by: Aug. 18/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

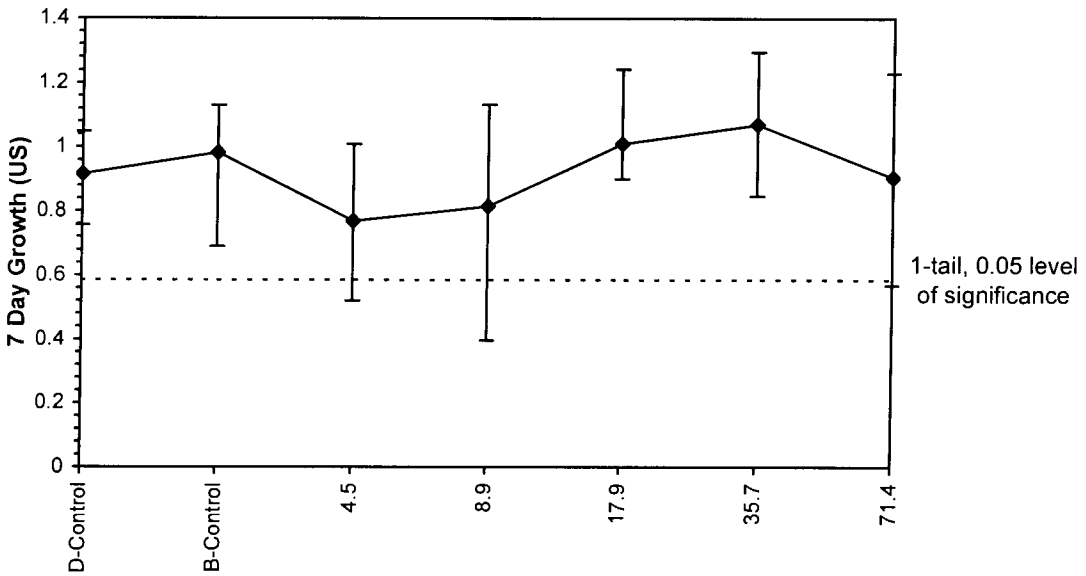
Conc-%	1	2	3	4	5
D-Control	0.9600	1.0480	0.7560	1.0100	0.8060
B-Control	1.0780	1.1300	1.0720	0.9420	0.6900
4.5	0.7320	0.6840	0.9000	0.5200	1.0080
8.9	1.0120	1.1320	0.9960	0.5400	0.3960
17.9	0.9600	1.0280	0.9220	1.2440	0.9020
35.7	0.8420	1.2900	1.2400	0.9640	0.9900
71.4	1.2300	0.6620	0.9660	1.1000	0.5680

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9160	0.1284	0.9160	0.7560	1.0480	14.012	5			
B-Control	0.9824	0.1775	0.9824	0.6900	1.1300	18.072	5			
4.5	0.7688	0.1903	0.7688	0.5200	1.0080	24.755	5	1.051	2.360	0.3307
8.9	0.8152	0.3253	0.8152	0.3960	1.1320	39.903	5	0.719	2.360	0.3307
17.9	1.0112	0.1387	1.0112	0.9020	1.2440	13.719	5	-0.679	2.360	0.3307
35.7	1.0652	0.1916	1.0652	0.8420	1.2900	17.985	5	-1.065	2.360	0.3307
71.4	0.9052	0.2828	0.9052	0.5680	1.2300	31.246	5	0.077	2.360	0.3307

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96171	0.9	-0.2156	-0.8642
Bartlett's Test indicates equal variances (p = 0.42)	4.97608	15.0863		
The control means are not significantly different (p = 0.52)	0.67773	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	71.4	>71.4		1.40056	0.33065	0.36097	0.06323	0.04907	0.30153	5, 24

Dose-Response Plot



Statistical comparisons were against the negative control.

Reviewed by: Aug. 18/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

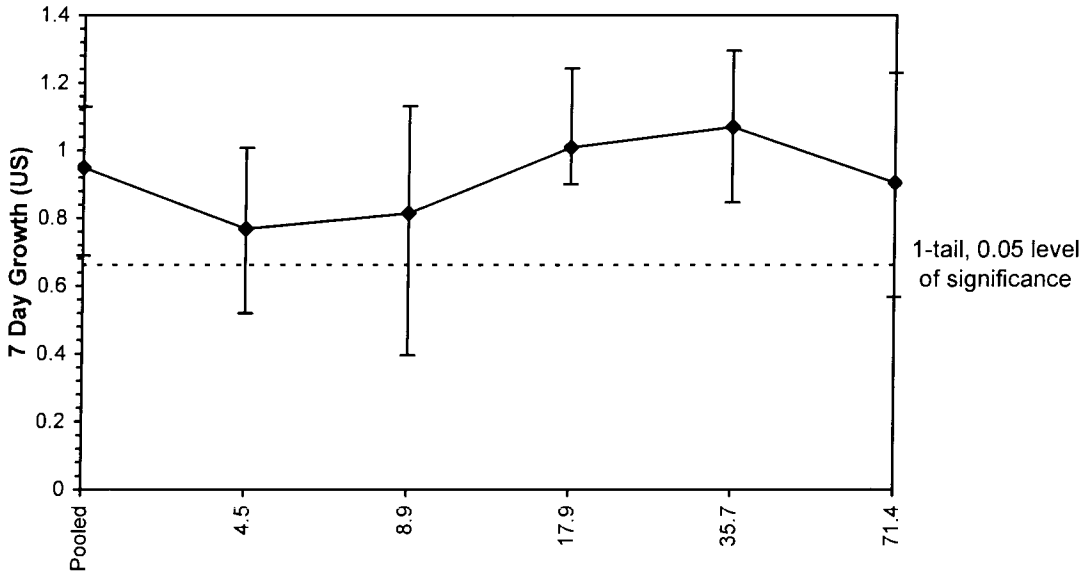
Conc-%	1	2	3	4	5
D-Control	0.9600	1.0480	0.7560	1.0100	0.8060
B-Control	1.0780	1.1300	1.0720	0.9420	0.6900
4.5	0.7320	0.6840	0.9000	0.5200	1.0080
8.9	1.0120	1.1320	0.9960	0.5400	0.3960
17.9	0.9600	1.0280	0.9220	1.2440	0.9020
35.7	0.8420	1.2900	1.2400	0.9640	0.9900
71.4	1.2300	0.6620	0.9660	1.1000	0.5680

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Pooled	0.9492	0.1502	0.9492	0.6900	1.1300	15.822	10			
4.5	0.7688	0.1903	0.7688	0.5200	1.0080	24.755	5	1.547	2.462	0.2871
8.9	0.8152	0.3253	0.8152	0.3960	1.1320	39.903	5	1.149	2.462	0.2871
17.9	1.0112	0.1387	1.0112	0.9020	1.2440	13.719	5	-0.532	2.462	0.2871
35.7	1.0652	0.1916	1.0652	0.8420	1.2900	17.985	5	-0.995	2.462	0.2871
71.4	0.9052	0.2828	0.9052	0.5680	1.2300	31.246	5	0.377	2.462	0.2871

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.9613	0.91	-0.2544	-0.8676
Bartlett's Test indicates equal variances (p = 0.38)	5.3243	15.0863		
The control means are not significantly different (p = 0.52)	0.67773	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	71.4	>71.4		1.40056	0.28714	0.30251	0.06509	0.04534	0.24132	5, 29

Dose-Response Plot



Statistical comparisons were against the ~~negative control~~ Pooled controls

ToxCalc v5.0.23

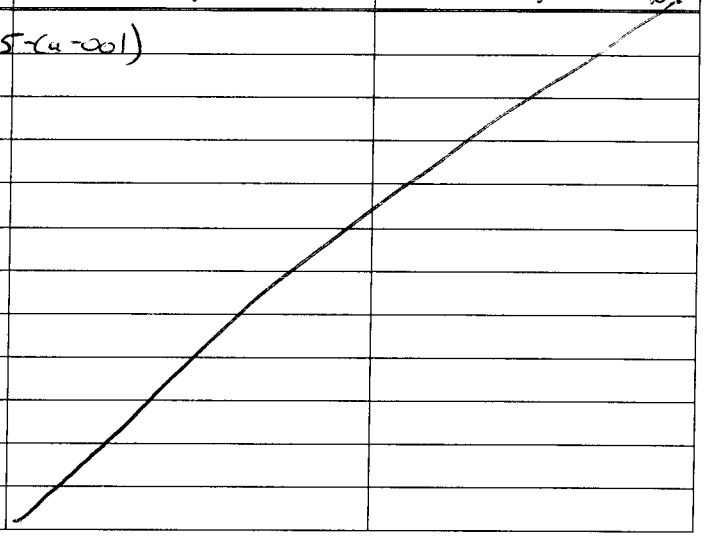
Reviewed by Aug-18/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~5298~~ 5298

EVS Analysts JXS, SXB, MJC, AKF
Test Initiation Date 19-July-05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	100 mg/L Cu Stock (05-Cu-001)		
Amount ~~Received~~ Prepared	1 x 1L		
Date ~~Collected~~ Prepared	7 Mar 05		
Date Received	Ma		
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			



DILUTION/CONTROL WATER (initial water quality)
Water Type Filtered, UV sterilized seawater
Temperature (°C) 20.0
pH 7.8
Dissolved Oxygen (mg/L) 7.5
Salinity 28

TEST SPECIES INFORMATION
Source ABS
Date Received 19-July-05
Age (on Day 0) 10-d
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 19 Jul 05
7-d survival LC50 ~~122 (106-140)~~ 117 (100-136) ug/L Cu
7-d growth IC50 ~~112 (80-147)~~ 116 (81-156) ug/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 133 ± 39 ug/L Cu CV = 15%
7-d growth IC50 132 ± 46 ug/L Cu CV = 17%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.7 - 8.0
Dissolved Oxygen Range (mg/L) ~~6.3~~ 6.2 - 7.7
Salinity (ppt) 28
Photoperiod (L:D h) 16:8
Aeration Provided? No
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	ug/L Cu	100	180	117 (100-136) ~~122 (106-140)~~		
Growth		56	100		116 (81-156) ~~112 (80-147)~~	83 (68-114) ~~80 (65-114)~~

Other

Data Verified By Qualfish
Date Verified Aug 22/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~258~~ 298 RSD

Sample ID Cu Reference Toxicant
Test Initiation Date/Time 19-July-05/1440h
Source/Date Received ABS/19-July-05

Cu (ug/L) Concentration	Temperature (°C)													
	0	old	1 new	2		3		4		5		6		7
D-control	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
32	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
56	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
100	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
180	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
320	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0 ~~21.0~~	—	—	—	—	—	—
								MG						
Tech. Initials	TH	SxB	SxB	SxB	SxB	SxB	SxB	MG	MG	MG	MG	MG	MG	TH

Cu (ug/L) Concentration	pH													
	0	old	1 new	2		3		4		5		6		7
D-control	7.8	7.7	7.7	7.7	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9
32	7.8	7.7	7.7	7.7	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9
56	7.8	7.7	7.8	7.7	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9
100	7.8	7.7	7.7	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.8	8.0	7.9	7.9
180	7.8	7.7	7.8	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.8	8.0	7.9	7.9
320	7.8	7.7	7.8	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.8	8.0	7.9	7.9
Tech. Initials	TH	SxB	SxB	SxB	SxB	SxB	SxB	MG	MG	MG	MG	MG	MG	TH

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-030301
Comments

Test Set Up By JMS. SxB Data Verified By Qalfish Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 05072158 2918 RSP

Sample ID Cu Reference Toxicant
Test Initiation Date/Time 19-July-05/1440h
Source/Date Received ABS/19-July-05

Cu (mg/L) Concentration	Salinity (ppt)													
	0	1		2		3		4		5		6		7
0-control	28	28	28	28	28	28	28	28	28	28	28	28	28	28
32	28	28	28	28	28	28	28	28	28	28	28	28	28	28
56	28	28	28	28	28	28	28	28	28	28	28	28	28	28
100	28	28	28	28	28	28	28	28	28	28	28	28	28	28
180	28	28	28	28	28	28	28	28	28	28	28	28	28	28
320	28	28	28	28	28	28	28	28	—	—	—		—	—
Tech. Initials	TJ	SXB	SXB	SXB	SXB	SXB	SXB	SXB	MC	SXB	MC	SXB	MC	SXB

Cu (mg/L) Concentration	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6 MC 7.7		7
0-control	7.5	6.8	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.5	7.7	6.6	7.9	6.2
32	7.5	6.5	7.5	6.7	7.5	6.5	7.5	6.6	7.7	6.5	7.7	6.6	7.7	6.3
56	7.5	6.6	7.5	6.8	7.5	6.6	7.5	6.5	7.7	6.5	7.7	6.7	7.7	6.6
100	7.5	6.6	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.4	7.7	6.7	7.7	6.4
180	7.5	6.6	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.5	7.7	6.6	7.7 MC	6.6
320	7.5	6.6	7.5	6.7	7.5	6.7	7.5	6.5	~~7.7~~ MC	—	—	—	—	
Tech. Initials	TJ	SXB	SXB	SXB	SXB	SXB	SXB	MC	MC	MC	MC	MC	MC	TJ

WQ Instruments Used: Salinity I-A-050505 DO I-A-0814
Comments

Test Set Up By TJ SXB Data Verified By [signature] Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client (Polaris) Azimuth
EVS Project No. 04-1424-04AC
EVS Work Order No. 0580 ~~458~~ 298
RSO

Sample ID Cu Reference Toxicant
Test Species/Batch A. affinis/19-July-05
Test Initiation Date/Time 19-July-05/1440h
No. of Organisms/Volume 5/200mL

Cu (mg/L) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
D-control	A	A80	5	5	5	5	5	5	5	
	B	A81	5	5	5	5	5	5	5	
	C	A82	5	5	5	5	5	5	5	
	D	A83	5	5	5	5	5	5	dead 4	
	E	A84	5	5	5	5	5	5	5	
32	A	A85	5	5	5	5	5	5	5	
	B	A86	5	5	5	5	5	5	5	
	C	A87	5	5	5	5	5	5	5	
	D	A88	5	5	5	5	5	5	5	
	E	A89	5	5	5	5	5	5	4	
56	A	A91	5	5	4	4	4	4	4	
	B	A92	5	5	5	5	5	5	5	
	C	A93	5	5	5	5	5	5	5	
	D	A94	5	5	5	5	5	5	5	
	E	A95	5	5	5	5	5	5	5	
100	A	A66	5	3	2	2	2	2	2	
	B	A67	4	1	1	1	1	1	1	
	C	A68	5	4	4	4	4	4	4	
	D	A69	5	4	4	4	4	5	4	
	E	A70	5	5	5	5	5	5	5	
Technician Initials		TM	SXB	SXB	SXB	TM	TM	TM	TM	

Sample Description clear, colorless.
Data Verified By Qalfish Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~158~~ 292
150

Sample ID Cu Reference Toxicant
Test Species/Batch A. affinis/19-July-05
Test Initiation Date/Time 19-July-05/1440h
No. of Organisms/Volume 5/200 ml

Cu (mg/L) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
180	A		4	3	0	0	0	0 MK	—	
	B	471	5	5	4	4	4	~~3~~ 4	3	
	C		5	3	2	1	0	0	—	
	D		4	2	2	1	0	0	—	
	E	472	5	3	2	2	1	1	1	
320	A		3	2	1	0	0	0	-	
	B		2	2	0	0	0	0	—	
	C		2	2	1	0	0	0	—	
	D		2	2	0	0	0	0	—	
	E		3	2	0	0	0	0	—	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials		TM	SxB	SxB	SxB	MK	MK	MK	TM	

Sample Description clear, colorless
Data Verified By Malfish Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500298

Start Date (Day 0): 19-July-05
Sample ID: Cu Reference Toxicant
Balance Type/Serial Number: Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
D-CTL	A	A80	1225.71	1231.08	5	5		JxT/17
	B	A81	1228.66	1232.69	5	5		
	C	A82	1235.20	1239.66	5	5	Confirmed 1239.84 mg ✓	
	D	A83	1233.97	1239.36	~~5~~ 4	~~5~~ 4	1 fish lost when transferring	
	E	A84	1228.91	1234.00	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]

Date Verified: Aug. 18/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500298

Start Date (Day 0): 19-Jul-05
Sample ID: Cu Reference Toxicant
Balance Type/Serial Number: Sartorius/BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
32	A	A85	1229.51	1236.23	5	5		AXF/TH
	B	A86	1233.16	1239.24	5	5		
	C	A87	1234.56	1238.84	5	5		
	D	A88	1225.13	1231.48	5	5		
	E	A89	1236.28	1241.25	4	4		
56	A	A91	1245.68	1249.99	4	4		
	B	A92	1222.48	1227.32	5	5		
	C	A93	1240.76	1246.95	5	5		
	D	A94	1233.51	1239.05	5	5		
	E	A95	1239.61	1245.85	5	5		
	A							
	B							
	C							
	D							
	E							

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Ralph

Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500248

Start Date (Day 0): 19-Jul-05
Sample ID: Cu Reference Toxicant
Balance Type/Serial Number: Sartorius/BP-211D

Sample ID mg/L	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
100	A	A66	1227.36	1229.94	2	2		AXF
	B	A67	1237.38	1238.70	1	1		
	C	A68	1224.68	1228.~~49~~ 24	4	4	Confirmed 1228.25 mg ✓	
	D	A69	1232.31	1236.61	4	4		
	E	A70	1244.03	1247.98	5	5		
180	~~A~~ B	A71	1239.12	1241.93	3	3	Confirmed 1241.90 mg ✓	
	~~B~~ E	A72	1214.89	1215.67	1	1		
	~~C~~	~~A73~~	~~1221.50~~ [2]					
	~~D~~	~~A74~~	~~1238.30~~ [2]					
	~~E~~ [2]							
	A							
	B							
	C							
	D							
	E							

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Qalpty
Date Verified: Aug. 17/05

Test: LF-Larval Fish Growth and Survival Test | Test ID: RTAACu45
Species: AA-Atherinops affinis | Protocol: EPAW 95-EPA West Coast
Sample ID: REF-Ref Toxicant | Sample Type: CU-Copper
Start Date: 7/19/2005 End Date: 7/26/2005 | Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1225.71	1231.08
	2	2	D-Control	5							5	5	1228.66	1232.69
	3	3	D-Control	5							5	5	1235.2	1239.86
	4	4	D-Control	5							5	5	1233.97	1239.36
	5	5	D-Control	5							5	5	1228.91	1234
	6	1	32.0	5							5	5	1229.51	1236.23
	7	2	32.0	5							5	5	1233.16	1239.24
	8	3	32.0	5							5	5	1234.56	1238.84
	9	4	32.0	5							5	5	1225.13	1231.48
	10	5	32.0	5							4	4	1236.28	1241.25
	11	1	56.0	5							4	4	1245.68	1249.99
	12	2	56.0	5							5	5	1222.48	1227.32
	13	3	56.0	5							5	5	1240.76	1246.95
	14	4	56.0	5							5	5	1233.51	1239.05
	15	5	56.0	5							5	5	1239.61	1245.85
	16	1	100.0	5							2	2	1227.36	1229.94
	17	2	100.0	5							1	1	1237.38	1238.7
	18	3	100.0	5							4	4	1224.68	1228.24
	19	4	100.0	5							4	4	1232.31	1236.61
	20	5	100.0	5							5	5	1244.03	1247.98
	21	1	180.0	5							0	0	0	0
	22	2	180.0	5							3	3	1239.12	1241.93
	23	3	180.0	5							0	0	0	0
	24	4	180.0	5							0	0	0	0
	25	5	180.0	5							1	1	1214.89	1215.67
	26	1	320.0	5							0	0	0	0
	27	2	320.0	5							0	0	0	0
	28	3	320.0	5							0	0	0	0
	29	4	320.0	5							0	0	0	0
	30	5	320.0	5							0	0	0	0

Comments: Azimuth Polaris 04-1424-044 (0500298)

Reviewed by: Aug. 22/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	7/19/2005	Test ID:	RTAACu45	Sample ID:	REF-Ref Toxicant
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth Polaris 04-1424-044 (0500298)				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
32	1.0000	1.0000	1.0000	1.0000	0.8000
56	0.8000	1.0000	1.0000	1.0000	1.0000
100	0.4000	0.2000	0.8000	0.8000	1.0000
180	0.0000	0.6000	0.0000	0.0000	0.2000
320	0.0000	0.0000	0.0000	0.0000	0.0000

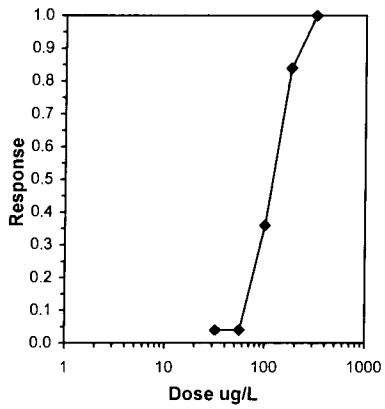
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
100	0.6400	0.3286	0.9416	0.4636	1.3453	38.004	5	17.50	17.00	9	25
*180	0.1600	0.2608	0.4053	0.2255	0.8861	71.039	5	15.00	17.00	21	25
320	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.90309	0.888	0.17519	1.66432
Equality of variance cannot be confirmed				

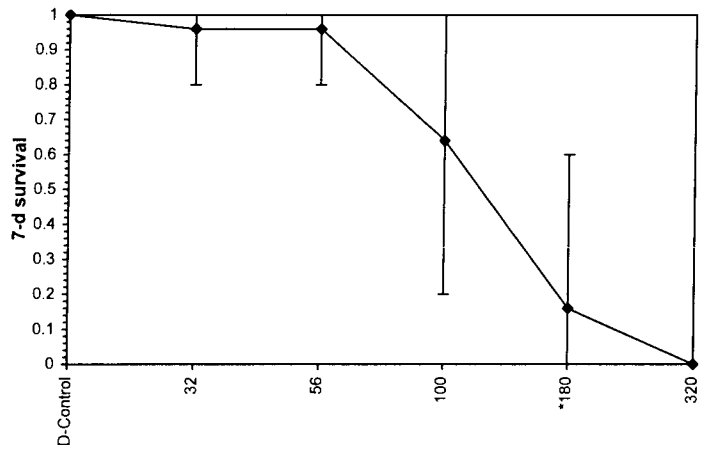
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	180	134.164	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%	116.88	100.05	136.55	
10.0%	116.41	98.86	137.08	
20.0%	117.22	94.25	145.79	
Auto-4.0%	117.04	100.39	136.44	ug/L Cu



Dose-Response Plot



Reviewed by Aug. 22/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/19/2005	Test ID:	RTAACu45	Sample ID:	REF-Ref Toxicant
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth Polaris 04-1424-044 (0500298)				

Conc-ug/L	1	2	3	4	5
D-Control	1.0740	0.8060	0.9320	1.0780	1.0180
32	1.3440	1.2160	0.8560	1.2700	0.9940 ✓
56	0.8620	0.9680	1.2380	1.1080	1.2480
100	0.5160	0.2640 ✓	0.7120	0.8600	0.7900
180	0.0000	0.5620	0.0000	0.0000	0.1560 ✓
320	0.0000	0.0000	0.0000	0.0000	0.0000

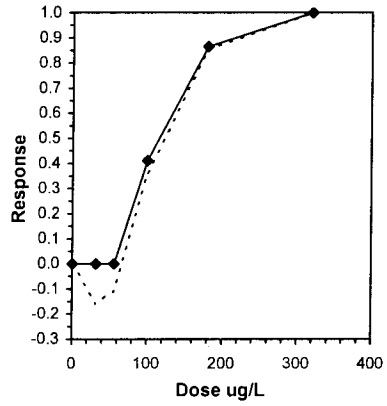
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.9816	0.1145	0.9816	0.8060	1.0780	11.666	5				1.0675	1.0000
32	1.1360	0.2038	1.1360	0.8560	1.3440	17.943	5	-1.219	2.300	0.2913	1.0675	1.0000
56	1.0848	0.1688	1.0848	0.8620	1.2480	15.557	5	-0.815	2.300	0.2913	1.0675	1.0000
*100	0.6284	0.2409	0.6284	0.2640	0.8600	38.338	5	2.789	2.300	0.2913	0.6284	0.5887
*180	0.1436	0.2435	0.1436	0.0000	0.5620	169.535	5	6.618	2.300	0.2913	0.1436	0.1345
320	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5				0.0000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.9755	0.888	0.077	-0.1953
Bartlett's Test indicates equal variances (p = 0.66)	2.41004	13.2767		

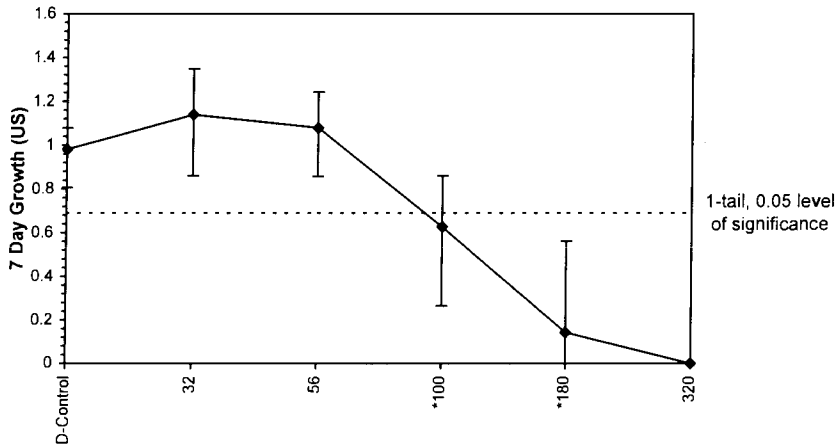
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	56	100	74.8331		0.29126	0.29672	0.85895	0.04009	5.4E-07	4, 20

Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew	
IC05	61.35	6.16	30.65	67.13	-1.9529	
IC10	66.70	4.93	43.95	78.27	-0.6852	
IC15	72.05	5.63	55.64	91.09	0.5478	
IC20	77.39	6.77	62.96	102.78	1.0777	
IC25	82.74	7.81	67.65	114.17	0.9592	
IC40	98.79	11.11	78.22	135.91	0.5373	
IC50	115.62	14.64	80.73	156.41	0.6255	ug/L Cu



Dose-Response Plot



Reviewed by Aug 22/05

APPENDIX II

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299

EVS Analysts: SRS
Test Initiation Date: 19 July 05

SAMPLE

Identification: G-creek sublethal 071605
Amount Received: 3x20L
Date Collected: 16-Jul-05
Date Received: 19-Jul-05
Temperature (°C): 14.0 ① → 15.0
pH: 7.5 ① → 8.2
Dissolved Oxygen (mg/L): 11.1 ① → 8.5
Conductivity (µmhos/cm): 1520
Salinity (ppt): 3.0 ① → 28
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: —

① Brine Adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sea Lab
Date Received: ~~SRS~~ 19 Jul 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 19 Jul 05
IC50 (and 95% CL): 5.8 (5.2 - 6.5) mg/L
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.6 ± 4.4 mg/L SDS; CV = 60%

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized, 0.45µm filtered SW
Temperature (°C): 15
pH: 7.9
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 15.0
pH Range: ~~7.8~~ SRS 7.9 - 8.3
Dissolved Oxygen Range (mg/L): ~~7.9~~ SRS 7.9 - 8.5
Salinity Range (ppt): 28
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

Statistical comparisons were against pooled controls
IC_{50}: 13.2 (10.8 - ~~16.9~~ SRS 16.1) % v/v
IC_{25}: 5.2 (4.4 - 6.1) % v/v
NOEC: < 4.6 % v/v
LOEC: 4.6 % v/v

Data Verified By: [signature]
Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299
Logbook: Edmonds #13 Pages: 68-71

Test Initiation Date/Time: 19 July 05 / 1514
Test Species: Dendraster excentricus
Source/Date Received: Westmar Seatab / 19 July 05
Test Duration: 10:10

Sample ID G-Creek sublethal 071605	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Control	15	7.9	28	8.5	
Brine Control	15	8.3	28	8.5	
4.6 %v/v	15	8.0	28	8.5	
9.1% v/v	15	8.1	28	8.5	
18.2 ~~SDS~~ ±8.3% v/v	15	8.1	28	8.5	
36.4 ~~SDS~~ ±6.6% v/v	15	8.1	28	8.5	
Max (72.8%)	15	8.2	28	8.5	
Technician Initials	SRS	SRS	SRS	SRS	

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-030301 Salinity II-A-030304 DO II-A-20

Sample Description: Sample is clear with no odour.

Data Verified By: Qaljf Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client Azimuth (Polaris Mine)
EVS Project No. 04-1424-044
EVS Work Order No. 0500299
Logbook Echinoid #13 Pages 68-71

Test Initiation Date/Time 19 July 05 / 1514
Test Species Dendraster excentricus
Source/Date Received 19 July 05 / Westwind SeaLab
Test Duration 10:10
Sperm:Egg Ratio 2000:1

Sample ID % (V/V)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
Control	A	64	36		SRS
	B	60	40		
	C	66	34		
	D	69	31		
G-Creek Sublethal 071605 4.6	A	56	44		SRS
	B	51	49		
	C	52	48		
	D	53	47		
G-Creek Sublethal 071605 9.1	A	39	61		SRS
	B	37	63		
	C	37	63		
	D	36	64		
G-Creek Sublethal 071605 18.2 SRS	A	33	67		SRS
	B	~~38~~ 28	72		
	C	29	71		
	D	30	70		
G-Creek Sublethal 071605 36.4 SRS	A	20	80		SRS
	B	27	73		
	C	23	77		
	D	24	76		
G-Creek Sublethal 071605 Max (72.8)	A	20	80		SRS
	B	16	84		
	C	21	79		
	D	21	79		

Data Verified By [signature] Date Verified Aug. 17/05

Test: SC-Sperm Cell Fertilization test					Test ID: 0500299		
Species: DE-Dendraster excentricus					Protocol: EPS1/RM/27-EC 92 (Sperm Cell)		
Sample ID: g_creek sublethal 071605					Sample Type: GW-groundwater		
Start Date: 7/19/2004 10:10			End Date: 7/19/2004		Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	64	36	
	2	2	D-Control	100	60	40	
	3	3	D-Control	100	66	34	
	4	4	D-Control	100	69	31	
	5	1	B-Control	100	70	30	
	6	2	B-Control	100	68	32	
	7	3	B-Control	100	71	29	
	8	4	B-Control	100	67	33	
	9	1	4.600	100	56	44	
	10	2	4.600	100	51	49	
	11	3	4.600	100	52	48	
	12	4	4.600	100	53	47	
	13	1	9.100	100	39	61	
	14	2	9.100	100	37	63	
	15	3	9.100	100	37	63	
	16	4	9.100	100	36	64	
	17	1	18.200	100	33	67	
	18	2	18.200	100	28	72	
	19	3	18.200	100	29	71	
	20	4	18.200	100	30	70	
	21	1	36.400	100	20	80	
	22	2	36.400	100	27	73	
	23	3	36.400	100	23	77	
	24	4	36.400	100	24	76	
	25	1	72.800	100	20	80	
	26	2	72.800	100	16	84	
	27	3	72.800	100	21	79	
	28	4	72.800	100	21	79	

Comments: Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)

Reviewed by: Aug 19/04

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/19/2004 10:10	Test ID:	500299	Sample ID:	g_creek sublethal 071605
End Date:	7/19/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	GW-groundwater
Sample Date:	7/16/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)				

Conc-%	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
B-Control	0.7000	0.6800	0.7100	0.6700
4.6	0.5600	0.5100	0.5200	0.5300
9.1	0.3900	0.3700	0.3700	0.3600
18.2	0.3300	0.2800	0.2900	0.3000
36.4	0.2000	0.2700	0.2300	0.2400
72.8	0.2000	0.1600	0.2100	0.2100

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.6688	0.0356	0.6688	0.6000	0.7100	5.328	8				0.6688	1.0000
*4.6	0.5300	0.0216	0.5300	0.5100	0.5600	4.076	4	8.308	2.508	0.0419	0.5300	0.7925
*9.1	0.3725	0.0126	0.3725	0.3600	0.3900	3.378	4	17.739	2.508	0.0419	0.3725	0.5570
*18.2	0.3000	0.0216	0.3000	0.2800	0.3300	7.201	4	22.080	2.508	0.0419	0.3000	0.4486
*36.4	0.2350	0.0289	0.2350	0.2000	0.2700	12.284	4	25.972	2.508	0.0419	0.2350	0.3514
*72.8	0.1950	0.0238	0.1950	0.1600	0.2100	12.208	4	28.367	2.508	0.0419	0.1950	0.2916

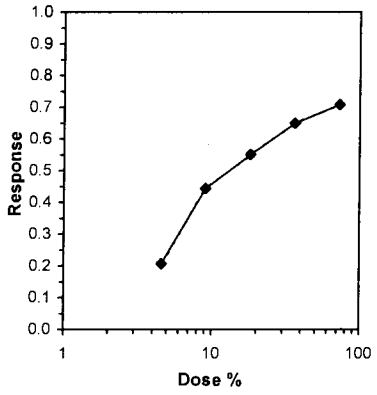
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96577	0.896	-0.6264	0.89125
Bartlett's Test indicates equal variances (p = 0.59)	3.72999	15.0863		
The control means are not significantly different (p = 0.09)	2.02707	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	<4.6	4.6			0.04189	0.06264	0.18978	0.00074	1.0E-18	5, 22

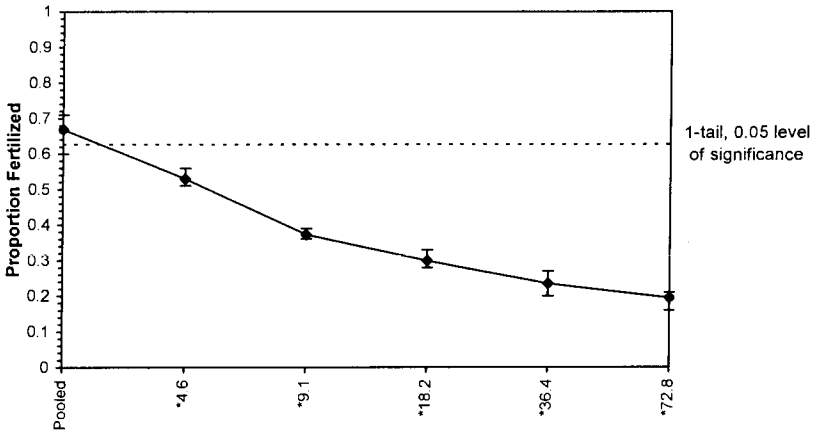
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	0.515	0.065	0.376	0.746	1.1707	
IC10*	1.294	0.204	0.886	2.030	1.4723	
IC15*	2.475	0.454	1.574	4.227	1.0928	
IC20*	4.263	0.546	2.495	5.437	-0.5325	
IC25	5.229	0.268	4.417	6.073	-0.2992	
IC40	8.069	0.268	7.197	8.864	-0.1114	
IC50	13.159	1.074	10.756	16.853	0.9349	%v/v

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: Statistical comparisons were against pooled controls

Reviewed by:

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/19/2004 10:10	Test ID:	500299	Sample ID:	g_creek sublethal 071605
End Date:	7/19/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	GW-groundwater
Sample Date:	7/16/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)				

Conc-%	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
B-Control	0.7000	0.6800	0.7100	0.6700
4.6	0.5600	0.5100	0.5200	0.5300
9.1	0.3900	0.3700	0.3700	0.3600
18.2	0.3300	0.2800	0.2900	0.3000
36.4	0.2000	0.2700	0.2300	0.2400
72.8	0.2000	0.1600	0.2100	0.2100

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.6475	0.0377	0.6475	0.6000	0.6900	5.830	4				0.6475	1.0000
B-Control	0.6900	0.0183	0.6900	0.6700	0.7100	2.646	4					
*4.6	0.5300	0.0216	0.5300	0.5100	0.5600	4.076	4	6.504	2.410	0.0435	0.5300	0.8185
*9.1	0.3725	0.0126	0.3725	0.3600	0.3900	3.378	4	15.222	2.410	0.0435	0.3725	0.5753
*18.2	0.3000	0.0216	0.3000	0.2800	0.3300	7.201	4	19.235	2.410	0.0435	0.3000	0.4633
*36.4	0.2350	0.0289	0.2350	0.2000	0.2700	12.284	4	22.833	2.410	0.0435	0.2350	0.3629
*72.8	0.1950	0.0238	0.1950	0.1600	0.2100	12.208	4	25.047	2.410	0.0435	0.1950	0.3012

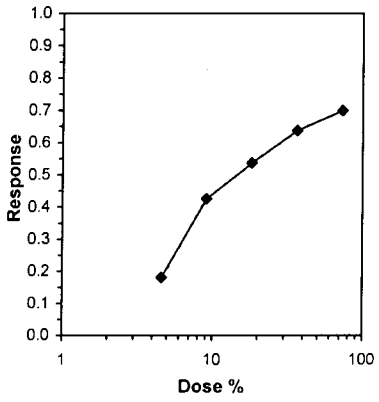
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98059	0.884	-0.1047	-0.1759
Bartlett's Test indicates equal variances (p = 0.67)	3.19845	15.0863		
The control means are not significantly different (p = 0.09)	2.02707	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<4.6	4.6			0.04354	0.06724	0.12461	0.00065	6.1E-15	5, 18

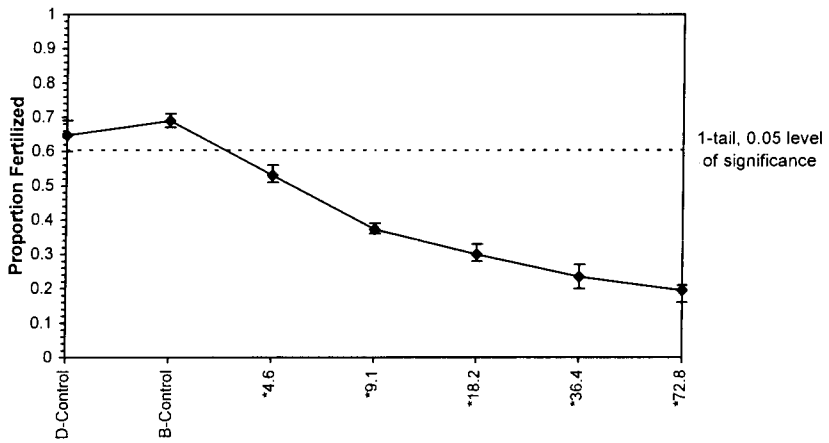
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	0.607	0.161	0.394	1.360	2.3644	
IC10*	1.584	0.557	0.927	4.356	2.4779	
IC15*	3.154	0.865	1.634	6.106	0.5417	
IC20	4.857	0.524	3.042	6.173	-0.5720	
IC25	5.612	0.375	4.664	6.952	0.2814	
IC40	8.513	0.444	7.515	10.306	1.0512	
IC50	14.556	1.689	10.887	21.343	0.9377	%v/v

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: Statistical comparisons were against the dilution control

Reviewed by

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299

EVS Analysts: SRS
Test Initiation Date: 19 July 05

SAMPLE

Identification: SDS Reftox Stock Soln #05-3-004
Amount ~~Received~~ Prep'd: 1 x 1L
Date ~~Collected~~ Prep'd: 7-Jun-05
Date Received: N/A
Temperature (°C):
pH:
Dissolved Oxygen (mg/L):
Conductivity (µmhos/cm):
Salinity (ppt):
Ammonia (mg/L N):
Chlorine (mg/L Cl):
Other:

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab
Date Received: 19 July 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 19 July 05
IC50 (and 95% CL): 5.8 (5.2 - 6.5) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.6 ± 4.4 mg/L SDS, CV% = 60

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized; 0.45 µm filtered SW
Temperature (°C): 15
pH: 7.9
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 15
pH Range: 7.8 - 7.9
Dissolved Oxygen Range (mg/L): 8.5
Salinity Range (ppt): 28
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC50: 5.8 (5.2 - 6.5) mg/L SDS
IC25: 3.0 (2.6 - 3.5) mg/L SDS
NOEC: 1.0 mg/L SDS
LOEC: 1.8 mg/L SDS

Data Verified By: [signature]
Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299
Logbook: #13 Pages: 68-71'

Test Initiation Date/Time: 19 July 05 / 1514
Test Species: Dendraster excentricus
Source/Date Received: Westwind Seatab / 19 July 05
Test Duration: 10:10

Reftox

Sample ID SDS (mg/L)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Control	15	7.9	29	8.5	
1.0	15	7.8	28	8.5	
1.8	15	7.8	28	8.5	
3.2	15	7.8	28	8.5	
5.6	15	7.8	28	8.4 8.5	
10.0	15	7.8	28	8.4 8.5	
Technician Initials	SRS	SRS	SRS	SRS	

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-030301 Salinity II-A-080304 DO II-A-20

Sample Description

Data Verified By: [signature] Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0508299
Logbook: #13 Pages: 68-71

Test Initiation Date/Time: 19 Aug 05 / 1514
Test Species: Dendraster excentricus
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Concentration SDS (mg/L)	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	71	29		SRS
	B	69	31		
	C	71	29		
	D	70	30		
1.8	A	56	44		
	B	60	40		
	C	62	38		
	D	60	40		
3.2	A	~~51~~ 51	~~49~~ 49		
	B	47	53		
	C	51	49		
	D	50	50		
5.6	A	34	66		
	B	37	63		
	C	32	68		
	D	36	64		
10	A	20	80		
	B	21	79		
	C	18	82		
	D	19	81		
Control Seawater					
Brine Control	A	70	30		SRS
	B	68	32		
	C	71	29		
	D	67	33		

Data Verified By: [signature] Date Verified: Aug 17/05

Test: SC-Sperm Cell Fertilization test						Test ID: rtdesds051	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: REF-Ref Toxicant						Sample Type: SDS-Sodium dodecyl sulfate	
Start Date: 7/19/2005 10:10			End Date: 7/19/2005			Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	64	36	
	2	2	D-Control	100	60	40	
	3	3	D-Control	100	66	34	
	4	4	D-Control	100	69	31	
	5	1	1.000	100	71	29	
	6	2	1.000	100	69	31	
	7	3	1.000	100	71	29	
	8	4	1.000	100	70	30	
	9	1	1.800	100	56	44	
	10	2	1.800	100	60	40	
	11	3	1.800	100	62	38	
	12	4	1.800	100	60	40	
	13	1	3.200	100	51	49	
	14	2	3.200	100	47	53	
	15	3	3.200	100	51	49	
	16	4	3.200	100	50	50	
	17	1	5.600	100	34	66	
	18	2	5.600	100	37	63	
	19	3	5.600	100	32	68	
	20	4	5.600	100	36	64	
	21	1	10.000	100	20	80	
	22	2	10.000	100	21	79	
	23	3	10.000	100	18	82	
	24	4	10.000	100	19	81	

Comments: Azimuth Consulting Group 04-1424-044 (0500299)

Reviewed by Aug. 17/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/19/2005 10:10	Test ID:	rtdesds051	Sample ID:	REF-Ref Toxicant
End Date:	7/19/2005	Lab ID:	BCEVS-EVS Environment C(	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 04-1424-044 (0500299)				

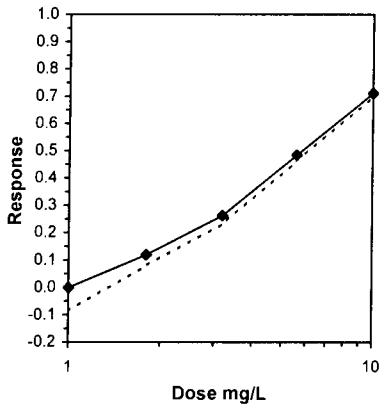
Conc-mg/L	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
1	0.7100	0.6900	0.7100	0.7000
1.8	0.5600	0.6000	0.6200	0.6000
3.2	0.5100	0.4700	0.5100	0.5000
5.6	0.3400	0.3700	0.3200	0.3600
10	0.2000	0.2100	0.1800	0.1900

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.6475	0.0377	0.6475	0.6000	0.6900	5.830	4				0.6750	1.0000
1	0.7025	0.0096	0.7025	0.6900	0.7100	1.363	4	-3.386	2.410	0.0391	0.6750	1.0000
*1.8	0.5950	0.0252	0.5950	0.5600	0.6200	4.230	4	3.232	2.410	0.0391	0.5950	0.8815
*3.2	0.4975	0.0189	0.4975	0.4700	0.5100	3.805	4	9.234	2.410	0.0391	0.4975	0.7370
*5.6	0.3475	0.0222	0.3475	0.3200	0.3700	6.381	4	18.468	2.410	0.0391	0.3475	0.5148
*10	0.1950	0.0129	0.1950	0.1800	0.2100	6.620	4	27.855	2.410	0.0391	0.1950	0.2889

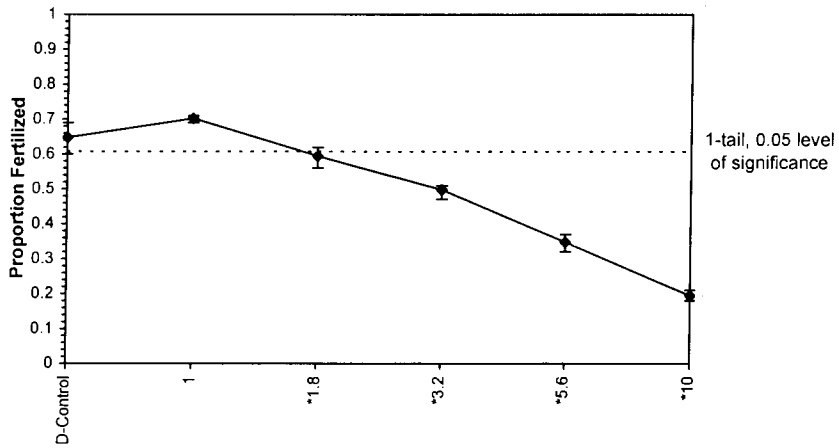
Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.96443		0.884		-0.4619	0.4979
Bartlett's Test indicates equal variances (p = 0.33)					5.80467		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	1	1.8	1.34164		0.03915	0.06046	0.15043	0.00053	1.8E-16	5, 18

Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew	
IC05	1.3050	0.0620	1.1588	1.5675	0.7327	
IC10	1.6566	0.1267	1.3262	2.1192	0.1987	
IC15	2.0587	0.1538	1.5036	2.4959	-0.3268	
IC20	2.5196	0.1504	2.0886	3.0277	-0.0752	
IC25	3.0499	0.1581	2.5656	3.5441	-0.1894	
IC40	4.5501	0.1485	4.0503	5.0634	-0.0472	
IC50	5.8248	0.2258	5.1944	6.4999	-0.1156	mg/L SDS



Dose-Response Plot



Reviewed by: Aug. 17/05

APPENDIX III

Chain-of-Custody Form

CHAIN-OF-CUSTODY/TEST REQUEST FORM

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Client Name: Teck Cominco
Client Contact Name: Bruce Donald
Ship to: BILL TO AZIMUTH CONSULTING GROUP.
Address: Bay 2000 Kimberley BC V1A 3E1
Phone: (250)427-8405
Fax: (250)427-8451
Sampled By: Blake Hamer
Attn: Edmond Canuria
Shipping Date: July 16/05

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested: 96-hr LC50 Rainbow Trout	48-hr LC50 Daphnia Magna	7-Day Toxicity Test	20 min Echinoderm Fertilization			3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Receipt Sample Temp. (°C)	4 Condition/Integrity
For composite sample record date & time starting and ending																
16/07/05	0900	C-Creek_Acute_071605	E		G	2x20	P	X	X					Effluent Water		
16/07/05	0900	C-Creek_Sublethal_071605	E		G	3x20	P			X	X			Effluent Water		

EVS Receipt Check List SAP
EVS Project #: 04-1424-00044
EVS Workorder #: 0500296/7/8/9
Sample Storage Location: 4°C [X], Chemical [ ], Other ____
Supporting documentation/other information attached if applicable.

1.	Signatures & dates correct?	Y N
2.	Chain-of-custody fully completed?	Y N
3.	Containers arrived in good condition (unbroken)?	Y N
4.	Container labels completed (i.e., dates, ID's)?	Y N
5.	Container labels agreed with custody papers?	Y N
6.	Sample receipt temperature within acceptable range?	Y N
7a.	Sediment testing going to be initiated within 14 days?	Y N
7b.	If no, are samples under Nitrogen? If not, why?	Y N
8.	Chain-of-custody generated upon receipt.	[ ]
9.	Sample containers originate from EVS.	[ ]

PO/Reference No.:
Project Title: Polaris MMER.
Results Needed By: Routine Turn Around.

Comments/Instructions: Bill to: Azimuth Consulting Group.
Electronic Results to: Cheryl Mackintosh, Azimuth, cmackintosh@azimuthgroup.ca
Bruce Donald, Teck Cominco ~~tcominco~~ bruce.donald@teckcominco.com.
Temp: 12.7°C

A) Released By: Blake Hamer Date: July 16, 2005
Company: GLL Time: 1030
Courier name: ____
Shipping containers secured by: ~~Tape~~ Straps Lock Other ____ (circle one)
Custody seals used? Yes No

B) Received by: SAP Date: 19 July 05
Company: Golder Time: 10:45
Shipping containers received secure? (Yes) No
Custody seals intact? (Yes) No N/A

C) Released By: Date:
Company: Time:
Courier name: ____
Shipping containers secured by: Tape Straps Lock Other ____ (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

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smart science solutions

Champia parvula Sexual Reproduction Test Results

for Sample E452

for

Azimuth Consulting Group

by

Mary Moody
Environment and Minerals Division
Saskatchewan Research Council

SRC Publication No. 11020-7C05

August 2005

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Champia parvula Sexual Reproduction Test Quality Assurance Summary

Client	Azimuth Consulting Group	SRC Sample #	E452
File #	MM478	Test Initiation Date	Aug 9/05
Analyst	M. Moody	Test Completion Date	Aug 16/05
Sample Identity/Name	Garrow Creek		

This report is based on the Report Assessment Checklist for EEM Cycle Two: Test of Sexual Reproduction using the Red Macroalga *Champia parvula.* (May 1999)

Test Organisms, Method and Conditions - Species: *Champia parvula,* sexually mature male and female branches, in good health, males having sori with spermatia, females having trichogynes. Method: EPA/600/4-91/003, Method 1009.0, static, non-renewal; 2-day effluent exposure followed by 5 to 7 day recovery period in control medium for cystocarp development. Exposure/Dilution Medium: natural seawater collected at Pacific Environmental Science Centre, Environment Canada, North Vancouver, B.C., filtered to 0.2µm and autoclaved before use, adjusted as necessary to salinity 30 ppt. with hypersaline brine made from the same source water. Test medium is natural seawater enriched with 10 ml/L Test Nutrient Solution. Recovery Medium is natural seawater as above, enriched with 10 ml/L Culture Nutrient Solution (method section 16.10.1.3).

Reference Toxicant Test - Method: EPA/600/4-91/003, Method 1009.0, static, non-renewal; 2-day toxicant exposure followed by 5 to 7 day recovery period in control medium for cystocarp development. Test conditions: performed under same experimental conditions as effluent sample. Compound: sodium dodecyl sulphate mg/L

Date of test: Aug 17/05	Historic value, warning limits ±2SD
IC_{50} (95 % CL) mg/L 1.31 (1.20 - 1.41)	1.41 (1.15 - 1.74)

Quality Control Data - There was no unusual appearance or treatment of test organisms before their use in the test. There was nothing unusual about the test, no deviation from the test method or problems encountered. No control mortality was observed in any control solution during observation periods. Sample was tested within 72 hours of collection. The mean number of cystocarps per plant counted in this test must be >10 to be acceptable. Data for this test is as follows.

natural seawater controls	85.9
brine controls	95.8
pooled control cystocarp count*	90.9

* this number used in calculation of IC values as required in EC guidance document on salinity adjustment, July 1997

Toxicity Test Results

IC_{25} (95 % CL) %v/v	45.3 (27.5 - 52.4)
Signature	M. Moody
Date	Aug 24/05

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Phone: 306-933-5469

Test Data Summary

SAMPLE

				SRC#	E452
Identification/Name	Garrow Creek			Analyst	Mary Moody
Date/Time Received	Aug 9/05@ 0900	Date Collected	Aug 6/05	Temperature Upon Receipt (°C)	22 with ice packs
Test Initiation Date	Aug 9/05	Test Completion Date	Aug 16/05		

ORGANISM INFORMATION

Species	*Champia parvula*	Appearance/Health of *Champia*	excellent
Source	sexually mature male and female branches, obtained from USEPA, Hatfield Marine Science Center, Newport, Oregon, 1995		
Females, Presence of Trichogynes	yes	Males, Presence of Sori with Spermatia	yes

TEST CONDITIONS

Test Method	USEPA/600/4-91/003, Method 1009.0	Dilution water	Natural seawater from Pacific Environmental Science Centre, North Vancouver B.C.
Test Type	static, non-renewal; 2 day effluent exposure followed by 5-7 day recovery period in control medium for cystocarp development		
Test Vessels (Exposure & Recovery)	270 ml transparent polystyrene cups, transparent polystyrene lids		
Exposure Volume / Depth	100 ml / 4.5 cm	Recovery Volume / Depth	200 ml / 7.3 cm
Replicates/Conc.	3	No. of organisms (female/male)	5/2
Number and Concentrations of Test Solutions (%v/v)	Controls: (two) natural sea water, brine Tests: 70, 35, 17.5, 8.75, 4.38		
Chemicals added to control/dilution water	Test Nutrients as described in method cited at 10 ml/L, analytical grade		

Sample Treatment

D.O. on unadjusted sample salinity adjustment (mg/L)	8.6	D.O. after salinity adjustment (mg/L)	7.7		
Aeration (duration/rate)	none	Filtration	none	pH Adjustment	none
Salinity Adjustment*	600 mL effluent + 260 mL hypersaline brine + 8.6 mL test nutrient solution				
Hypersaline Brine for Salinity Adjustment*	Prepared from natural seawater, at 90 ppt salinity				

* *as per EC guidance document on salinity adjustment, May 2001*

Exposure Period (48 h) and Recovery Period (5-7 days)

Temperature, pH, D.O. and Salinity of test solutions and controls on following page

Photoperiod (L:D h)	16:8	Agitation of tests and controls during exposure	gentle rotary shaking

Recovery Medium: natural sea water containing 10 ml/L Culture Nutrients (section 16.10.1.3 of cited method)

Aeration during recovery: gentle aeration supplied

TOXICITY TEST RESULTS

IC_{25} (%v/v) (95% CL)	45.3 (27.5 - 52.4)	IC_{50} (%v/v), (95% CL)	61.4 (50.4 - 66.6)
Mean control cystocarps/female (pooled natural sea water and brine controls)			90.9

Submitted By: M Moody **Date:** Aug 24/05

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Phone: 306-933-5469

Water Quality Data

Sample Identification/Name Garrow Creek SRC# E452

INITIAL WATER QUALITY	UNADJUSTED SAMPLE at test start, without salinity adjustment	TEST MEDIUM	RECOVERY MEDIUM
Temperature (°C)	23	23	23
Dissolved Oxygen (mg/L)	8.6	7.6	7.8
pH	7.75	8.35	8.10
Salinity (ppt):	2	30	30

Sample Description clear colourless liquid Length of Recovery Period (days) 5

Water Quality Data during Exposure Period (0, 48 hr) and Recovery Period (0 and end)

Concentration % (v/v)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Salinity (ppt)			
	exposure		recovery		exposure		recovery		exposure		recovery		exposure		recovery	
	0	48	0	end	0	48	0	end	0	48	0	end	0	48	0	end
Control-NSW*	23	23	23	23	7.6	7.8	7.8	7.9	8.34	8.37	8.10	7.98	30	30	30	30
Control-brine	23	23	23	23	7.8	7.8	7.8	7.8	8.11	8.59	8.10	8.01	30	30	30	30
A 70	23	23	23	23	7.7	7.8	7.8	7.9	8.05	8.54	8.10	8.03	30	30	30	30
C 17.5	23	23	23	23	7.8	7.8	7.8	7.9	8.29	8.64	8.10	8.67	30	30	30	30
E 4.38	23	23	23	23	7.6	7.8	7.8	7.9	8.34	8.47	8.10	8.05	30	30	30	30

RECOVERY PERIOD - TEMPERATURE MONITORING (initial daily entries)

Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
23	23	23	23	23	23		

Comments

pH before salt addition: 7.75, after salt addition 8.12

*NSW natural sea water

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Test Data

Sample Identification: Garrow Creek — E452

Concentration % (v/v) #		Rep	Mortality #	Mortality %	Individual Plant Cystocarp Counts 1	2	3	4	5	mean	SD*	Comments
Control, Natural Sea Water		A	0	0	130	80	119	96	95	104.0	20.1	Mean and SD 85.9, 23.8 Healthy red colour, normal growth
		B	0	0	63	86	60	60	102	74.2	19.0	
		C	0	0	95	106	54	54	89	79.6	24.2	
Control, brine		A	0	0	96	98	129	106	90	103.8	15.2	Mean and SD 95.8, 15.3 Healthy red colour, normal growth
		B	0	0	75	74	103	91	80	84.6	12.3	
		C	0	0	97	96	104	118	80	99.0	13.8	
E	4.38	A	0	0	105	60	81	103	100	89.8	19.2	Mean and SD 80.8, 17.4 Healthy red colour, normal growth
		B	0	0	88	53	65	84	60	70.0	15.3	
		C	0	0	103	75	85	64	86	82.6	14.5	
D	8.75	A	0	0	110	88	75	72	88	86.6	15.0	Mean and SD 92.9, 22.9 Healthy red colour, normal growth
		B	0	0	109	127	75	71	110	98.4	24.3	
		C	0	0	82	50	124	121	91	93.6	30.5	
C	17.5	A	0	0	100	138	92	71	77	95.6	24.6	Mean and SD 92.7, 19.1 Healthy red colour, normal growth
		B	0	0	107	107	65	100	91	94.0	17.5	
		C	0	0	99	101	63	94	85	88.4	15.5	
B	35	A	0	0	82	67	118	115	77	91.8	23.2	Mean and SD 82.6, 24.2 Healthy red colour, normal growth
		B	0	0	67	88	76	138	75	88.8	28.5	
		C	0	0	55	75	58	57	91	67.2	15.5	
A	70	A	0	0	35	27	40	37	36	35.0	4.8	Mean and SD 33.3, 8.3 Healthy red colour, normal growth
		B	0	0	44	41	18	40	40	36.6	10.5	
		C	0	0	22	41	23	25	31	28.4	7.9	

* Standard Deviation

Submitted by: _____ Date: Aug 24/05

Algal Reproduction Test-Reproduction

Start Date:	8/9/2005	Test ID:	CP478IM	Sample ID:	E452
End Date:	8/16/2005	Lab ID:	SRC-Saskatchewan Researc	Sample Type:	effluent
Sample Date:	8/6/2005	Protocol:	EPA MARINE	Test Species:	CP-Champia parvula
Comments:	Azimuth, Garrow Creek				

Conc-%	1	2	3
control NSW	104.0	74.2	79.6
control salt	103.8	84.6	99.0
4.38	89.8	70.0	82.6
8.75	86.6	98.4	93.6
17.5	95.6	94.0	88.4
35	91.8	88.8	67.2
70	35.0	36.6	28.4

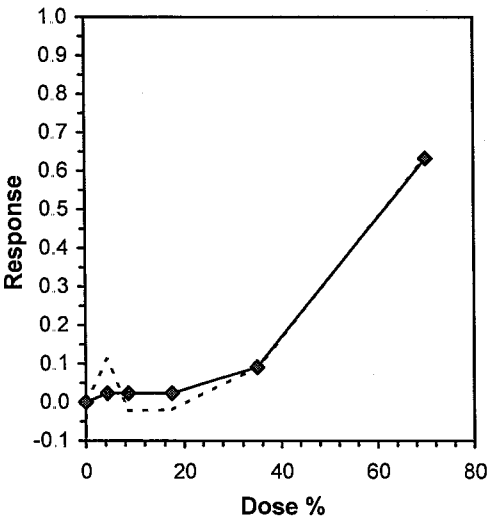
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	90.867	1.0000	90.867	74.200	104.000	14.348	6				90.867	1.0000
4.38	80.800	0.8892	80.800	70.000	89.800	12.403	3	1.401	2.602	18.693	88.778	0.9770
8.75	92.867	1.0220	92.867	86.600	98.400	6.390	3	-0.278	2.602	18.693	88.778	0.9770
17.5	92.667	1.0198	92.667	88.400	95.600	4.080	3	-0.251	2.602	18.693	88.778	0.9770
35	82.600	0.9090	82.600	67.200	91.800	16.248	3	1.151	2.602	18.693	82.600	0.9090
*70	33.333	0.3668	33.333	28.400	36.600	13.040	3	8.010	2.602	18.693	33.333	0.3668

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95534	0.873	-0.382	-0.7392
Bartlett's Test indicates equal variances (p = 0.41)	5.05585	15.0863		
The control means are not significantly different (p = 0.41)	0.91096	2.77645		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test Treatments vs Pooled Controls	35	70	49.4975	2.85714	18.6933	0.20572	1647.03	103.188	1.5E-05	5, 15

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	24.453	14.175	0.000	46.034	-0.2407
IC10	35.583	10.745	0.000	44.063	-1.3971
IC15	38.810	6.323	10.646	46.832	-1.1329
IC20	42.038	5.167	19.403	49.607	-1.0896
IC25	45.266	4.472	27.509	52.378	-1.0088
IC40	54.949	3.252	41.542	60.787	-1.0203
IC50	61.404	2.558	50.439	66.550	-0.9526



Reviewed by: GW

SRC

CHAIN-OF-CUSTODY / TEST REQUEST FORM

№ 0744

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Client Name: Bruce Donald
Address: 200 2000 Kimberly BC V1A 3E1
Client Contact: Bruce Donald
Phone: 250-427-8905
Fax: 250-427-8451
Sampled by: B Bolton
Ship to: SRC
15 Innovation Boulevard
Saskatoon SK S7N 2X8
Attn.: Mary Moody
Shipping Date: Aug 6/05

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
								Establish toxicity					
Aug/8/05	10:00	Gavrow Creek	E		G	2x2L							
		received Aug 9/05				2x2L	at	22°C	with ice packs				

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Bolton
Company: Gartner Lee
Courier Name:
Date: Aug 6/05
Time: 1400 hrs

2) Released by:
Company:
Courier Name:
Date:
Time:

1) Received by: M Moody
Company: SRC
Date: Aug 9/05
Time: 0900

2) Received by:
Company:
Date:
Time:

Shaded area to be completed by Golder Laboratory upon sample receipt

Golder Project No.:
Golder Work Order No.:
Condition Upon Receipt:
Receipt Sample Temp. (°C):

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

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Revision Date: November 22, 2004

September 2005

LABORATORY REPORT

Azimuth Consulting Group

POLARIS MINE

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

August 6, 2005 Sample

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

AUGUST 6, 2005 SAMPLE

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants (A Member of the Golder Group of Companies)
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

04-1424-044

September 2005

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GLOSSARY

Control — A treatment in an investigation or study that duplicates all the conditions and factors that might affect the results of the investigation, except the specific condition that is being studied. In an aquatic toxicity test, the control must duplicate all the conditions of the exposure treatment(s), but must contain no test substance. The control is used to determine the absence of measurable toxicity due to basic test conditions (e.g., quality of the dilution water, health of test organisms, or effects due to handling of test organisms). (Environment Canada, 1998)

Dilution water — Water used to dilute the test material in an aquatic toxicity test in order to prepare either different concentrations of a test chemical or different percentages of an effluent for the various test treatments. The water (negative) control in a test is prepared with dilution water only. (Rand, 1995)

Effluent — Any liquid waste (e.g., industrial, municipal) discharged to the aquatic environment. (Environment Canada, 1998)

Endpoint — The reaction of the organisms to show the effect which is intended to mark completion of the test, and also the measurement(s) or value(s) derived, that characterize the results of the test (e.g., IC*p*). (Environment Canada, 1998)

IC*p* — The inhibiting concentration for a (specified) percent effect. It represents a point estimate of the concentration of test substance that is estimated to cause a designated percent impairment in a quantitative biological function such as the size attained by fish during a growth period. This term should be used for any toxicological test which measures a quantitative effect or change in rate, such as growth, reproduction, or respiration. (Environment Canada, 1998)

LC50 — The median lethal concentration, i.e., the concentration of substance in water estimated to be lethal to 50% of the test organisms. The LC50 and its 95% confidence limits are usually derived by statistical analysis of mortalities in several test concentrations, after a fixed period of exposure. The duration of exposure must be specified (e.g., 96-h LC50). (Environment Canada, 1998)

LOEC	The lowest-observed-effect-concentration. This is the lowest concentration of a test substance to which organisms are exposed, that causes adverse effects on the organism which are detected by the observer and are statistically significant. For example, the LOEC might be the lowest test concentration at which growth of fish was decreased significantly from that of the control groups. LOEC is generally reserved for adverse sublethal effects but can also be used for mortality, which might sometimes be the most sensitive effect observed. (Environment Canada, 1998)
NOEC	The no-observed-effect-concentration. This is the highest concentration of a test substance or material to which organisms are exposed, that does not cause any observed and statistically significant adverse effects on the organism. For example, the NOEC might be the highest test concentration at which growth was not decreased significantly from that of the control groups. NOEC customarily refers to adverse sublethal effects, and to the most sensitive effect unless otherwise specified. (Environment Canada, 1998)
Percentage (%)	A concentration expressed in parts per hundred parts. One percentage represents one unit or part of substance (e.g., effluent, elutriate, leachate or receiving water) diluted with water or medium to a total of 100 parts. Depending on the test substance, concentrations can be prepared on a weight-per-weight, weight-per-volume, or volume-per-volume basis, and are expressed as the percentage of test substance in the final sediment mixture or solution. (Environment Canada, 1999b)
Quality assurance (QA)	A program organized and designed to provide accurate and precise results. Included are selection of proper technical methods; tests, or laboratory procedures; sample collection and preservation; selection of limits; evaluation of data; quality control; and qualifications and training of personnel. (Rand, 1995)
Quality control (QC)	Specific actions required to provide information for the quality assurance program. Included are standardization, calibration, replicates, and control and check samples suitable for statistical estimates of confidence of the data. (Rand, 1995)

Reference toxicant	A standard chemical used to measure the sensitivity of the test organisms to establish confidence in the toxicity data obtained for a test substance. In most instances, a toxicity test with a reference toxicant is performed to assess the sensitivity of the organisms at the time the test substance is evaluated, and to determine the precision of results obtained by the laboratory for that chemical. (Environment Canada, 1999b)
Significant difference	A quantitative determination of the probability that two measurements of the same parameter are different, given the variability of the measurements.

1. INTRODUCTION

EVS Environment Consultants (a member of the Golder Group of Companies) conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as Garrow Creek, was collected from the Polaris Mine Site on August 6, 2005 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on August 9, 2005 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. Toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. The raw data and statistical analyses are provided in Appendices I and II respectively, and the chain-of-custody form is provided in Appendix III.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d survival and growth toxicity and reference toxicant tests using topsmelt (*A. affinis*) was conducted in accordance with U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was conducted in accordance with Environment Canada (1992 with 1997 amendments). Test conditions and methods are summarized in Table 2.

This fertilization test involves exposing echinoderm sperm to a series of test concentrations for ten minutes, echinoderm eggs are then added allowing fertilization to occur for ten minutes. Following the ten minutes exposure time, the eggs are preserved and the number of fertilized and unfertilized eggs in each replicate are counted. These observations are assessed in comparison to the pooled negative and brine controls.

2.3 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994).

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and

record-keeping, and use of standard operating procedures (SOPs). To ensure data and reporting meet quality standards, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Toxicity testing was carried out in accordance with applicable test methodologies and/or standards of practice. Our liability is limited solely to the cost of re-testing in the event of non-compliance with such test specifications or standards of practice. Golder/EVS accepts no responsibility or liability for the interpretation or use of these testing results by others, or for any delay, loss, damage or interruptions of testing, collection, preparation, and delivery of samples or test results resulting from events or circumstances beyond our control.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10 d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.2, 8.4, 16.9, 33.7, 67.4% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.5, 8.9, 17.8, 35.6, 71.3% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The test results are summarized in Table 3 and the raw statistical analyses are provided in Appendix I.

The highest concentration tested was approximately 67.4% due to salinity adjustment. The mean survival for the negative and brine controls was 92 and 88%, respectively. Mean dry weight in the pooled controls was 0.86mg. The negative and brine controls were not significantly different for both the growth and survival endpoints (p = 0.40 and p = 0.70, respectively).

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). For the survival and growth endpoints, the NOEC was 67.4, and the LOEC was >67.4% (v/v). The LC50 for survival was >67.4% (v/v). The IC50 and IC25 for growth were both >67.4% (v/v).

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The test results are summarized in Table 4 and the raw statistical analyses are provided in Appendix II.

The highest concentration tested was 71.3% due to salinity adjustment. Mean fertilization in the pooled controls was 86%. The negative and brine controls were not significantly different (p =0.30).

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was <4.5 and LOEC was 4.5% (v/v). The IC50 and IC25 (95% confidence limits) values were 55.0 (49.2 – 61.1) and 15.6 (13.6 – 18.3) % (v/v), respectively.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 3. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% V/V)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
Negative Control	92.0 ± 11.0	0.81 ± 0.24
Brine Control	88.0 ± 17.9	0.91 ± 0.12
Pooled Controls	90.0 ± 11.0	0.86 ± 0.18
4.2	88.0 ± 11.0	0.86 ± 0.18
8.4	96.0 ± 8.9	0.90 ± 0.13
16.9	80.0 ± 14.1	0.76 ± 0.17
33.7	92.0 ± 11.0	0.75 ± 0.13
67.4	80.0 ± 14.1	0.81 ± 0.16
TEST ENDPOINT	**SURVIVAL (% V/V)**	**GROWTH (% V/V)**
NOEC	67.4	67.4
LOEC	>67.4	>67.4
LC50	>67.4	na
IC50	na	>67.4
IC25	na	>67.4

SD – Standard Deviation; na – not applicable.

Table 4. Summary of results for the Echinoderm (*Dendraster excentricus)* fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	85.0 ± 2.9
Brine Control	87.2 ± 2.6
Pooled Controls	86.1 ± 2.8
4.5	79.8 ± 1.7*
8.9	76.5 ± 0.6*
17.8	61.8 ± 2.2*
35.6	52.8 ± 1.9*
71.3	37.2 ± 2.1*
TEST ENDPOINT	**PROPORTION FERTILIZED %(v/v)**
NOEC	<4.5
LOEC	4.5
IC50 (95% CL)	55.0 (49.2 – 61.1)
IC25 (95% CL)	15.6 (13.6– 18.3)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

4. REFERENCES

Environment Canada. 1992. Biological test method: fertilization of echinoids (sea urchins and sand dollars). Environmental Protection Series, Report EPS 1/RM/27, December 1992. Environment Canada, Conservation and Protection, Ottawa, ON. 68 pp + appendices. Amended November 1997.

US EPA. 1995. Short term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 2nd edition. US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Office of Research and Development, Washington, DC. EPA/600/R-95/136. 563 pp.

Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX I

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

EVS Analysts MJG SxB JxS RSO
Test Initiation Date 9 Aug 05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	Garrow Creek	Garrow Creek	Garrow Creek
Amount Received	5 x 20L	5 x 20L	5 x 20L
Date Collected	6-Aug-05	6 Aug 05	6 Aug 05
Date Received	9-Aug-05	9 Aug 05	9 Aug 05
Temperature (°C)	20.0	20.0	20.0
pH	7.7 ① → 8.3	7.8 ① → 8.4	7.9 ① → 8.4
DO (mg/L)	9.8 ① → 7.6	10.0 ① → 7.6	10.5 ① → 7.6
Conductivity (µmhos/cm)	-	-	-
Salinity (ppt)	1.0 ① → 30.0	1.0 ① → 30.0	1.0 ① → 30.0
Ammonia (mg/L N)	-	-	
Chlorine (mg/L Cl)	-	-	
Other	① After salinity adjustment	① After salinity adjustment	① After salinity adjustment

DILUTION/CONTROL WATER (initial water quality)
Water Type unsterilized filtered SW
Temperature (°C) 20.0
pH 7.9
Dissolved Oxygen (mg/L) 7.7
Salinity 29

TEST SPECIES INFORMATION
Source ABS Inc.
Date Received 9-Aug-05
Age (on Day 0) 10 days
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 9 Aug 05
7-d survival LC50 103 (91-118) ~~103 (88-124)~~ mg/L Cu
7-d growth IC50 95 ~~(75-125)~~ (76-127) mg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 132 ± 40 mg/L Cu CV=15%
7-d growth IC50 133 ± 40 mg/L Cu CV=15%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.7 ~~7.9~~ - 8.4
Dissolved Oxygen Range (mg/L) 6.4-7.7
Salinity (ppt) 28-31
Photoperiod (L:D h) 16:8
Aeration Provided? None
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	67.4	>67.4	>67.4		
Growth		67.4	~~>67.4~~ >67.4		>67.4	>67.4

Other

Data Verified By Qualfish
Date Verified Sept 1/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth | Sample ID: G. Creek (Garrow Creek)

EVS Project No.: C4-1424-04.4 | Test Initiation Date/Time: 9 Aug 05 / 1500h

EVS Work Order No.: 0500327 | Source/Date Received: ABS Inc / 9 Aug 05

Concentration % (v/v)	Temperature (°C)													
	0	1		2		3		4		5		6		7
D-Control	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0
B-Control	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
4.2	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
8.4	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0
16.9	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
33.7	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
67.4	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
Tech. Initials	SxB	SxB	SxB	VL	VL	SxB	SxB	SxB	SxB	SxB	SxB	TM	TM	TM

Concentration % (v/v)	pH													
	0	old	New	2		3		4		5		6		7
D-Control	7.9	7.9	8.0	7.9	7.9	7.7	7.9	7.7	SxB 8.0 8.2	7.8	7.9	8.0	7.9	8.0
B-Control	8.0	7.9	8.1	8.0	8.0	7.7	7.9	7.7	SxB 7.9	7.8	7.9	8.0	7.9	7.9
4.2	8.0	7.9	8.2	7.9	8.1	7.7	8.0	7.7	8.1	7.8	8.0	8.0	7.9	7.9
8.4	8.0	8.0	8.2	7.9	8.1	7.8	8.0	7.8	8.1	7.8	8.0	8.0	8.0	8.0
16.9	8.1	8.0	8.3	8.0	8.2	7.9	8.1	7.8	8.2	7.9	8.1	8.1	8.0	8.0
33.7	8.1	8.0	8.3	8.1	8.3	8.1	8.1	7.9	8.3	7.9	8.2	8.2	8.1	8.1
67.4	8.3	8.1	8.4	8.1	8.4	8.1	8.2	8.0	8.4	8.0	8.3	8.4	8.1	8.1
Tech. Initials	SxB	SxB	SxB	VL	VL	SxB	SxB	SxB	SxB	SxB	SxB	TM	TM	TM

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH 030302

Comments

Test Set Up By: SxB | Data Verified By: [signature] | Date Verified: Aug. 31/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth

EVS Project No. C4-1424-044

EVS Work Order No. 0500327

Sample ID C. Creek Control Creek

Test Initiation Date/Time 9 Aug 05 / 1500

Source/Date Received ABS Inc. / 9 Aug 05

Concentration %(v/v)	Salinity (ppt)													
	0	1		2		3		4		5		6 D		7
D-Control	29	29	29	29	29	30	30	30	30	31	30	28	28	29
B-Control	30	30	30	30	30	30	30	31	30	30	30	30	30	30
4.2	30	31	30	30	30	30	30	30	30	30	30	30	28	29
8.4	30	30	30	30	30	30	30	30	30	30	30	30	28	29
16.9	30	30	30	30	30	30	30	30	30	30	30	30	28	29
33.7	30	31	30	30	30	31	30	30	30	30	30	30	28	29
67.4	30	30	30	30	30	31	30	31	30	31	30	30	29	30
Tech. Initials	SxB	SxB	SxB	MJG	MJG	SxB	SxB	SxB	SxB	SxB	SxB	TT	TT	TT

Concentration %(v/v)	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
D-Control	7.7	6.7	7.7	6.6	7.6	6.6	7.6	6.6	7.6	6.7	7.6	6.4	7.5	6.4
B-Control	7.6	6.6	7.6	6.4	7.6	6.6	7.6	6.6	7.6	6.7	7.6	6.6	7.5	6.6
4.2	7.6	6.7	7.6	6.4	7.6	6.4	7.6	6.5	7.6	6.5	7.6	6.6	7.5	6.6
8.4	7.6	6.7	7.6	6.5	7.6	6.7	7.6	6.6	7.6	6.6	7.6	6.4	7.5	6.4
16.9	7.7	6.6	7.6	6.4	7.6	6.5	7.6	6.5	7.6	6.6	7.6	6.5	7.5	6.6
33.7	7.6	6.6	7.6	6.8	7.6	6.8	7.6	6.6	7.6	6.5	7.6	6.5	7.5	6.6
67.4	7.6	6.7	7.6	6.6	7.6	6.6	7.6	6.7	7.6	6.7	7.6	6.4	7.6	6.4
Tech. Initials	SxB	SxB	SxB	MJG	MJG	SxB	SxB	SxB	SxB	SxB	SxB	TT	TT	TT

WQ Instruments Used: Salinity ~~II~~ III (Acc) C3 DO II-A-20

Comments (1) meet II-14-030306

Test Set Up By SxB Data Verified By Qualified Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

Sample ID G-Creek (Perran Creek)
Test Species/Batch Atherinops affinis, Petagos
Test Initiation Date/Time 9 Aug 05 1500
No. of Organisms/Volume 5 / 200 mL

Concentration % (v/v)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
D.CTL	A	1T	5	5	5	5	5	5	5	
	B	2T	5	5	5	5	5	5	4	
	C	3T	5	5	5	5	5	5	5	
	D	4T	5	5	5	5	5	5	5	
	E	5T	5	5	5	5	5	5	4	
B-CTL	A	6T	5	5	5	5	5	5	5	
	B	7T	5	5	5	5	5	5	5	
	C	8T	5	5	5	5	5	5	5	
	D	9T	5	5	5	5	5	5	4	
	E	10T	5	5	4 ①	4	4	4	3	
4.2	A	11T	5	4	SXB 4	4	4	4	4	
	B	12T	5	5	5	5	5	5	5	
	C	13T	5	5	5	5	5	5	5	
	D	14T	5	4	SXB 4	4	4	4	4	
	E	15T	5	4 ①	4 SXB	4	4	4	4	① No Body
8.4	A	16T	5	5	5	5	5	5	5	
	B	17T	5	5	5	5	5	5	5	
	C	18T	5	5	5	5	5	5	4	
	D	19T	5	5	5	5	5	5	5	
	E	20T	5	5	5	5	5	5	5	
Technician Initials		SXB	SXB	ML	SXB	SXB	SXB	JH	SXB	

Sample Description light brown, no smell
Data Verified By [signature] Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

Sample ID Garrow Creek
Test Species/Batch Atherinops affinis
Test Initiation Date/Time 9 Aug 05 1500
No. of Organisms/Volume 5/200mL

Concentration % (v/v)	Rep.	Pan No.	Number of Survivors – Day of Test 1	2	3	4	5	6	7	Comments
16.9	A	21 T	5	5	5	5	5	5	5	① No dead body - ~~Technician~~ Eng
	B	22	5	5	4	4	4	4	4	
	C	23	5	5	5	5	5	5	4	
	D	24	5	5	①4	4	4	4	3	
	E	25	5	5	5	5	5	5	4	
33.7	A	26	5	5	5	5	5	5	5	
	B	27	5	5	~~5~~5	4	4	4	4	
	C	28	5	5	5	5	5	5	5	
	D	~~29~~	5	5	4	4	4	*	4	
	E	30	5	5	5	5	5	5	5	
67.4	A	31	5	5	5	5	5	5	5	
	B	32	5	4	4	4	4	4	4	
	C	33	5	5	5	5	5	5	~~4~~3	
	D	34	5	5	5	5	5	5	4	
	E	35	~~5~~4	5	5	5	5	5	4	
	A									
	B									
	C									
	D									
	E									
Technician Initials		~~SXB~~	SXB	ML	SXB	SXB	SXB	MS	SXB	

Sample Description clear - colourless
Data Verified By Qualified Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS

Larval Fish Toxicity Tests - Dry Weight Data

CLIENT:	Azimuth	TEST TYPE:	7-d Survival and Growth
PROJECT #	04-1424-044	TEST SPECIES:	*Atherinops affinis*
WORK ORDER #:	0500327	TEST INITIATION DATE:	9-Aug-05
BALANCE TYPE:	Sartorius BP211D		

Pan No.	Rep	Sample ID: Garrow Creek % (v/v)	Survival At Start	Number of Survivors	Number Weighed	Pan weight (mg)	Final Weight (mg) Pan + Biomass	Tech'n Initials	Comments
T-1	A	Control	5	5	4	1218.92	1222.92	RSD	Fish lost in transfer.
T-2	B		5	4	4	1231.52	1234.56	RSD	
T-3	C		5	5	5	1229.15	1234.64	RSD	
T-4	D		5	5	5	1235.47	1239.35	RSD	
T-5	E		5	4	4	1241.65	1244.47	RSD	
T-6	A	Brine Control	5	5	5	1217.25	1221.44	RSD	
T-7	B		5	5	5	1229.47	1234.85	RSD	
T-8	C		5	5	5	1233	1237.96	RSD	
T-9	D		5	4	4	1236.48	1240.49	RSD	
T-10	E		5	3	3	1237.67	1241.98	RSD	
T-11	A	4.2	5	4	4	1236.79	1240.85	RSD	
T-12	B		5	5	5	1221.62	1226.26	RSD	
T-13	C		5	5	5	1236.85	1241.7	RSD	
T-14	D		5	4	4	1231.67	1236.88	RSD	
T-15	E		5	4	4	1227.6	1230.46	RSD	
T-16	A	8.4	5	5	5	1232.12	1236.61	RSD	
T-17	B		5	5	5	1221.55	1225.83	RSD	
T-18	C		5	4	4	1226.4	1229.96	RSD	
T-19	D		5	5	5	1224.88	1229.98	RSD	
T-20	E		5	5	5	1228.72	1233.82	RSD	
T-21	A	16.9	5	5	5	1226.33	1231.24	RSD	
T-22	B		5	4	4	1227.45	1231.89	RSD	
T-23	C		5	4	4	1223.67	1227.1	RSD	
T-24	D		5	3	3	1228.16	1231.05	RSD	
T-25	E		5	4	4	1218.71	1221.92	RSD	
T-26	A	33.7	5	5	5	1229.33	1232.96	RSD	
T-27	B		5	4	4	1223.13	1227.98	RSD	
T-28	C		5	5	5	1222.55	1226.08	RSD	
T-29	D		5	4	4	1231.12	1234.27	RSD	
T-30	E		5	5	5	1230.86	1234.48	RSD	
T-31	A	67.4	5	5	5	1234.04	1239.21	RSD	
T-32	B		5	4	4	1236.02	1240.21	RSD	
T-33	C		5	3	3	1229.02	1232.08	RSD	
T-34	D		5	4	4	1231.66	1235.98	RSD	
T-35	E		5	4	4	1231.22	1234.74	RSD	
T-16	(d)						1236.52 ✓	RSD	
T-21	(d)						1231.16 ✓	RSD	
T-35	(d)						1234.81 ✓	RSD	

(d) - duplicate; pan reweighed after being placed in the oven and desiccated a second time.

Aug. 31/05

Test: LF-Larval Fish Growth and Survival Test
Species: AA-Atherinops affinis
Sample ID: Garrow_Creek
Start Date: 8/9/2005 End Date: 8/16/2005

Test ID: 0500327
Protocol: EPAW 95-EPA West Coast
Sample Type: EFF2-Industrial
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	4	1218.92	1222.92
	2	2	D-Control	5							4	4	1231.52	1234.56
	3	3	D-Control	5							5	5	1229.15	1234.64
	4	4	D-Control	5							5	5	1235.47	1239.35
	5	5	D-Control	5							4	4	1241.65	1244.47
	6	1	B-Control	5							5	5	1217.25	1221.44
	7	2	B-Control	5							5	5	1229.47	1234.85
	8	3	B-Control	5							5	5	1233	1237.96
	9	4	B-Control	5							4	4	1236.48	1240.49
	10	5	B-Control	5							3	3	1237.67	1241.98
	11	1	4.2	5							4	4	1236.79	1240.85
	12	2	4.2	5							5	5	1221.62	1226.26
	13	3	4.2	5							5	5	1236.85	1241.7
	14	4	4.2	5							4	4	1231.67	1236.88
	15	5	4.2	5							4	4	1227.6	1230.46
	16	1	8.4	5							5	5	1232.12	1236.61
	17	2	8.4	5							5	5	1221.55	1225.83
	18	3	8.4	5							4	4	1226.4	1229.96
	19	4	8.4	5							5	5	1224.88	1229.98
	20	5	8.4	5							5	5	1228.72	1233.82
	21	1	16.9	5							5	5	1226.33	1231.24
	22	2	16.9	5							4	4	1227.45	1231.89
	23	3	16.9	5							4	4	1223.67	1227.1
	24	4	16.9	5							3	3	1228.16	1231.05
	25	5	16.9	5							4	4	1218.71	1221.92
	26	1	33.7	5							5	5	1229.33	1232.96
	27	2	33.7	5							4	4	1223.13	1227.98
	28	3	33.7	5							5	5	1222.55	1226.08
	29	4	33.7	5							4	4	1231.12	1234.27
	30	5	33.7	5							5	5	1230.86	1234.48
	31	1	67.4	5							5	5	1234.04	1239.21
	32	2	67.4	5							4	4	1236.02	1240.21
	33	3	67.4	5							3	3	1229.02	1232.08
	34	4	67.4	5							4	4	1231.66	1235.98
	35	5	67.4	5							4	4	1231.22	1234.74

Comments: Azimuth - Polaris 04-1424-044

Reviewed by: Aug 31/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	Garrow_Creek
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

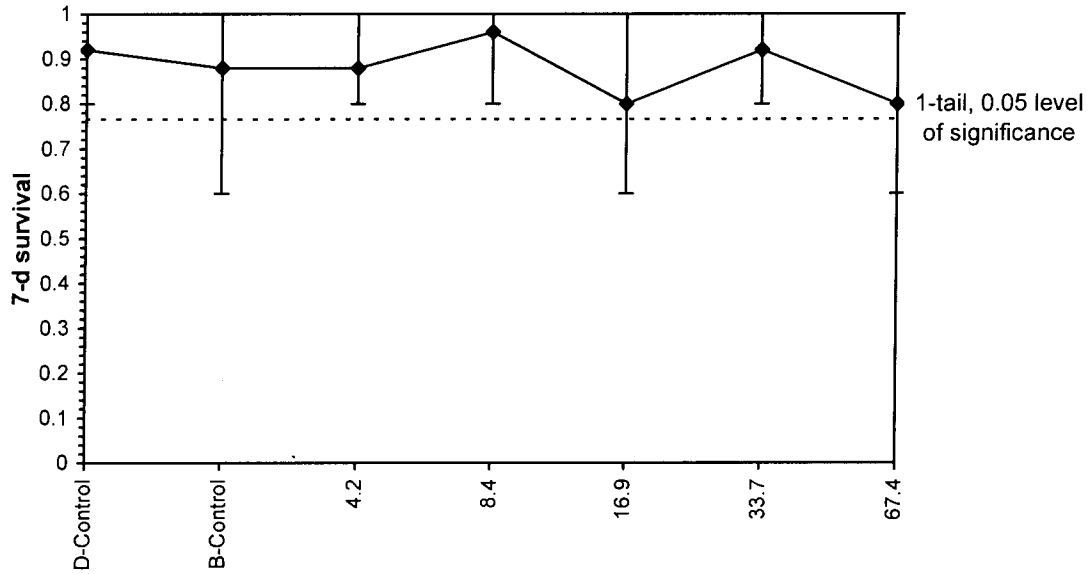
Conc-%	1	2	3	4	5
D-Control	1.0000	0.8000	1.0000	1.0000	0.8000
B-Control	1.0000	1.0000	1.0000	0.8000	0.6000
4.2	0.8000	1.0000	1.0000	0.8000	0.8000
8.4	1.0000	1.0000	0.8000	1.0000	1.0000
16.9	1.0000	0.8000	0.8000	0.6000	0.8000
33.7	1.0000	0.8000	1.0000	0.8000	1.0000
67.4	1.0000	0.8000	0.6000	0.8000	0.8000

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5			
B-Control	0.8800	0.1789	1.2058	0.8861	1.3453	17.113	5			
4.2	0.8800	0.1095	1.2024	1.1071	1.3453	10.848	5	0.544	2.360	0.2068
8.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	-0.544	2.360	0.2068
16.9	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.592	2.360	0.2068
33.7	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5	0.000	2.360	0.2068
67.4	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.592	2.360	0.2068

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94769	0.9	-0.1197	-0.6919
Bartlett's Test indicates equal variances (p = 0.97)	0.91421	15.0863		
The control means are not significantly different (p = 0.70)	0.405	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	67.4	>67.4		1.48368	0.154	0.171	0.03047	0.01919	0.20149	5, 24

Dose-Response Plot



Statistical analysis performed with the negative control.

Reviewed by: Aug 31/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	Garrow_Creek
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

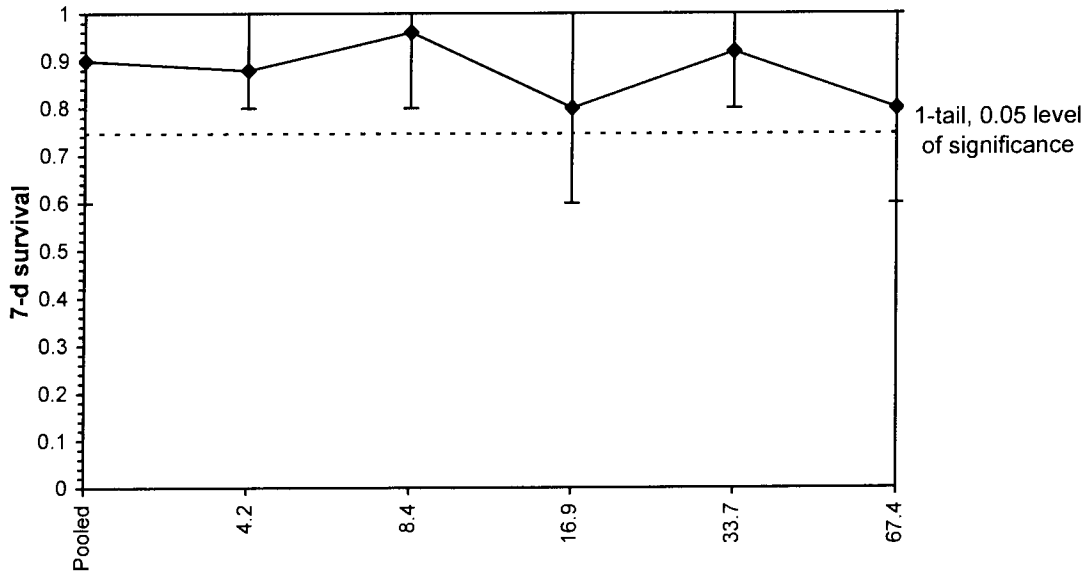
Conc-%	1	2	3	4	5
D-Control	1.0000	0.8000	1.0000	1.0000	0.8000
B-Control	1.0000	1.0000	1.0000	0.8000	0.6000
4.2	0.8000	1.0000	1.0000	0.8000	0.8000
8.4	1.0000	1.0000	0.8000	1.0000	1.0000
16.9	1.0000	0.8000	0.8000	0.6000	0.8000
33.7	1.0000	0.8000	1.0000	0.8000	1.0000
67.4	1.0000	0.8000	0.6000	0.8000	0.8000

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Pooled	0.9000	0.1414	1.2279	0.8861	1.3453	13.389	10			
4.2	0.8800	0.1095	1.2024	1.1071	1.3453	10.848	5	0.315	2.462	0.1997
8.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	-0.860	2.462	0.1997
16.9	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.447	2.462	0.1997
33.7	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5	-0.273	2.462	0.1997
67.4	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.447	2.462	0.1997

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95136	0.91	-0.4731	-0.265
Bartlett's Test indicates equal variances (p = 0.95)	1.19442	15.0863		
The control means are not significantly different (p = 0.70)	0.405	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	67.4	>67.4		1.48368	0.15355	0.17312	0.0295	0.02192	0.27347	5, 29

Dose-Response Plot



Statistical analysis performed with pooled controls.

Reviewed by: Aug 31/05

Larval Fish Growth and Survival Test-7 Day Growth (CND)

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	GARROW_CREEK
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

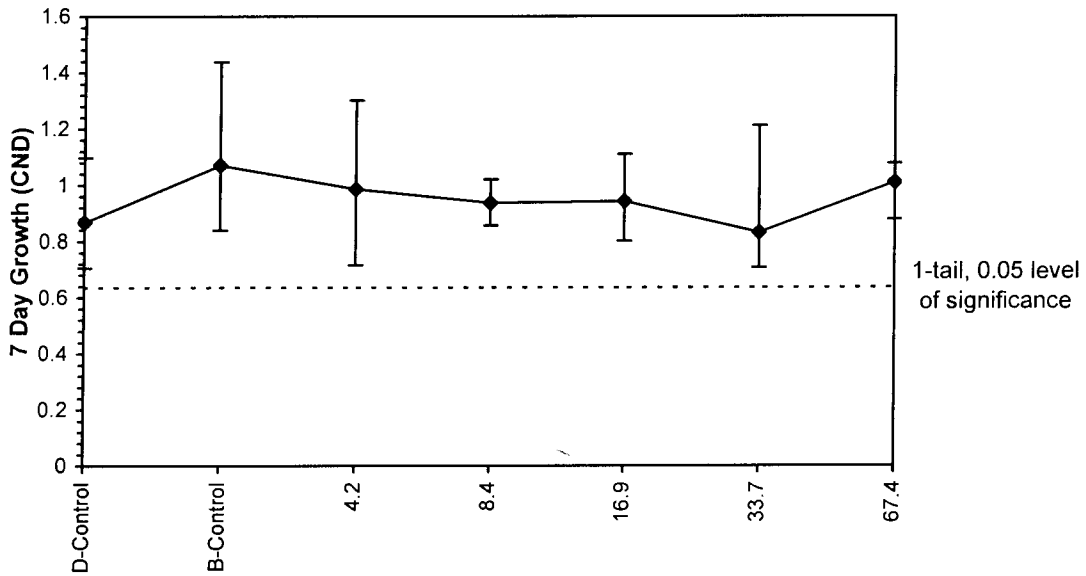
Conc-%	1	2	3	4	5
D-Control	1.0000	0.7600	1.0980	0.7760	0.7050
B-Control	0.8380	1.0760	0.9920	1.0025	1.4367
4.2	1.0150	0.9280	0.9700	1.3025	0.7150
8.4	0.8980	0.8560	0.8900	1.0200	1.0200
16.9	0.9820	1.1100	0.8575	0.9633	0.8025
33.7	0.7260	1.2125	0.7060	0.7875	0.7240
67.4	1.0340	1.0475	1.0200	1.0800	0.8800

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.8678	0.1710	0.8678	0.7050	1.0980	19.710	5			
B-Control	1.0690	0.2230	1.0690	0.8380	1.4367	20.861	5			
4.2	0.9861	0.2110	0.9861	0.7150	1.3025	21.397	5	-1.198	2.360	0.2331
8.4	0.9368	0.0776	0.9368	0.8560	1.0200	8.280	5	-0.699	2.360	0.2331
16.9	0.9431	0.1192	0.9431	0.8025	1.1100	12.644	5	-0.762	2.360	0.2331
33.7	0.8312	0.2154	0.8312	0.7060	1.2125	25.910	5	0.371	2.360	0.2331
67.4	1.0123	0.0772	1.0123	0.8800	1.0800	7.629	5	-1.463	2.360	0.2331

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94085	0.9	0.90895	1.11753
Bartlett's Test indicates equal variances (p = 0.22)	7.00651	15.0863		
The control means are not significantly different (p = 0.15)	1.60103	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	67.4	>67.4		1.48368	0.23312	0.26863	0.02377	0.02439	0.45333	5, 24

Dose-Response Plot



Statistical analysis performed on negative control using Canadian method to assess test validity criteria.

Reviewed by: Aug-31/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	GARROW_CRE
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

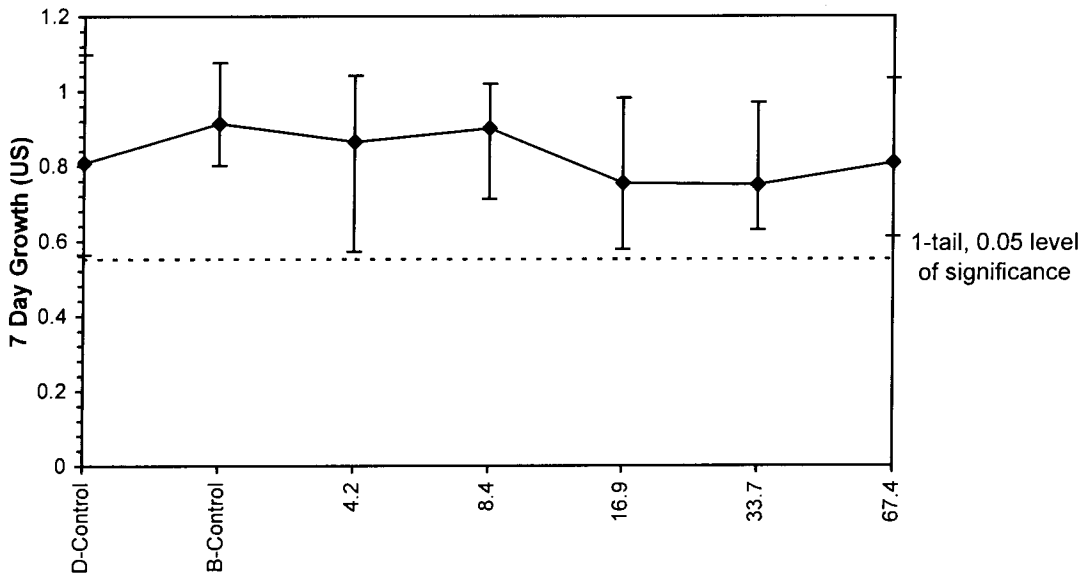
Conc-%	1	2	3	4	5
D-Control	1.0000	0.6080	1.0980	0.7760	0.5640
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620
4.2	0.8120	0.9280	0.9700	1.0420	0.5720
8.4	0.8980	0.8560	0.7120	1.0200	1.0200
16.9	0.9820	0.8880	0.6860	0.5780	0.6420
33.7	0.7260	0.9700	0.7060	0.6300	0.7240
67.4	1.0340	0.8380	0.6120	0.8640	0.7040

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.8092	0.2353	0.8092	0.5640	1.0980	29.082	5			
B-Control	0.9140	0.1155	0.9140	0.8020	1.0760	12.636	5			
4.2	0.8648	0.1837	0.8648	0.5720	1.0420	21.242	5	-0.511	2.360	0.2569
8.4	0.9012	0.1285	0.9012	0.7120	1.0200	14.262	5	-0.845	2.360	0.2569
16.9	0.7552	0.1718	0.7552	0.5780	0.9820	22.750	5	0.496	2.360	0.2569
33.7	0.7512	0.1284	0.7512	0.6300	0.9700	17.097	5	0.533	2.360	0.2569
67.4	0.8104	0.1615	0.8104	0.6120	1.0340	19.927	5	-0.011	2.360	0.2569

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96877	0.9	0.03752	-0.9001
Bartlett's Test indicates equal variances (p = 0.85)	1.98489	15.0863		
The control means are not significantly different (p = 0.40)	0.89395	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	67.4	>67.4		1.48368	0.25689	0.31747	0.01761	0.02962	0.70433	5, 24

Dose-Response Plot



Statistical analysis performed with D-control

Reviewed by: Sept 1/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	GARROW_CRE
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

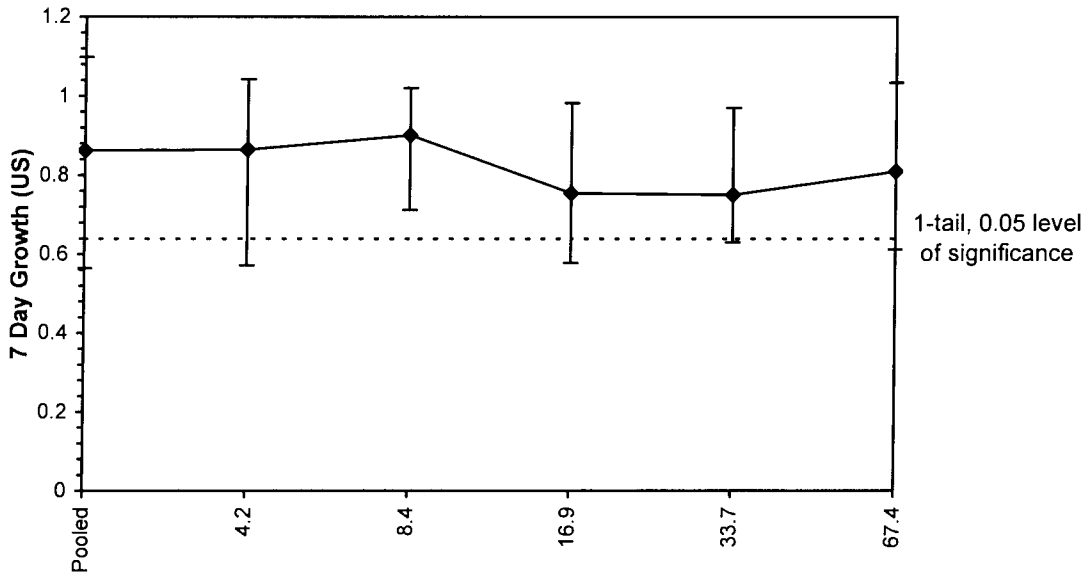
Conc-%	1	2	3	4	5
D-Control	1.0000	0.6080	1.0980	0.7760	0.5640
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620
4.2	0.8120	0.9280	0.9700	1.0420	0.5720
8.4	0.8980	0.8560	0.7120	1.0200	1.0200
16.9	0.9820	0.8880	0.6860	0.5780	0.6420
33.7	0.7260	0.9700	0.7060	0.6300	0.7240
67.4	1.0340	0.8380	0.6120	0.8640	0.7040

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Pooled	0.8616	0.1833	0.8616	0.5640	1.0980	21.272	10			
4.2	0.8648	0.1837	0.8648	0.5720	1.0420	21.242	5	-0.035	2.462	0.2228
8.4	0.9012	0.1285	0.9012	0.7120	1.0200	14.262	5	-0.438	2.462	0.2228
16.9	0.7552	0.1718	0.7552	0.5780	0.9820	22.750	5	1.176	2.462	0.2228
33.7	0.7512	0.1284	0.7512	0.6300	0.9700	17.097	5	1.220	2.462	0.2228
67.4	0.8104	0.1615	0.8104	0.6120	1.0340	19.927	5	0.566	2.462	0.2228

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95378	0.91	-0.1738	-0.7645
Bartlett's Test indicates equal variances (p = 0.96)	1.08676	15.0863		
The control means are not significantly different (p = 0.40)	0.89395	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	67.4	>67.4		1.48368	0.22282	0.25861	0.02046	0.0273	0.59313	5, 29

Dose-Response Plot



Statistical analysis performed with pooled controls.

Reviewed by: Qualph
9/ Sept 1/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

EVS Analysts SxB MJG JxS RS
Test Initiation Date 9 Aug 05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	100mg/L Cu Stock (05Cu001)		
Amount ~~Received~~ Prepared	1X1L		
Date ~~Collected~~ Prepared	1-Mar-05		
Date Received	na		
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			

DILUTION/CONTROL WATER (initial water quality)
Water Type UV sterilized filtered Sw
Temperature (°C) 20.0
pH 7.9
Dissolved Oxygen (mg/L) 7.7
Salinity 29

TEST SPECIES INFORMATION
Source ABS Inc
Date Received 9 Aug 05
Age (on Day 0) 10 days
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 9 Aug 05
7-d survival LC50 ~~107 (88-129)~~ 103 (91-118) mg/L Cu
7-d growth IC50 95 (76-127) mg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 132 ± 40 mg/L Cu CV=15%
7-d growth IC50 133 ± 40 mg/L Cu CV=15%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 20.5
pH Range 7.8 - 8.0
Dissolved Oxygen Range (mg/L) 6.4 - 7.7
Salinity (ppt) 28 - 31
Photoperiod (L:D h) 16:8
Aeration Provided? None
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	mg/L Cu	56	100	~~107 (88-129)~~ 103 (91-118) RSS		
Growth		~~32~~ 56	~~100~~ 32		95 (76-127) RSS	~~64 (51-81)~~ 71 (61-91) RSS

Other

Data Verified By [signature] Date Verified Sept. 1/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Azimuth

EVS Project No. 04-1424-044

EVS Work Order No. C500327

Sample ID Cu Reftox

Test Initiation Date/Time 9 Aug 05 1500

Source/Date Received ABS Inc. / 9 Aug 05

Concentration mg/L Cu	Temperature (°C)													
	0	old 1	new 1		2		3		4		5		6	7
CTL	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.5
32	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.5
56	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.5
100	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5
180	20.0	20.0	20.0	20.0	20.0	20.0	20.0	~~20.0~~	~~20.0~~	20.0	20.0			
320	20.0	20.0	20.0	20.0	20.0									
Tech. Initials	SxB	SxB	SxB	MTL	MTL	SRS	SRS	SxB	SxB	SxB	SxB	TM	TM	TM

Concentration mg/L Cu	pH													
	0	1		2		3		4		5		6		7
CTL	7.9	7.9	8.0	7.9	7.9	~~7.8~~	7.9	7.8	8.0	7.9	7.9	7.9	8.0	7.9
32	7.9	8.0	8.0	7.9	7.9	7.8	7.9	~~7.8~~ 7.8	7.9	7.9	7.9	7.9	8.0	8.0
56	7.9	7.9	8.0	8.0	7.9	7.8	7.9	~~7.8~~ 7.8	8.0	7.9	7.9	8.0	8.0	8.0
100	7.9	7.9	8.0	8.0	7.9	7.8	7.9	7.8	8.0	7.9	7.9	8.0	8.0	8.0
180	7.9	7.8	8.0	~~7.9~~ 7.9	7.9	7.8	7.9	~~7.8~~	~~8.0~~	~~7.9~~	~~7.9~~			
320	7.9	7.9	8.0	~~7.9~~	7.9									
				MTL										
Tech. Initials	SxB	SxB	SxB	MTL	MTL	SRS	SRS	SxB	SxB	SxB	SxB	TM	TM	TM

WQ Instruments Used: Temp. Calibrated Ag Thermometer pH 030302

Comments

Test Set Up By SxB Data Verified By [signature] Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Azimuth
Sample ID Cu Reftox
EVS Project No. 04-1424-044
Test Initiation Date/Time 9 Aug -05 / 1500
EVS Work Order No. 0500327
Source/Date Received ABS In 9 Aug 05

Concentration mg/L Cu	Salinity (ppt)													
	0	1		2		3		4		5		6 D		7
CTL	29	29	29	29	29	30	30	31	30	30	30	30	28	29
32	29	29	29	29	29	30	30	30	30	30	30	29	28	29
56	29	29	29	29	29	30	30	30	30	30	30	29	28	29
100	29	29	29	29	29	30	30	30	30	30	30	29	28	29
180	29	29	29	29	29	~~30~~	30	~~30~~	~~30~~	~~30~~	~~30~~			
320	29	29	29	29	29									
Tech. Initials	SXB	SXB	SXB	MC	MC	SRS	SRS	SXB	SXB	SXB	SXB	TH	TH	TH

Concentration mg/L Cu	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
CTL	7.7	6.8	7.7	6.6	7.6	6.8	7.6	6.6	7.6	6.7	7.6	6.6	~~7.6~~ 7.5	6.6
32	7.7	6.9	7.7	6.5	7.6	6.9	7.6	6.7	7.6	6.9	7.6	6.4	7.5	6.6
56	7.7	6.8	7.7	6.7	7.6	7.0	7.6	6.8	7.6	6.9	7.6	6.6	7.5	6.4
100	7.7	6.8	7.7	6.6	7.6	7.0	7.6	6.9	7.6	7.0	7.6	6.6	7.5	6.4
180	7.7	6.9	7.7	6.5	7.6	7.1	7.6	~~6.9~~	~~7.6~~	~~7.0~~				
320	7.7	6.8	7.7	6.5	7.6	X								
Tech. Initials	SXB	SXB	SXB	MC	MC	SRS	SRS	SXB	SXB	SXB	SXB	TH	TH	TH

WQ Instruments Used: Salinity II-C-3 DO II-A-20
Comments Dosed II-A-050506

Test Set Up By SXB Data Verified By Qualified Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500327

Sample ID: Cu_Lofton
Test Species/Batch: Atherinops affinis
Test Initiation Date/Time: 9 Aug 05 1500
No. of Organisms/Volume: 5/200mL

Concentration mg/L Cu	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
CTL	A	36 T	5	5	5	5	5	5	5	
	B	37	5	5	5	5	5	5	5	
	C	38	5	5	5	5	5	5	5	
	D	39	5	5	4	4	4	4	4	
	E	40	5	5	5	5	5	5	5	
32	A	41	5	5	5	5	5	5	5	
	B	42	5	5	5	5	5	5	4	① one fish stuck on wall while feeding – technician error.
	C	43	5	5	4	4	4	4	4	
	D	44	5	5	①4	4	4	4	4	
	E	45	5	5	4	4	4	3①	3	
56	A	46	5	5	5	5	5	5	5	
	B	47	5	5	5	5	5	5	5	
	C	48	5	5	5	5	5	5	5	
	D	49	5	5	5	5	5	5	5	
	E	50	5	5	5	5	5	5	5	
100	A	51	5	3	3	3	3	3	3	
	B	52	5	~~3~~ 2	2	2	2	2	2	
	C	53	5	4	3	3	3	3	3	
	D	54	5	4	4	4	3	3	3	
	E	55	5	3	2	2	2	2	2	
Technician Initials		SXB	SXB	MH	SXB	SXB	SXB	TM	SXB	

Sample Description: clear colourless
Data Verified By: [signature]
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth
EVS Project No.: 041424049
EVS Work Order No.: 0500327

Sample ID: Cu Reftox
Test Species/Batch: Atherinops affinis
Test Initiation Date/Time: 9 Aug 05 / 1500
No. of Organisms/Volume: 5 / 200mL

Concentration mg/L Cu	Rep.	Pan No.	Number of Survivors – Day of Test 1	2	3	4	5	6	7	Comments
18	A	56	3	2	2	2	2	2	1	
	B		4	0	0	-	-	-	-	
	C		5	0	0	-	-	-	-	
	D		4	1	0	-	-	-	-	
	E		2	0	0	-	-	-	-	
32	A		SXB 0	0	0	-	-	-	-	
	B		2	0	0	-	-	-	-	
	C		SXB 0	0	0	-	-	-	-	
	D		SXB 0	0	0	-	-	-	-	
	E		1	0	0	-	-	-	-	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials		SXB	SXB	MV	SXB	SXB	SXB	TM	SXB	

Sample Description: clear - colourless
Data Verified By: Qa/Qc
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS

Larval Fish Toxicity Tests - Dry Weight Data

CLIENT: Azimuth
PROJECT #: 04-1424-044
WORK ORDER #: 0500327
BALANCE TYPE: Sartorius BP211D

TEST TYPE: 7-d Survival and Growth
TEST SPECIES: *Atherinops affinis*
TEST INITIATION DATE: 9-Aug-05

Pan No.	Rep	Sample ID: Cu ug/L	Survival At Start	Number of Survivors	Number Weighed	Pan weight (mg)	Final Weight (mg) Pan + Biomass	Tech'n Initials	Comments
T-36	A	Control	5	5	5	1227.73	1231.65	RSD	
T-37	B		5	5	5	1237.69	1243.76	RSD	
T-38	C		5	5	5	1233.73	1238.72	RSD	
T-39	D		5	4	4	1228.92	1231.78	RSD	
T-40	E		5	5	5	1227.75	1233.44	RSD	
T-41	A	32	5	5	5	1231.67	1236.17	RSD	
T-42	B		5	4	4	1224.44	1228.26	RSD	
T-43	C		5	4	4	1238.77	1241.92	RSD	
T-44	D		4	4	4	1227	1230.34	RSD	Tech error --fish killed during testing.
T-45	E		4	3	3	1236.71	1239.86	RSD	Tech error - fish killed during testing.
T-46	A	56	5	5	5	1230.75	1234.97	RSD	
T-47	B		5	5	5	1220.44	1224.77	RSD	
T-48	C		5	5	5	1226.91	1231.88	RSD	
T-49	D		5	5	5	1227.66	1232.44	RSD	
T-50	E		5	5	5	1233.65	1238.33	RSD	
T-51	A	100	5	3	3	1063.07	1065.92	RSD	
T-52	B		5	2	2	1070.3	1071.8	RSD	
T-53	C		5	3	3	1061.53	1063.78	RSD	
T-54	D		5	3	3	1059.1	1061.99	RSD	
T-55	E		5	2	2	1037.82	1038.91	RSD	
T-56	A	180	5	1	1	1044.2	1044.67	RSD	
T-57	B		5	0	0	1036.78	0	RSD	
T-58	C		5	0	0	1044.68	0	RSD	
T-59	D		5	0	0	1044.41	0	RSD	
T-60	E		5	0	0	1045.27	0	RSD	
T-61	A	320	5	0	0	0	0	RSD	
T-62	B		5	0	0	0	0	RSD	
T-63	C		5	0	0	0	0	RSD	
T-64	D		5	0	0	0	0	RSD	
T-65	E		5	0	0	0	0	RSD	
T-36	(d)						1231.53 ✓	RSD	
T-50	(d)						1238.37 ✓	RSD	
T-51	(d)						1065.88 ✓	RSD	

(d) - duplicate; pan reweighed after being placed in the oven and desiccated a second time.

QA/QC review: Ralph 4
Sept. 1/05

Test: LF-Larval Fish Growth and Survival Test												Test ID: rtaacu46		
Species: AA-Atherinops affinis												Protocol: EPAW 95-EPA West Coast		
Sample ID: REF-Ref Toxicant												Sample Type: CU-Copper		
Start Date: 8/9/2005			End Date: 8/16/2005									Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1227.73	1231.65
	2	2	D-Control	5							5	5	1237.69	1243.76
	3	3	D-Control	5							5	5	1233.73	1238.72
	4	4	D-Control	5							4	4	1228.92	1231.78
	5	5	D-Control	5							5	5	1227.75	1233.44
	6	1	32.0	5							5	5	1231.67	1236.17
	7	2	32.0	5							4	4	1224.44	1228.26
	8	3	32.0	5							4	4	1238.77	1241.92
	9	4	32.0	4							4	4	1227	1230.34
	10	5	32.0	4							3	3	1236.71	1239.86
	11	1	56.0	5							5	5	1230.75	1234.97
	12	2	56.0	5							5	5	1220.44	1224.77
	13	3	56.0	5							5	5	1226.91	1231.88
	14	4	56.0	5							5	5	1227.66	1232.44
	15	5	56.0	5							5	5	1233.65	1238.33
	16	1	100.0	5							3	3	1063.07	1065.92
	17	2	100.0	5							2	2	1070.3	1071.8
	18	3	100.0	5							3	3	1061.53	1063.78
	19	4	100.0	5							3	3	1059.1	1061.99
	20	5	100.0	5							2	2	1037.82	1038.91
	21	1	180.0	5							1	1	1044.2	1044.67
	22	2	180.0	5							0	0	1036.78	0
	23	3	180.0	5							0	0	1044.68	0
	24	4	180.0	5							0	0	1044.41	0
	25	5	180.0	5							0	0	1045.27	0
	26	1	320.0	5							0	0	0	0
	27	2	320.0	5							0	0	0	0
	28	3	320.0	5							0	0	0	0
	29	4	320.0	5							0	0	0	0
	30	5	320.0	5							0	0	0	0

Comments: Azimuth - Polaris 04-1424-044

Reviewed by Aug 31/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	8/9/2005	Test ID:	rtaacu46	Sample ID:	REF-Ref Toxicant
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	0.8000	1.0000
32	1.0000	0.8000	0.8000	1.0000	0.7500
56	1.0000	1.0000	1.0000	1.0000	1.0000
100	0.6000	0.4000	0.6000	0.6000	0.4000
180	0.2000	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

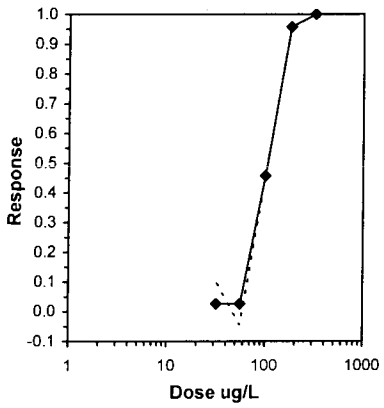
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5			1	25
32	0.8700	0.1204	1.1850	1.0472	1.3453	11.519	5	20.00	17.00	3	23
56	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	17.00	0	25
*100	0.5200	0.1095	0.8055	0.6847	0.8861	13.691	5	15.00	17.00	12	25
*180	0.0400	0.0894	0.2731	0.2255	0.4636	38.990	5	15.00	17.00	24	25
320	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98032	0.888	0.05175	-0.2912
Equality of variance cannot be confirmed				

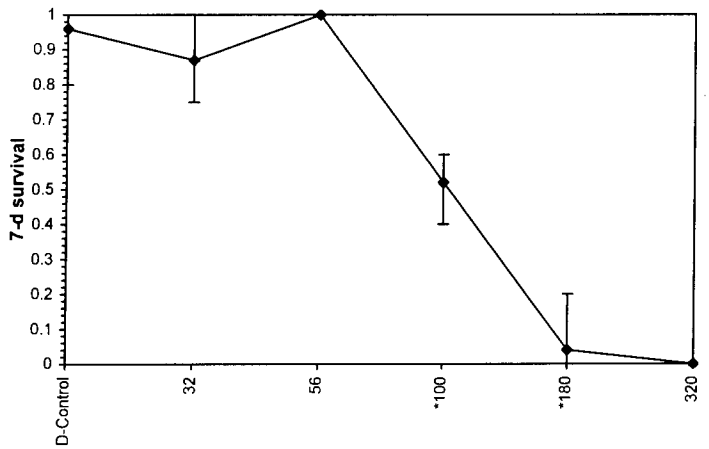
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	56	100	74.8331	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%	103.41	90.52	118.14	
10.0%	103.63	89.27	120.30	
20.0%	104.05	85.12	127.20	
Auto-2.6%	103.48	90.82	117.90	ug/L Cu



Dose-Response Plot



Reviewed by [signature] Aug-31/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/9/2005	Test ID:	rtaacu46	Sample ID:	REF-Ref Toxicant
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

Conc-ug/L	1	2	3	4	5
D-Control	0.7840	1.2140	0.9980	0.5720	1.1380
32	0.9000	0.7640	0.6300	0.8350	0.7875
56	0.8440	0.8660	0.9940	0.9560	0.9360
100	0.5700	0.3000	0.4500	0.5780	0.2180
180	0.0940	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

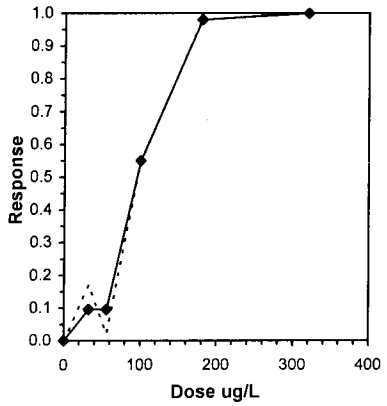
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
D-Control	0.9412	0.2633	0.9412	0.5720	1.2140	27.979	5			0.9412	1.0000
32	0.7833	0.1002	0.7833	0.6300	0.9000	12.796	5	23.00	17.00	0.8512	0.9044
56	0.9192	0.0627	0.9192	0.8440	0.9940	6.819	5	25.00	17.00	0.8512	0.9044
*100	0.4232	0.1609	0.4232	0.2180	0.5780	38.013	5	16.00	17.00	0.4232	0.4496
*180	0.0188	0.0420	0.0188	0.0000	0.0940	223.607	5	15.00	17.00	0.0188	0.0200
320	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5			0.0000	0.0000

Auxiliary Tests				Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)				0.96904	0.888	-0.5637	1.29994
Bartlett's Test indicates unequal variances (p = 8.40E-03)				13.6784	13.2767		
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**			
Steel's Many-One Rank Test	56	100	74.8331				

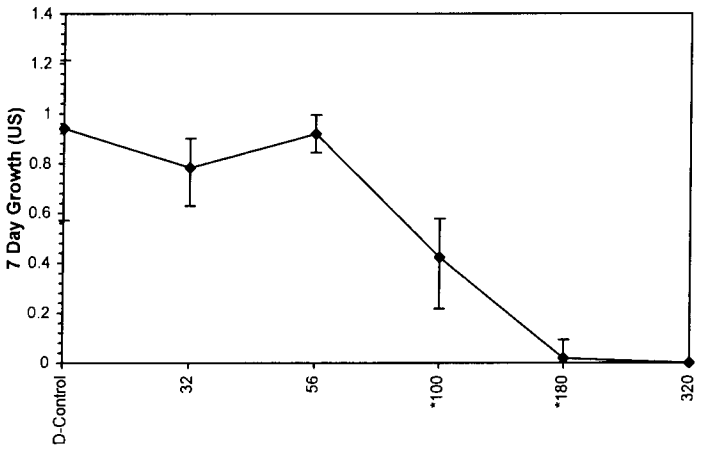
Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew	
IC05*	16.742	22.428	0.966	84.151	0.6591	
IC10	56.429	21.864	0.000	72.829	0.0540	
IC15	61.266	19.804	0.000	78.932	-0.6284	
IC20	66.103	16.425	4.297	85.035	-1.1939	
IC25	70.941	10.605	11.216	91.139	-1.6164	
IC40	85.453	7.896	65.694	112.047	0.4556	
IC50	95.128	8.949	75.508	127.164	0.6374	ug/L Cu

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by Aug. 31/05

APPENDIX II

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Pebble Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328

EVS Analysts: SRS, JAP
Test Initiation Date: 09 Aug 05

SAMPLE

Identification: Garrow Creek
Amount Received: 5x20L
Date Collected: 06 Aug 05
Date Received: 09 Aug 05
Temperature (°C): 16 @ → 15
pH: 7.3 @ → 8.3
Dissolved Oxygen (mg/L): 10.0 @ → 8.5
Conductivity (µmhos/cm): 2700
Salinity (ppt): 1.0 @ → 29.0
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: —

@ Brine Adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab
Date Received: 09 Aug 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 09 Aug 05
IC50 (and 95% CL): 3.9 (3.6-4.1) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.9 ± 4.3 mg/L SDS, CV = 55%

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized, 0.5µm filtered SW
Temperature (°C): 15
pH: 8.0
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 29
Other: —

TEST CONDITIONS

Temperature Range (°C): 15
pH Range: 7.8 → ~~8.04~~ 8.2 @ 8.4
Dissolved Oxygen Range (mg/L): ~~7.81~~ 7.8 @ → 8.5
Salinity Range (ppt): 29
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC 50: 55.0 (49.2 - 61.1) % v/v
IC 25: 15.6 (13.6 - 18.3) % v/v
NOEC: < 4.5 % v/v
LOEC: 4.5 % v/v
Statistical comparisons were against pooled controls

Data Verified By: [signature]
Date Verified: Aug. 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth Consulting (Polaris Mine)
EVS Project No. 04-1424-04
EVS Work Order No. 0500328
Logbook Echinoid #13 Pages 71-74

Test Initiation Date/Time 9Aug05 / 1723
Test Species Dendraster excentricus
Source/Date Received Westwind Seafds / 9 Aug 05
Test Duration 10:10

Sample ID %(v/v)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Garrow Creek - Max	15	8.3	29	8.5	
Garrow Creek - 36	15	8.1	29	8.4	
Garrow Creek - 18	15	7.9	29	8.4	
Garrow Creek - 9	15	7.9	29	8.4	
Garrow Creek - 4.5	15	7.8	29	8.4	
Cntl	15	8.0	29	8.5	
Brine Cntl	15	8.4	29	7.8	
Technician Initials	SRS/JAP	SRS/JAP	SRS/JAP	SRS/JAP	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-030303 DO II-A-20

Sample Description Clear with no odour

Data Verified By [signature] Date Verified Aug-31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328
Logbook: Echinoid Pages: 71-74

Test Initiation Date/Time: 09 Aug 05 / 1723
Test Species: Dendraster excentricus
Source/Date Received: Westcoast Sealab / 09 Aug 05
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Sample ID	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
Control	A	88	12		SRS
	B	81	19		
	C	85	15		
	D	86	14		
Brine Control	A	91	9		
	B	86	14		
	C	85	15		
	D	87	13		
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				

Data Verified By: Ralph
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328
Logbook: Echinoid Pages: 71-74

Test Initiation Date/Time: 09 Aug 05 / 1723
Test Species: Dendraster excentricus
Source/Date Received: Westcoast Seafoods / 09 Aug 05
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Sample ID (Y-Outfall, Swan Creek)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
Max 71.3%	A	37	63		SRS
	B	40	60		
	C	37	63		
	D	35	65		
35.6 ~~36%~~ 35%	A	50	50		
	B	54	46		
	C	54	46		
	D	53	47		
17.2 18.9% RD	A	64	36		
	B	59	41		
	C	63	37		
	D	61	39		
8.9%	A	76	24		
	B	77	23		
	C	77	23		
	D	76	24		
4.5%	A	82	18		
	B	80	20		
	C	79	21		
	D	78	22		
	A				
	B				
	C				
	D				

Data Verified By: Ralph
Date Verified: Aug 31/05

Test: SC-Sperm Cell Fertilization test					Test ID: 0500328		
Species: DE-Dendraster excentricus					Protocol: EPS1/RM/27-EC 92 (Sperm Cell)		
Sample ID: Garrow Creek					Sample Type: ~~GW-groundwater~~ Effluent		
Start Date: 8/9/2004 10:10			End Date: 8/9/2004		Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	88	12	
	2	2	D-Control	100	81	19	
	3	3	D-Control	100	85	15	
	4	4	D-Control	100	86	14	
	5	1	B-Control	100	91	9	
	6	2	B-Control	100	86	14	
	7	3	B-Control	100	85	15	
	8	4	B-Control	100	87	13	
	9	1	4.500	100	78	22	
	10	2	4.500	100	79	21	
	11	3	4.500	100	80	20	
	12	4	4.500	100	82	18	
	13	1	8.900	100	76	24	
	14	2	8.900	100	77	23	
	15	3	8.900	100	77	23	
	16	4	8.900	100	76	24	
	17	1	17.800	100	61	39	
	18	2	17.800	100	63	37	
	19	3	17.800	100	59	41	
	20	4	17.800	100	64	36	
	21	1	35.600	100	53	47	
	22	2	35.600	100	54	46	
	23	3	35.600	100	54	46	
	24	4	35.600	100	50	50	
	25	1	71.300	100	35	65	
	26	2	71.300	100	37	63	
	27	3	71.300	100	40	60	
	28	4	71.300	100	37	63	

Comments: Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)

Reviewed by: Aug. 31/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/9/2004 10:10	Test ID:	500328	Sample ID:	Garrow Creek
End Date:	8/9/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	~~GW-groundwater~~ Effluent
Sample Date:	8/6/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm I	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)				

Conc-%	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
B-Control	0.9100	0.8600	0.8500	0.8700
4.5	0.7800	0.7900	0.8000	0.8200
8.9	0.7600	0.7700	0.7700	0.7600
17.8	0.6100	0.6300	0.5900	0.6400
35.6	0.5300	0.5400	0.5400	0.5000
71.3	0.3500	0.3700	0.4000	0.3700

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.8500	0.0294	0.8500	0.8100	0.8800	3.463	4				0.8500	1.0000
B-Control	0.8725	0.0263	0.8725	0.8500	0.9100	3.014	4					
*4.5	0.7975	0.0171	0.7975	0.7800	0.8200	2.141	4	3.662	2.410	0.0346	0.7975	0.9382
*8.9	0.7650	0.0058	0.7650	0.7600	0.7700	0.755	4	5.929	2.410	0.0346	0.7650	0.9000
*17.8	0.6175	0.0222	0.6175	0.5900	0.6400	3.591	4	16.217	2.410	0.0346	0.6175	0.7265
*35.6	0.5275	0.0189	0.5275	0.5000	0.5400	3.589	4	22.494	2.410	0.0346	0.5275	0.6206
*71.3	0.3725	0.0206	0.3725	0.3500	0.4000	5.534	4	33.305	2.410	0.0346	0.3725	0.4382

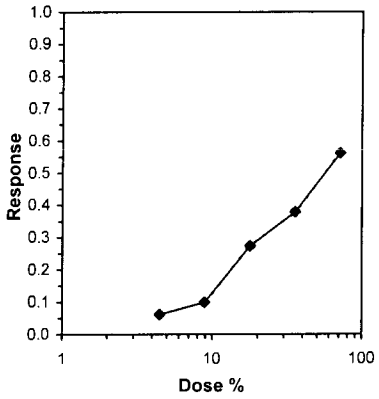
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96944	0.884	-0.376	-0.1401
Bartlett's Test indicates equal variances (p = 0.37)	5.40444	15.0863		
The control means are not significantly different (p = 0.30)	1.13994	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<4.5	4.5			0.03455	0.04065	0.13432	0.00041	5.3E-17	5, 18

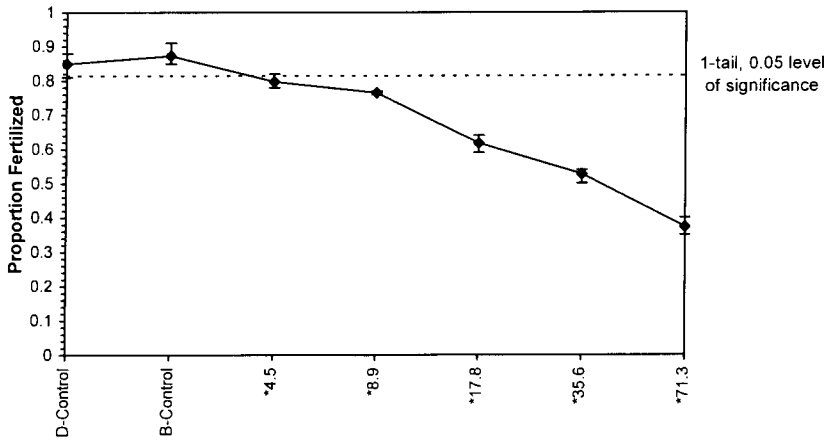
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.975	1.400	0.565	7.600	0.6911
IC10	8.900	1.288	3.027	10.418	-0.8297
IC15	10.909	0.614	9.311	12.929	0.4646
IC20	13.326	0.777	11.427	15.949	0.5340
IC25	16.234	1.070	13.604	20.191	0.7205
IC40	38.524	1.817	32.550	43.489	-0.4616
IC50	56.411	2.378	49.614	64.710	0.5505

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: statistical comparisons are against dilution control

Reviewed by: Aug 31/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/9/2004 10:10	Test ID:	500328	Sample ID:	Garrow Creek
End Date:	8/9/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	~~GW-groundwater~~ Effluent
Sample Date:	8/6/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)				

Conc-%	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
B-Control	0.9100	0.8600	0.8500	0.8700
4.5	0.7800	0.7900	0.8000	0.8200
8.9	0.7600	0.7700	0.7700	0.7600
17.8	0.6100	0.6300	0.5900	0.6400
35.6	0.5300	0.5400	0.5400	0.5000
71.3	0.3500	0.3700	0.4000	0.3700

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.8613	0.0285	0.8613	0.8100	0.9100	3.310	8				0.8613	1.0000
*4.5	0.7975	0.0171	0.7975	0.7800	0.8200	2.141	4	4.768	2.508	0.0335	0.7975	0.9260
*8.9	0.7650	0.0058	0.7650	0.7600	0.7700	0.755	4	7.199	2.508	0.0335	0.7650	0.8882
*17.8	0.6175	0.0222	0.6175	0.5900	0.6400	3.591	4	18.231	2.508	0.0335	0.6175	0.7170
*35.6	0.5275	0.0189	0.5275	0.5000	0.5400	3.589	4	24.962	2.508	0.0335	0.5275	0.6125
*71.3	0.3725	0.0206	0.3725	0.3500	0.4000	5.534	4	36.555	2.508	0.0335	0.3725	0.4325

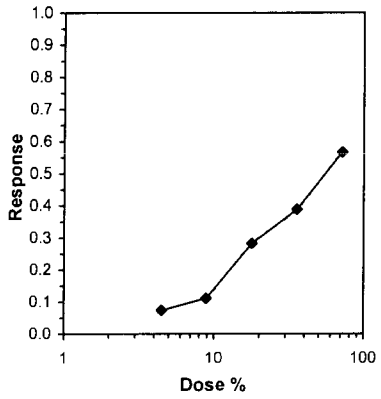
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97972	0.896	-0.1255	1.3485
Bartlett's Test indicates equal variances (p = 0.30)	6.1116	15.0863		
The control means are not significantly different (p = 0.30)	1.13994	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	<4.5	4.5			0.03354	0.03894	0.16656	0.00048	3.5E-20	5, 22

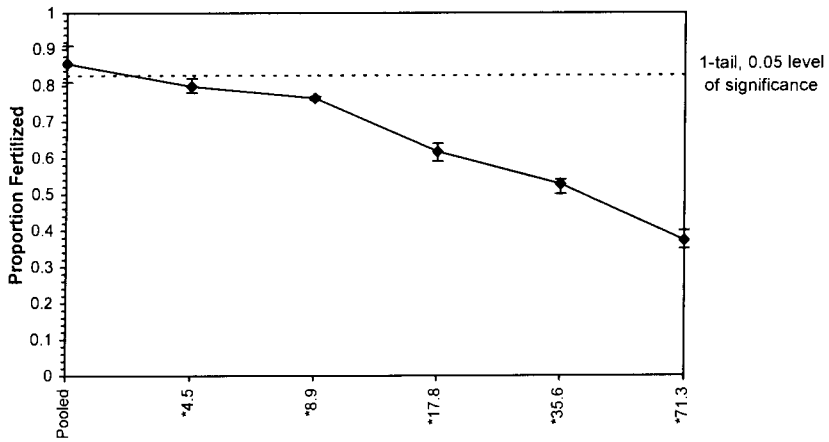
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	2.163	0.950	0.835	6.375	1.2352	
IC10	7.243	1.368	2.765	10.506	-0.2796	
IC15	10.424	0.446	9.200	11.908	0.1462	
IC20	12.777	0.574	11.163	14.753	0.1484	
IC25	15.613	0.797	13.605	18.305	0.1477	
IC40	37.370	1.848	30.582	42.085	-0.6715	
IC50	55.010	2.043	49.176	61.090	0.1372	%v/v

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: statistical comparisons are against pooled controls

Reviewed by: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Pebble Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328

EVS Analysts: SRS, JAP
Test Initiation Date: 09 Aug 05

SAMPLE

Identification: SDS Reflux Soil #05-5-009
Amount ~~Received~~ Prep'd: 1L
Date ~~Collected~~ Prep'd: 05 Aug 05
Date Received: —
Temperature (°C): —
pH: —
Dissolved Oxygen (mg/L): —
Conductivity (µmhos/cm): —
Salinity (ppt): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: —

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab
Date Received: 09 Aug 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 09 Aug 05
IC50 (and 95% CL): 3.9 (3.6 - 4.1) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.9 ± 4.3 mg/L SDS; CV = 55%

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized, 0.5µm filtered SW
Temperature (°C): 15
pH: 8.0
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 29
Other: —

TEST CONDITIONS

Temperature Range (°C): 15
pH Range: 7.8 - 8.0
Dissolved Oxygen Range (mg/L): 8.4 - 8.5
Salinity Range (ppt): 29
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC 50: 3.9 (3.6-4.1) mg/L SDS
IC 25: 2.3 (2.2-2.4) mg/L SDS
NOEC: 1.0 mg/L SDS
LOEC: 1.8 mg/L SDS

Data Verified By: [signature]
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth Consulting (Polaris Mine)
EVS Project No. 04-1424-8044
EVS Work Order No. 0500328
Logbook Echinoid #13 Pages 71-74

Test Initiation Date/Time 9 Aug 05 / 1723
Test Species Dendraster excentricus
Source/Date Received Westwind Seclab / 9 Aug 05
Test Duration 10:16

Reftox

Sample ID SDS (mg/L)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Cnt1	15	8.0	29	8.5	
1.0	15	7.8	29	8.4	
1.8	15	7.8	29	8.4	
3.2	15	7.8	29	8.4	
5.6	15	7.9	29	8.4	
10.0	15	7.9	29	8.4	
Technician Initials	SRS/JAP	SRS/JAP	SRS/JAP	SRS/JAP	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-57 Salinity II-A-030303 DO II-A-20

Sample Description

Data Verified By Ralph K Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client: Azimuth Consulting (Polaris Mine) Test Initiation Date/Time: 09/Aug/05 / 1723
EVS Project No.: 04-1424-044 Test Species: Dendraster excentricus
EVS Work Order No.: 0500328 Test Duration: 10:10
Logbook: Echinoid Pages: 71-74 Sperm:Egg Ratio: 2000:1
Reftox

Concentration 5 DS (mg/L)	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	88	12		SRS
	B	84	16		
	C	89	11		
	D	87	13		
1.8	A	75	25		
	B	~~74~~ SRS 73	27		
	C	~~72~~ SRS 74	26		
	D	73	27		
3.2	A	49	51		
	B	52	48		
	C	53	47		
	D	49	51		
5.6	A	26	74		
	B	28	72		
	C	26	74		
	D	27	73		
10.0	A	16	84		
	B	11	89		
	C	14	86		
	D	15	85		
Control Seawater					
Cntl	A	88	12		SRS
	B	81	19		
	C	85	15		
	D	86	14		

Data Verified By: Gaff Ky Date Verified: Aug 31/05

Test: SC-Sperm Cell Fertilization test						Test ID: rtdesds052	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: REF-Ref Toxicant						Sample Type: SDS-Sodium dodecyl sulfate	
Start Date: 8/9/2005 10:10			End Date: 8/9/2005			Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	88	12	
	2	2	D-Control	100	81	19	
	3	3	D-Control	100	85	15	
	4	4	D-Control	100	86	14	
	5	1	1.000	100	88	12	
	6	2	1.000	100	84	16	
	7	3	1.000	100	89	11	
	8	4	1.000	100	87	13	
	9	1	1.800	100	75	25	
	10	2	1.800	100	73	27	
	11	3	1.800	100	74	26	
	12	4	1.800	100	73	27	
	13	1	3.200	100	49	51	
	14	2	3.200	100	52	48	
	15	3	3.200	100	53	47	
	16	4	3.200	100	49	51	
	17	1	5.600	100	26	74	
	18	2	5.600	100	28	72	
	19	3	5.600	100	26	74	
	20	4	5.600	100	27	73	
	21	1	10.000	100	16	84	
	22	2	10.000	100	11	89	
	23	3	10.000	100	14	86	
	24	4	10.000	100	15	85	

Comments: Azimuth Consulting Group 04-1424-044 (0500328)

Reviewed by: Aug 31/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/9/2005 10:10	Test ID:	rtdesds052	Sample ID:	REF-Ref Toxicant
End Date:	8/9/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 04-1424-044 (0500328)				

Conc-mg/L	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
1	0.8800	0.8400	0.8900	0.8700
1.8	0.7500	0.7300	0.7400	0.7300
3.2	0.4900	0.5200	0.5300	0.4900
5.6	0.2600	0.2800	0.2600	0.2700
10	0.1600	0.1100	0.1400	0.1500

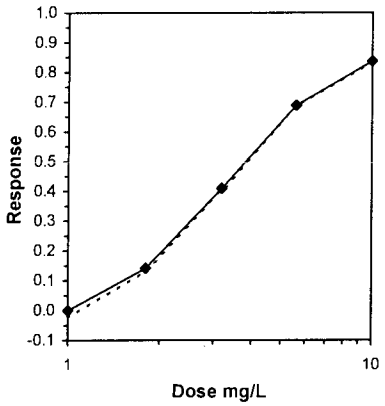
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.8500	0.0294	0.8500	0.8100	0.8800	3.463	4				0.8600	1.0000
1	0.8700	0.0216	0.8700	0.8400	0.8900	2.483	4	-1.412	2.410	0.0341	0.8600	1.0000
*1.8	0.7375	0.0096	0.7375	0.7300	0.7500	1.298	4	7.941	2.410	0.0341	0.7375	0.8576
*3.2	0.5075	0.0206	0.5075	0.4900	0.5300	4.062	4	24.176	2.410	0.0341	0.5075	0.5901
*5.6	0.2675	0.0096	0.2675	0.2600	0.2800	3.579	4	41.118	2.410	0.0341	0.2675	0.3110
*10	0.1400	0.0216	0.1400	0.1100	0.1600	15.430	4	50.118	2.410	0.0341	0.1400	0.1628

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.95791		0.884		-0.5718	-0.0762
Bartlett's Test indicates equal variances (p = 0.43)					4.8475		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	1	1.8	1.34164		0.03414	0.04017	0.38111	0.0004	3.8E-21	5, 18

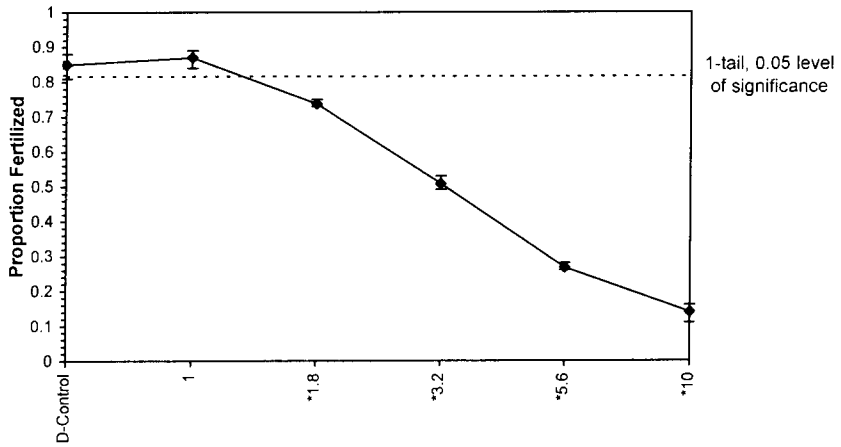
Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew
IC05	1.2507	0.0219	1.1728	1.3194	0.2839
IC10	1.5329	0.0430	1.4377	1.6889	1.2146
IC15	1.8323	0.0408	1.7124	1.9570	0.2306
IC20	2.0553	0.0391	1.9513	2.1828	0.4191
IC25	2.2959	0.0426	2.1872	2.4359	0.3093
IC40	3.1375	0.0735	2.9274	3.3760	0.1213
IC50	3.8600	0.0706	3.6272	4.0719	-0.0638

mg/L SDS



Dose-Response Plot



Reviewed by: Aug 31 05

APPENDIX III

Chain-of-Custody Form

CHAIN-OF-CUSTODY / TEST REQUEST FORM

0743

Client Name: Teck Cominco
Address: Box 2000, Kimberley BC, V1A 3E1
Client Contact: Bruce Donald
Phone: 250-427-5405
Fax: 250-427-8451
Sampled by: B Bolton
Ship to:
Attn.: Edmund Canonica
Shipping Date: Aug 6/05

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Sublethal toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00 am	Garrow Creek	E		G	1 x 20L		X					Client is actually Azimuth Consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Bolton Date: Aug 6/05
Company: Gartner Lee Ltd. Time: 14:00 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder Laboratory upon sample receipt.

Golder Project No.: 0500327 / 328 / 334 / 335
Golder Work Order No.: 04-1424-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, Yellow — accompany the shipment
Pink — kept by consignor (e.g. shipper)
Yellow — kept by consignee (e.g. receiver)
White — returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

CHAIN-OF-CUSTODY / TEST REQUEST FORM

No. 0742

Client Name: Teck Cominco
Client Contact: Bruce Donald
Ship to:
Address: Box 2000
Kimberly, BC
V1A 3E1
Phone: 250-427-8405
Fax: 250-427-8451
Sampled by: B Bolton
Attn.: Edmund Camacia

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Shipping Date: Aug 6/05

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Sub-lethal toxicity	Test(s) Requested	Test(s) Requested	Test(s) Requested	Test(s) Requested	4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00 am	Garrow Creek	E		G	2x20L	P	X					Client is actually Azimuth consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Bolton Date: Aug 6/05
Company: Gartner Lee Ltd Time: 14 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder Laboratory upon sample receipt

Golder Project No.: 0500327 /328/334/335
Golder Work Order No.: 04-1924-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, Yellow – accompany the shipment
Pink – kept by consignor (e.g. shipper)
Yellow – kept by consignee (e.g. receiver)
White – returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

CHAIN-OF-CUSTODY / TEST REQUEST FORM

10 0741

Client Name: Teck Cominco
Address: Box 2000, Kimberly, BC V1A 3E1
Client Contact: Bruce Donald
Phone: 250-427-8405
Fax: 250-427-8451
Sampled by: B Bolton
Attn.: Edmund Camaria
Ship to:

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Shipping Date: Aug 6/05

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Acute toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00	Garrow Creek	20L		G	2x20L	P	X					Client is actually Azimuth consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: Brenda Bolton Date: Aug 6/05
Company: Gartner Lee Time: 14:00 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder laboratory upon sample receipt.

Golder Project No.: 0500327 / 328/334/335
Golder Work Order No.: 04-1429-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies:
White, Yellow – accompany the shipment
Pink – kept by consignor (e.g. shipper)
Yellow – kept by consignee (e.g. receiver)
White – returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

APPENDIX I

Polaris 2005 Sampling Event Chronology

Appendix I - Polaris 2005 Sampling and Event Chronology

Becasue mine activities at the Polaris Mine Site ceased during the 2005 season, collection of the MMER and EEM data was conducted by small field crews stationed on-site for limited time periods (early season) and then by flying technicians into the site on a weekly basis in the latter part of the season. Because of the remote location of the high Arctic mine site and the unpredictable weather conditions, sample shipping and transport issues typically arise throughout the season. This season there were several flight attempts into the mine site during the latter part of the season that were unsuccessful due to hazardous weather conditions. The following is a chronology of the 2005 MMER/EEM sampling program, including sample attempts that were prevented due to weather conditions and/or shipping difficulties.

Date	Event Type	Observation/ Comments
Sat. Jun-25-05	-	Flow initiated in Garrow Creek
Wed. Jun-29-05	Monthly/Quarterly	FDP accessible; exposure (Garrow Bay) and reference (Garrow Bay) stations were ice covered precluding sample collection; no exceedances of MMER Schedule 4 limits; T-Hg, alkalinity and nitrate were analyzed after holding times due to an oversight by the ALS lab; a letter explaining this oversight was included in the 2nd quarter report. The EVS and Stantech labs were not able to accommodate a toxicity testing program for this event, as samples would have arrived during a statutory holiday (i.e., Friday July 1, 2005)
Wed. Jul-06-05	Monthly/Quarterly Failed attempt for collecting toxicity samples	FDP accessible; exposure (Garrow Bay) and reference (Garrow Bay) stations were ice covered precluding sample collection; no exceedances of MMER Schedule 4 limits; alkalinity and nitrate were analyzed after holding time due to an oversight by the ALS lab; a letter explaining this oversight is included in the 3nd quarter report Samples for toxicity testing were collected. However, due to fog conditions at the mine site, the flight into and out of the mine site was delayed and missed the connecting flight out of Resolute Bay. Toxicity samples missed holding times and were discarded by the labs, or stopped en-route.
Wed. Jul-13-05	Weekly	A weekly sample was collected as the program schedule was adjusted to Saturday collections to enable sample delivery to the labs earlier in the week (i.e., Tuesday). Although this shipping schedule adds an extra day in transit, if there are no weather delays, then samples should arrive at the labs within the holding time for all toxicity tests.
Sat. Jul-16-05	Monthly/Quarterly Acute Toxicity Sublethal Toxicity	All effluent and water quality monitoring stations were accessible for sample collection. Samples arrived at the labs on Tuesday July 19, 2005 within holding times for all tests. No exceedances of Schedule 4 limits. No acute toxicity.
Sat. Jul-23-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Jul-23-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Jul-23-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Aug-06-05	Monthly/Quarterly Acute Toxicity Sublethal Toxicity	All effluent and water quality monitoring stations were accessible for sample collection. Samples arrived at the labs on Tuesday August 9, 2005 within holding times for all tests. No exceedances of Schedule 4 limits. No acute toxicity.
Sat. Aug-13-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Aug-20-05	Failed attempt for Weekly sample	Flight to Polaris Mine site from Resolute was attempted but did not land due to thick fog and therefore unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Sun. Aug-21-05	Failed attempt for Weekly sample	Flight to Polaris Mine site from Resolute was attempted but did not land due to thick fog and therefore unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Mon. Aug-22-05	Failed attempt for Weekly sample	Fog conditions from satellite photos indicated weather was the same or worse than the previous 2 days. No flight attempted over to site due to unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Tue. Aug-23-05	Failed attempt for Weekly sample	Fog conditions from satellite photos indicated weather was the same or worse than the previous 3 days. No flight attempted over to site due to unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Wed. Aug-24-05	Weekly	The sample attempt made on Wed August 24, 2005, was successful, following the failed attempts since the previous Saturday. No exceedances of Schedule 4 limits.
Sat. Aug-27-05	Weekly	No exceedances of Schedule 4 limits.

Date	Event Type	Observation/ Comments
Wed. Aug-31-05	Failed attempt for Weekly sample	An attempt to fly into Polaris was made. However, due to fog conditions at the mine site, and the plane was unable to land. Ken Russell and Jenny Ferone were notified of this failed attempt on September 1, 2005.
Sat. Sep-03-05	Failed attempt for Weekly sample	Thick fog and poor visibility prevented the plane from leaving Resolute. Ken Russell and Jenny Ferone were notified of this failed attempt on September 6, 2005.
Wed. Sep-07-05	Failed attempt for Weekly sample	The planned flight into Polaris was cancelled by the pilot due to snow conditions (5-10cm) in Resolute and potentially unsafe conditions for landing at the mine site. Ken Russell and Jenny Ferone were notified of this failed attempt on September 7, 2005.
Sat. Sep-10-05	Failed attempt for Weekly sample	A monthly chemistry plus acute toxicity testing event was planned. However, due to blowing snow conditions, it was deemed by the pilot too hazardous to land an aircraft at the mine site. Ken Russell (Environment Canada) was informed on September 13, 2005.
Tue. Sep-13-05	-	A monthly chemistry plus acute toxicity testing event was planned. However, upon arrival at the mine site, the creek was found to be frozen. Ken Russell was informed on September 13, 2005

APPENDIX J

Letter from ALS explaining missed holding times for July 6, 2005 sample

ALS Environmental

August 5, 2005

Mr. Bruce Donald
Teck Cominco
Bag 2000
Kimberley, BC V1A 3E1

Dear Mr. Donald,

RE: Concerns Regarding Analytical Service

This is in response to email correspondence dated July 29, 2005 through August 3, 2005 expressing concerns over the services provided by ALS Environmental on some Teck Cominco / Azimuth Consulting Group submissions from late June and early July. The examples noted in the emails and the overall concerns over the service provided are taken very seriously by ALS Environmental, and this response letter will hopefully help to address the concerns that were expressed.

In order to provide some clarity and to help resolve the various items of concerns, the following are some of the details that relate to the individual concerns expressed in the emails.

1) missed analyses for samples submitted,
2) missed holding times for Nitrate, Mercury, Alkalinity.

Details of Expressed Concerns

Missed Analysis / Missed Holding Times for Samples Submitted for 2 Submissions:

Polaris MMER (ALS W1416) analysed for pH, Salinity, Total Cyanide, Ammonia, Total Suspended Solids, Radium 226 and total metals
Date / Time Received: Monday, July 11, 2005 @ 10:10 am.
Date / Time Reported: Monday, July 25, 2005 @ 2:23 pm for all but the Radium 226 via email
Wednesday, July 27, 2005 @ 2:42 pm for all analysis via email

Polaris MMER (ALS W1458) analysed for pH, Salinity, Total Cyanide, Ammonia, Total Suspended Solids, Radium 226 and total metals including Mercury
Date / Time Received: Tuesday, July 12, 2005 @ 9:30 am.
Date / Reported: Monday, July 25, 2005 @ 2:23 pm for all but the Radium 226 via email
Wednesday, July 27, 2005 @ 2:42 pm for all analysis via email.

On July 28, 2005, Cheryl Mackintosh of Azimuth Consulting Group called Leanne Harris and expressed concern over the fact that the Mercury analysis for W1416 was missing. Upon investigation, it was

discovered that the Mercury was missed at the time of receipt; although it was indicated on the chain of custody. The Mercury analysis for this sample was completed at Ms. Mackintosh's request, but it should be noted that it was one day past the recommended holding time of 28 days for Mercury analysis in water.

On July 29, 2005, Ms. Mackintosh emailed Ms. Harris to inquire about the missing analysis of Nitrate and Alkalinity on the two above referenced submissions. The 48 hour recommended holding time for Nitrate had been exceeded prior to receipt of the samples, but the analysis was carried out as per request. The 14 day holding time for Alkalinity had been exceeded by the time the analysis was completed.

Ms. Mackintosh indicated in subsequent email correspondence that these samples had been identified in an email as MMER monthly samples; which meant that they should have been analysed for a fuller suite of analyses. ALS missed the analysis requests and in future will work toward improved communication internally to prevent a similar situation from occurring again.

The results for the Mercury and Alkalinity analysis with holding time exceedences were compared to other routine monitoring results. Historically, the samples compare well with previous submissions analysed within the holding times. Future submissions will be analysed within the appropriate holding times for Mercury and Alkalinity as long as the samples are received with sufficient time to do the analysis. For the Nitrate analysis, with the very short holding time of 48 hours, these samples will not be able to reach a lab within the holding time due to the remote nature of the site. The recommended holding time for these analyses is usually based on studies done with chemically active samples (such as waste waters or discharge samples), which chemically change over short periods of time. While there is no way to tell exactly how these samples are changing over time (without doing a detailed study that incorporates time studies), in general clean water samples from groundwater or surface water sources usually don't have a large amount of chemical activity.

Hopefully, this letter has summarized and addressed the concerns that have been raised. Most of the issue relates to communication. Increased effort in ensuring that there is excellent communication between our staff and the client, as well as thorough communication internally, helps to yield a successful project.

Thank you for bringing this matter to our attention as it helps us to assess our operation and continuously adjust and improve. Please feel free to contact either of the undersigned if you would like to discuss the matter further.

Sincerely,

Joyce Chow, B. Sc.
Branch Manager

Heather Ross-Easton, B.Sc.
Client Services Representative

cc: Cheryl Mackintosh, Azimuth Consulting Group Inc.
Patrick Allard, Azimuth Consulting Group Inc.
Randy Baker, Azimuth Consulting Group Inc.

Limnology and Ecology of Garrow Lake, Little Cornwallis Island, Nunavut – August 2003

Prepared for

Teck Cominco Metals Ltd.
Bag 2000
Kimberley BC
V1A 3E1

May 2005

Azimuth Consulting Group Inc.
218-2902 West Broadway
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Project No

TC–03–03

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ACKNOWLEDGEMENTS

We would like to acknowledge the support of Teck Cominco Polaris staff for their assistance and logistical support while on site. Bruce Donald, Teck Cominco is especially thanked for his support of the study and providing latitude to conduct an independent investigation of Garrow Lake. Bruce Donald and Walter Kuit (Teck Cominco) are also thanked for providing historical insight about Garrow Lake and for their review of this report.

Applied Technical Services, Victoria BC is thanked for their careful taxonomic identification of benthic invertebrates. ALS Vancouver is acknowledged for their care in chemical analysis of water, sediment and fish samples.

Randy Baker (Azimuth Consulting Group) authored this report. Patrick Allard and Gary Mann (Azimuth) provided field assistance and Beth Power (Azimuth) is thanked for her technical review. I would also like to thank Bruce Fallis (Department of Fisheries and Oceans, Winnipeg) for sharing his historical experience at Garrow Lake with me.

GLOSSARY

Aquatic – Pertaining to plants or animals that live in freshwater or marine environments.

Arctic – The Arctic is a geographic region that is circumpolar in extent and generally characterized as being north of the treeline, in an area of continuous permafrost.

Benthic – Pertaining to the bottom region of a water body, such as a lake.

Benthic invertebrates / Benthos – Assemblage of organisms living in or on the bottom sediment of a water body and dependent upon the decomposition cycle for most, if not all, of their food supply.

Biomass – The total mass of living organisms usually expressed as a weight per unit area or volume (e.g., mg/m^3 of water).

Bivalves – Mollusks with shells consisting of two halves (i.e., valves) such as clams.

Chironomids – Midges (two-winged insects) in the order Diptera. The aquatic larval form of this insect is typically the most abundant and diverse group of insects found in lakes.

Density of organisms – A term that describes abundance. The total number of living organisms expressed per unit area (e.g., $no./m^2$) or volume ($\#/m^3$).

Dissolved concentrations (water) – The concentration of chemical parameters in water filtered through a 0.45µm glass fiber filter. This is operationally defined as the dissolved fraction in water.

Dipteran insects – Insects of the Order Diptera, consisting of flies having two-wings that includes chironomids, flies, and mosquitoes.

Diversity – A measure (e.g., Shannon-Weaver index) of the variety of living organisms in an area (e.g., number or richness of species).

Drainage basin – The term given to a geographic area that contributes surface and groundwater to a particular lake, river, or stream (also see watershed).

Ecosystem – A community of interacting organisms considered together with the chemical and physical factors that make up their environment.

Environment – Components of the earth including land, water, air, and all layers of the atmosphere. Also included are organic and inorganic matter, living organisms, and all interacting natural systems.

Food chain – Organisms that are linked together in a series that, by consuming lower level organisms, transfer nutrients and energy from one group to another.

Food web – The concept used to describe the relationships of organisms within an ecosystem that are interconnected through various feeding linkages, resulting in the transfer of nutrients and energy.

Freshet – The increased flow of water over a relatively short period of time, usually during spring, caused by snowmelt.

Global Positioning System (GPS) – A sophisticated system used to define a precise geographic location with the aid of a satellite system. Units are typically expressed as UTM (Universal Transverse Mercator) or in latitude and longitude.

Habitat – Any area that provides food, water and/or shelter for an organism.

Invertebrates – A collective term for all animals without a backbone or spinal column and includes all aquatic animal organisms except fish.

Larva – The immature stage, between egg and pupa, of an insect with complete metamorphosis. Many insect larvae are aquatic, including chironomids, mayflies, stoneflies and caddisflies.

Limnology – The study of freshwater lakes including biological, geological, physical, and chemical aspects.

Littoral – The region of a lake, including water and sediment, from the surface to a depth at which photosynthesis ceases, usually within the upper 10m of the water column.

Meromictic – A permanently stratified lake, usually without oxygen (or fish) in its deeper portions due to a density gradient and lack of turnover.

Micro (μ) – A unit of measurement denoting a factor of one-millionth, such as μg/g.

Milligram (mg) – A unit of measurement denoting a factor of one-thousandth, such as mg/g.

Mixolimnion – The low-density surface layer above the pycnocline in a meromictic layer.

Monimolimnion – The high-density bottom layer below the pycnocline in a meromictic lake.

Nutrient – Any substance that provides essential nourishment for the maintenance of life (e.g., carbon, nitrogen, and phosphorous).

Oligochaete – True worms from the Phylum Annelida (segmented worms) that are common in sediment of freshwater habitats.

Oligotrophic – Nutrient deficient waters with low productivity. The vast majority of Arctic lakes are oligotrophic.

Organic Carbon (sediments) – The non-mineral fraction of the sediments that consists of organic carbon, expressed as a percent (%) of the total weight of sediment. This includes all forms of carbon except carbonates.

Phytoplankton – Microscopic or small floating plants suspended in the water column of aquatic ecosystems.

Planktonic – Referring to organisms with limited mobility that are free-floating and living in the water column.

Predator – Any organism that consumes another organism.

Prey – Any organism that is consumed by another organism.

Primary consumers – Organisms such as zooplankton that feed on primary producers (e.g., phytoplankton) for their source of nutrients and energy.

Primary production – Production by photosynthetic organisms, such as algae, phytoplankton and periphyton. Photosynthetic organisms comprise the bottom of the food chain.

Primary productivity – A term given to the rate at which new biomass (i.e., plant tissue) is generated by photosynthetic organisms (i.e., plants) using energy captured from the sun.

Pycnocline – The term given to the density layer of rapid change in temperature and salinity that separates the surface water (epilimnion) from the bottom water (hypolimnion).

Quality Assurance / Quality Control [QA/QC] – Sampling and analytical procedures (such as lab replicate sample analysis) that are integrated in field collection and analytical procedures to ensure acceptable data quality.

Richness – The number of unique taxa (e.g., species) found at a particular location.

Secondary productivity – The rate of increase in biomass of organisms that consume plants or other primary producers.

Secondary consumer – Organisms such as forage fish that consume primary consumers (e.g., zooplankton) for their source of nutrients and energy.

Sediment grain size – Refers to the size and relative size distribution of the particles that make up the sediment. Typically they are divided into four groups including clay, silt, sand and gravel.

Stratification – Vertical differences in water temperature, causing a density difference between warm, less dense surface water and cold, more dense bottom water, retarding or preventing mixing of surface and bottom water.

Terrestrial – Pertaining to plants or animals that live on land.

Total metals concentrations (water) – The total concentration of a metal in the water, which includes both freely dissolved and particle-bound forms of the metal.

Total Suspended Solids [TSS] – The weight of solids that are suspended in a given volume of water, expressed as weight per unit volume (e.g., mg/L).

Trophic Levels – A functional classification of organisms in an ecosystem according to feeding relationships, from primary producers through primary consumers, through secondary consumers.

Tundra – Habitat typically found in the Arctic north of the treeline that is adapted to cold temperatures, a short growing season, and low precipitation. Typical tundra vegetation includes moss, lichen, Labrador tea, and small shrubs.

Turbidity – A condition of reduced transparency in water caused by suspended colloidal or particulate material; measured by a turbidimeter and recorded as nephelometric turbidity units (NTU).

Ultra-oligotrophic – Lakes with extremely low nutrient levels, high water clarity, low primary productivity, and a dominance of small unicellular phytoplankton species. Total phosphorous concentrations are typically <0.005ug/L in these lakes (Vollenweider 1968).

Watershed – An entire geographic area that contributes surface and groundwater to a particular lake, river, or stream.

Water Quality Guidelines – Reference concentrations of contaminants in water that, if exceeded, indicates that organism-level effects may occur.

Zooplankton – Small, floating or weakly swimming animals found in fresh and marine waters, such as copepods and cladocerans.

EXECUTIVE SUMMARY

The objective of this study was to determine the limnology and ecology of Garrow Lake and assess changes to the lake after more than 20 years of tailings disposal. Prior to mining, the lake supported a depauperate biological community including a small, dwarf population of landlocked fourhorn sculpin (*Myoxocephalus quadricornis*). Teck Cominco has regularly monitored lake water quality and stratification since pre-mine investigations. However, no study of sediment quality or biological studies have been conducted since disposal of tailings to the lake began in 1980. As part of a 2002 DFO habitat authorization (02-HCAA-000-000063), Teck Cominco was specifically required to determine TSS and turbidity in different strata of Garrow Lake, metals concentration in littoral zone sediment and whole-body metal concentration in fourhorn sculpin.

Teck Cominco Ltd.'s Polaris Mine (75°23'N 96°50'W) on southern Little Cornwallis Island, Nunavut used Garrow Lake for tailings disposal pursuant to its designation as a Tailings Impoundment Area (*Fisheries Act* Schedule 2). as a Tailings Impoundment Area (*Fisheries Act* Schedule 2). Underground zinc-lead mining permanently ceased in September 2002. Since then the mine has undergone reclamation and decommissioning that concluded in fall 2004. Polaris Mine is undergoing a full cycle of Environmental Effects Monitoring (EEM) under the federal Metal Mining Effluent Regulations that will conclude in 2005.

Garrow Lake is small, ultra-oligotrophic, permanently chemically and thermally stratified (i.e., meromictic) lake with a surface area of 4.18 km^2, maximum depth of 42 m and a depauperate biological community. Prior to tailings deposition, the biologically active mixolimnion ranged between zero and 12 m – 14 m in depth and was well oxygenated, cold and brackish (3 – 7 ppt salinity). The deep monimolimnion extended from about 18 m to the bottom and was unusually warm (8°C), completely anoxic, sulphide rich and hypersaline, with a salinity of up to 90 ppt. These layers were separated by a 6 m thick pycnocline where temperature increased, oxygen concentrations fell and salinity increased rapidly with increasing depth.

Between 1981 and 2002, approximately 15 million tonnes of tailings solids were deposited into the monimnolimnion. Gradual displacement of water upwards has reduced total depth of the lake from 46 m to 42 m, and reduced depth of the mixolimnion and thickness of the pycnocline. Discharge of tailings into the monimolimnion has also reduced mean salinity, from 90 ppt to 70 ppt, and caused complete mixing within the monimolimnion, such that temperature and salinity profiles are uniform from just beneath the pycnocline to the bottom.

Tailings deposition has not changed limnological conditions of the mixolimnion. Winter and summer water temperatures remain cold, ranging from –0.5 °C to 4 °C with little difference between seasons. Salinity ranged from 3.8 ppt at the surface to 7.1 ppt at the

pycnocline (9 m) with slight inverse stratification. Oxygen concentration was stratified and high in winter (13 – 20 mg/L) and supersaturated, a condition also noted during pre-mine conditions, presumably from algae and photosynthetic bacteria. In August oxygen was uniform at 11.5 mg/L, but was not supersaturated because absence of ice cover and mixing by wind, allowing oxygen to escape to the atmosphere.

Depth of the mixolimnion extends to 9 m at the top of the pycnocline. Maximum salinity is reached at the top of the monimolimnion at 12 m, a depth of only 3 m. Formerly, mixolimnion depth extended to 12 m and the bottom of the pycnocline ended at about 20 m. Oxygen concentration in the monimolimnion was nil and there was a strong hydrogen sulphide odor to the water.

Tailings deposition has displaced the mixolimnion depth by 4 – 5 m. Lake elevation in 2003 was 2 m higher than pre-mine elevation because of the dam that was still in place at the lake outlet. Removal of the dam in spring 2004 has allowed water level in the lake to return to near pre-dam elevations and will have reduced lake level and total depth of the mixolimnion to about 8 m, a further reduction of 2 m.

Prior to tailings deposition, sediment metals concentrations did not differ with depth and were relatively low, but reflected natural mineralization of the area, with elevated lead and zinc. A pipeline break in 1984/1985 caused tailings to spill into the littoral zone along the western shore of the lake, resulting in widespread contamination of lead and zinc in littoral zone sediment. This caused an increase in dissolved zinc concentration in surface waters of Garrow Lake and the outflow creek. Currently, zinc concentration in the Garrow Lake mixolimnion averages about 0.22 ppm, below the permit limit of 0.5 ppm established in 1992.

The only species of zooplankton known to be present in Garrow Lake is *Limnocalanus macrurus*, which was captured during pre-mine surveys. Amphipods (*Gammarus* sp.) and a mysid species (*Mysis oculata*) were also present in Garrow Lake prior to mining. No zooplankton species were captured during the 2003 survey. It is not known why zooplankton appeared to be absent. It is possible zooplankters were deeper in the water column than was sampled, or that changes to mixolimnion water chemistry may have caused a decline or extirpation of *L. macrurus* or its primary food source, phytoplankton. Phytoplankton were not collected in 2003.

Oligochaetes (F. Enchytraidae), nematodes and Foraminifera were the only benthic invertebrates identified in sediment collected at four stations within the mixolimnion zone in 2003. Although chironomid larvae were not collected from sediment, they were observed in stomachs of fourhorn sculpin. Pre-mining surveys also indicated a depauperate benthic fauna dominated by Foraminifera and a few harpacticoid copepods and chironomids. Garrow Creek sediment contained nematodes, oligochaetes a single mayfly (Ephemeroptera) species *Baetis bicaudatus* and several chironomid species.

All 19 sculpins captured in 2003 appeared to be healthy with no external or internal tumors, scars or other abnormalities. Mean length (149 mm), weight (25 g) and condition (0.70) of sculpins from 2003 were similar to sculpins collected in 1976 (155 mm, 26 g, 0.72) using the same gear. Length – frequency distributions of sculpins from 1976, 1977 and 2003 also demonstrated that the basic size distribution of adult sculpins has not changed over time.

Mean age of sculpins captured in 2003 was 5.7 years, with a range of 3 – 9 years. The small size, low lipid content (10%) and small size at age confirm that Garrow Lake sculpins are slow growing relative to other Arctic sculpin populations because of limitations in food and habitat.

Four of 11 sculpins stomachs examined contained food, with only a few chironomid larvae distinguishable. Pre-mine examination of stomachs indicated that half were empty while copepods, unidentified eggs, plant material, and a few amphipods were present in the other half. Copepods were not identified in stomachs in 2003, providing circumstantial evidence that zooplankton may not be abundant and comprise a very small component of the aquatic community in Garrow Lake post-mining.

Gonads of most sculpins examined appeared ripe or nearly ripe and these individuals would certainly spawn within the next few months during mid-winter, a trend that is consistent for this species.

Whole body concentration of manganese, lead (0.81 mg/kg ww) and zinc (72 mg/kg) in sculpins was higher in 2003 than prior to mining. Other metals including arsenic, cadmium, copper, mercury, and nickel were lower or did not differ among years. Elevated lead and zinc concentrations in sediment and the water column as a result of the spill may be responsible for elevated tissue concentration, however, the magnitude of increase in tissue was small, only 2 – 3 times higher than pre-mining concentration, despite a two-order of magnitude increase in lead and zinc concentration in sediment.

Overall, it appears as if the size, distribution, growth rate and reproductive status of the sculpin community has not changed markedly since pre-mining studies. Although catch-per-unit-effort was not recorded, sculpins were more difficult to capture and did not appear to be as abundant or as easy to capture as pre-mine surveys indicate. This may be related to the absence of zooplankton and reduced benthic habitat available to sculpins and their food sources because of gradual upward displacement of the mixolimnion. Nevertheless, sculpins have survived in Garrow Lake throughout the history of mining and tailings deposition to the lake, which is still designated as a tailings disposal facility.

Tailings introduction and upward displacement the pycnocline and mixolimnion will have reduced depth of the mixolimnion above the pycnocline to about 8 m in 2004, after removal of the dam. It has been determined that the magnitude of the thermal and salinity

difference between the mixolimnion and the monimolimnion in the lake will be sufficient to maintain separation of the two layers and prevent turnover and mixing.

1 INTRODUCTION

1.1. Background

Teck Cominco Metals Ltd.'s Polaris Mine (75°23'N 96°50'W) is situated on southern Little Cornwallis Island, Nunavut, in the high Arctic, approximately 90 km northwest of Resolute Bay (Figure 1). This region is characterized by short, cold summers and extremely cold, long and dark winters. Mean average air temperature is –17°C with an average of only 8 frost-free days annually. Precipitation is very low and is typical of desert conditions with only 25 cm of annual precipitation, most of this as snowfall. Winds are strong and predominantly from the northeast with an average wind speed of 20 kph (Gartner Lee, 2001).

Underground zinc-lead mining operations, which initially began in 1981, permanently ceased on September 3, 2002 with the final shipment of concentrate, taking place later that same month. The Polaris Mine has undergone a two-year reclamation and decommissioning phase (Garner Lee, 2001) that concluded in September 2004. In addition to remediation of upland soils, Polaris Mine is undergoing a full cycle of Environmental Effects Monitoring (EEM) under the federal Metal Mining Effluent Regulations (MMER; DFO, 2002). The MMER document (Azimuth Consulting Group, 2004) describes how the three main components of MMER are to be applied; routine effluent monitoring (chemistry, toxicity, mass loading) in Garrow Creek, emergency response, and Environmental Effects Monitoring (EEM) of receiving environment biota (benthic community and fish survey) in Garrow Bay.

As part of mine closure activities, Teck Cominco was required to undertake a basic ecological study of Garrow Lake as part of a Department of Fisheries and Oceans Habitat Authorization (see Section 1.4 and Appendix A). This document satisfies that directive.

1.2. Limnology

Garrow Lake is a small, permanently chemically and thermally stratified (i.e., meromictic) lake with a surface area of 4.18 km^2, a maximum depth of 46 m and unique limnological characteristics (BC Research, 1975; Ouellet and Dickman, 1984; Fallis et al., 1987). The lake is ultra-oligotrophic with very low nutrient concentration and a depauperate biological community (Fallis et al., 1987; BC Research, 1978). Because of its unique physical/chemical features, Garrow Lake has been the subject of much study, notwithstanding its designation as a Tailings Impoundment Area for Polaris Mine. Garrow is still considered a Tailings Impoundment under the current MMER (DFO, 2002).

The meromictic nature of Garrow Lake means that there are three distinct depth zones within the lake that never inter-mix, because of their particular thermal and chemical properties. These are the mixolimnion, pycnocline layer and monimolimnion, from top to bottom.

Prior to mining, the mixolimnion of Garrow Lake ranged from the surface to about 12 m – 14 m depth. It was well oxygenated, cold (0°C to 4°C) and brackish, ranging from 3 ppt at the surface to 7 ppt above the pycnocline. The monimolimnion ranged in depth from about 18 – 20 m to the bottom of the lake, at a maximum depth of 46 m. This deep layer was unusually warm (8°C), completely anoxic, sulphide rich and hypersaline, with a salinity of up to 90 ppt, nearly triple the salinity of seawater. These two very different layers were separated by a pycnocline. The pycnocline represents the transition zone between the mixolimnion and monimolimnion where temperature increases, oxygen concentration falls and salinity increases rapidly with increasing depth. The large increase in density transitioning from the mixolimnion to the monimolimnion through the pycnocline is great enough to maintain complete separation of the layers and prevent mixing, even over thousands of years.

Garrow Lake is situated in an area of continuous permafrost and is ice-covered for much of the year (Photo 1). In some years, the ice does not completely melt, leaving an ice cover. The lake slopes steeply from the narrow littoral zone into the anoxic, hyper-saline profundal zone within tens of meters from shore. The drainage area of Garrow Lake is very small and is only double the surface area of the lake. The small drainage area and low precipitation means that total annual discharge from the lake via Garrow Creek is correspondingly small.

Discharge to Garrow Bay, 1.4 km south of the lake outlet occurs during the brief open water period from mid to late July through late-August or early September. In the nearly 3,000 years since its separation from adjacent marine waters, the annual freeze-thaw cycle at the lake's surface has transferred and concentrated salt in the deeper parts of the lake. Interestingly, bottom temperature is nearly 8°C, much warmer than surface waters that are always near zero.

1.3. Mining Operations

Polaris was a zinc-lead mine that operated between 1981 and 2002 inclusive. Mined ore was crushed underground and moved by conveyor to a mill. Ore concentrate was stockpiled above ground in a covered building and shipped by ocean going bulk carrier to Europe during the brief open water period. Garrow Lake is a designated Tailings Disposal Facility. Over the life of the mine approximately 15 million tonnes of tailings solids were deposited to the bottom of Garrow Lake at a rate of up to 100 tonnes per hour (Gartner-Lee, 2001). Mill tailings were pumped via a 4 km long tailings line to a

thickener before being discharged to Garrow Lake via a submerged pipe. The pipe extended between 600 m and 1.2 km offshore and to a depth of 30 m (BC Research, 1988), at least 10 m below the pycnocline and 15 m above the bottom. The tailings line was moved every year to distribute tailings over the bottom. Small piles of tailings are apparent from lake bathymetry (Figure 2).

This disposal system was very effective, except for an incident in 1984/85 where a failure of the pipe resulted in tailings discharge into near-surface waters of Garrow Lake. This spill caused tailings to be deposited along the western shore of the lake near the tailings line and caused dissolved zinc concentration in surface waters to increase to more than 0.4 mg/L. Since the spill, zinc concentration in the mixolimnion has been slowly declining. Currently, zinc concentration in Garrow Lake averages about 0.23 ppm, below the permit limit (0.5 ppm) that was established in 1992.

To dilute zinc concentration in the mixolimnion and hence reduce zinc concentration in water discharged to Garrow Bay via Garrow Creek, Teck Cominco constructed a dam in 1989/1990 across the creek, about half way between the outlet and the mouth (Figure 2). Water was retained within the lake for three years, causing in increase in lake elevation and mixolimnion depth by about 2 m. Between 1994 and 2003 stream discharge and lake level was controlled by active siphoning of water over the dam into Garrow Creek between mid-July and early-September. Therefore, discharge was relatively constant throughout the discharge period, ranging between 0.19 m^3/s and 0.55 m^3/s, depending on the number of siphons in operation. The dike and siphons were removed in spring 2004 to allow the lake to return to its former level and in future, fluctuate naturally.

Prior to installation of the dam, flow in Garrow Creek was ephemeral with discharge typically occurring over a six to eight week period beginning in mid-July, once the stream mouth and channel had thawed. Stream flow began with melting and freshet, which lasts about two weeks (0.5 – 1.5 m^3/sec) before rapidly diminishing to relatively low discharge volume (0.1 m^3/sec) for the remainder of the summer/fall until freeze-up in early September. It is expected that since the dam and siphons have been removed, discharge will return to normal patterns, except with smaller discharge volume as no water is displaced by the addition of mine tailings.

1.4. Objective

Our objective was to describe the current limnology and ecology of Garrow Lake and assess changes after more than 20 years of use of Garrow as a tailings disposal facility. Prior to mining, the surface waters and littoral sediment of Garrow Lake supported a small community of zooplankton and benthos that sustained a small, dwarf population of landlocked fourhorn sculpin (*Myoxocephalus quadricornis*). It was not known if surface water conditions had deteriorated sufficiently as to cause unfavorable conditions for

aquatic life. Since pre-mine investigations in 1977 (BC Research, 1977), 1979 (Fallis et al. 1987) and 1980 (BC Research, 1981), very few studies on water quality have been conducted, outside of routine monitoring by Teck Cominco two or three times per year. No study of surface sediment quality (e.g., BC Research, 1988) or ecology of the lake has been conducted since deposition of mine tailings began. Therefore, as part of a 2002 DFO habitat authorization (02-HCAA-000-000063; Appendix A) during the decommissioning and dam removal process, Teck Cominco was specifically required to determine the following (see Section 4.0 of authorization; Appendix A):

- "TSS and turbidity in different strata of Garrow Lake to confirm the absence of contaminants in surface waters;

  metals concentration in sediment in the littoral zone of Garrow Lake; and
- whole-body metal concentration in fourhorn sculpin".

This report describes limnological and ecological features of Garrow Lake several months after cessation of more than 20 years of tailings disposal and satisfies requirements of the DFO Habitat Authorization. The data reported here extends beyond the requirements of the Habitat Authorization to review historical trends and provide a broader base of information.

2. MATERIALS AND METHODS

2.1. Limnology and Water Chemistry

Water sampling was conducted from a 3 m aluminum boat with 12 hp motor on August 8, 2003 (Photo's 2 and 3). Shifting ice pans covered at least 50% of the lake. One week earlier, ice cover on the lake was at least 80% (Photo 1). Based on historic bathymetric data and using a hand-held depth meter, the deepest depth on Garrow Lake that could be accessed because of ice, was located in 42.5 m of water (Figure 2). At this point, a vertical pH, temperature (°C), oxygen (ppm), conductivity (mS) and salinity (ppt) profile of the lake was acquired using a Hydrolab™ meter. Measurements were recorded at 1 m intervals between the surface and bottom. Vertical temperature and salinity profiles were compared with pre-mine profiles (BC Research, 1975; Fallis et al. 1987; BC Research, 1978) and during-mining profiles (BC Research, 1988) to determine the effects of mine tailings disposal on lake stratification, limnological parameters and water chemistry (Appendix B).

To acquire water samples for chemical analysis from this location (WQ-1), water was pumped from discrete depths using a direct pumping system. Depths were selected based on temperature and salinity data acquired with the Hydrolab. Weighted, ultra-clean metered Teflon tubing was deployed from the boat and lowered to the desired depth. A diaphragm pump was attached and water was pumped from depth for at least 1 minute before being discharged directly into sample collection bottles that were triple rinsed and held on ice. Water samples requiring filtering were filtered in the field by placing a 45 µm inline Gelman filter onto the end of the hose and discharging water directly into sample bottles.

Water was collected from the surface, mid-epilimnion (6 m), pycnocline (11 m) and hypolimnion layers (15 m and 30 m) to characterize each discrete layer. A 1-L plastic bottle with no preservative was used to hold water for determination of pH, conductivity, salinity, total suspended solids (TSS), alkalinity, sulphate and fluoride. A 250 ml glass amber bottle with no preservative was used to hold water for determination of DOC. Total metals and dissolved metals were collected in 250 mL plastic bottles preserved with nitric acid. Standard field collection and quality assurance/quality control (QA/QC) procedures were followed (BCMELP, 2003). Water samples were held on ice and during shipping to ALS Environmental Laboratory, Vancouver for analysis.

2.2. Sediment Chemistry

Sediment was collected from six littoral zone stations around the lake as ice conditions permitted using a 0.024 m^2 petite Ponar grab (Figure 2). Four stations were synoptically

sampled for sediment metals (GL-X-SED), benthos and zooplankton. Two stations (GL-N, GL-S) in the vicinity of the historic spill were only sampled for sediment metals. Stations were selected based on depth (<9 m) using a hand-held depth meter to ensure that sampling occurred within the mixolimnion layer of the lake to ensure consistency in grain size and avoid shallow depths with coarse substrate (Table 1).

Sediment was collected using proven sample collection and handling techniques (Environment Canada, 1994; BCMELP, 2003). Each deployed grab sample was examined to ensure acceptable sample quality (i.e., no large foreign objects; adequate penetration; not overfilled; no leaking water; no disturbance or winnowing). Once the grab sample quality was determined to be acceptable, overlying water was siphoned off and the top few cm of sediment was removed from the center of each grab using a pre-cleaned stainless steel spoon and placed in a pre-cleaned stainless steel mixing bowl. Two samples were acquired from each station and composited in the same bowl. Sediment was mixed using the spoon until it was homogenous in texture and colour. Aliquots of sediment were placed into 250-mL glass jars for analysis of total metals including mercury, total organic carbon (TOC) and grain size by ALS, Vancouver BC. Samples were stored in coolers with frozen gel packs on ice until analysis by the laboratory.

Total metals were analyzed using procedures from the BC Contaminated Sites Regulations (CSR) Analytical Method 8 *Strong Acid Leachable Metals (SALM) in Soil* and procedures adapted from *Test Methods for Evaluating Solid Waste SW-846* (US EPA Method 3050B or Method 3051). Sediment samples were manually homogenized, dried at 60 °C, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material was weighed. The sample was then digested at 90 °C for two hours by either hotplate or block digester using a 1:1 ratio of concentrated nitric and hydrochloric acids. Instrumental analysis was by atomic absorption/fluorescence spectrometry (CVAAS/CVAFS)(US EPA Method 7000 series) and/or inductively coupled plasma – optical emission spectrometry (US EPA Method 6010B).

2.3. Biota

2.3.1. Zooplankton

Vertical zooplankton tows were conducted from the four synoptic stations (Figure 2) using a 2 m long, 0.5 m diameter conical net, with 250 µm mesh size. The mouth of the net was lowered to a depth of 8 m and after waiting 30 sec, was towed vertically towards the lake surface. Two vertical tows were conducted and composited to determine zooplankton density (# organisms/m^3). Contents of the cod end were washed into a 500 mL HDPE jar and preserved with a 10% formalin solution. In addition, a horizontal tow was conducted at station 3. The net was weighted and towed behind the boat at a depth of

1 m for 3 minutes, to attempt to collect zooplankton for taxonomic analysis. Preserved samples were shipped to Applied Technical Services, Victoria BC for taxonomic identification.

2.3.2. Benthic Invertebrates

Sediment was acquired using a petite Ponar grab (0.024 m^2) at each of the four synoptic stations (Table 1). The top 5 cm of acceptable grabs was removed and sieved through a 500 μm sieve. Three grab samples were acquired at each station and composited (i.e., 0.072 m^2) to determine density of organisms (#/m^2).

Garrow Creek, just downstream from its outlet from Garrow Lake (i.e., below the dam) was sampled for benthic invertebrates using a kick-style sampler. Substrate upstream of a 250 μm net was disturbed, causing attached or burrowed organisms to drift into the net. This sampling was non-quantitative and was intended to determine species composition and relative abundance of benthic organisms in this ephemeral stream. Material retained by the sieve was transferred to a 500 mL HDPE container and preserved in a 10% buffered formalin solution. Preserved benthos samples were shipped to Applied Technical Services, Victoria BC for taxonomic identification and enumeration.

2.3.3. Fish

Pre-mining ecological surveys of Garrow Lake in 1976 (Fallis et al., 1987), 1977 (BC Research, 1987) and 1980 (BC Research, 1981) confirmed that Garrow Lake contained a glacial relict population of fourhorn sculpin (*Myoxocephalus quadricornis*). Since tailings deposition in Garrow Lake began in 1980, no sculpins have been collected from the lake, although divers have purportedly observed sculpins on an annual basis during maintenance and movement of the tailings line (W. Gzowski, Arctic Divers Ltd., August 2003). We collected sculpins in August 2003 using small-mesh (20 mm – 50 mm) Swedish gill nets and a baited prawn trap at various locations around the lake, as ice conditions permitted. Fallis et al. (1987) used similar size nets (19 – 64 mm stretch mesh) to catch sculpins in 1976.

All sculpins captured were measured for total length (mm), weight (g) and examined externally for any abnormalities. A subsample of sculpins were sacrificed and examined internally for gender, state of sexual maturity, stomach contents, parasites and internal condition and abnormalities. These sculpins were retained and frozen for subsequent whole-body analysis of metals concentration by ALS, Vancouver.

Length-frequency distribution, condition factor (K = length^3/weight x 10^5), sex ratio, maturity and diet from 2003 fish were compared with data collected from the pre-mining (1978 – 1979) period to determine changes in biology and life history characteristics.

3. RESULTS AND DISCUSSION

3.1. Limnology

3.1.1. Physical Attributes and History

Garrow Lake is one of the few meromictic (i.e., permanently stratified) lakes found in the Arctic and has the highest salinity content of all polar lakes (Ouellet et al., 1989). Strong vertical stratification due to large differences in salinity and temperature between the cold (~0°C), slightly brackish (2 – 7 ppt salinity) mixolimnion and the warm (8°C), anoxic, hypersaline, hydrogen sulphide rich monimolimnion maintains complete separation of these two discrete layers.

Garrow Lake was formed by isostatic rebound during the most recent Wisconsin glaciation period that ended 10,000 years ago. A marine depression was progressively uplifted, eventually isolating the marine water-filled depression from the surrounding ocean. Several independent estimates place the age of Garrow Lake (i.e., when it was physically separated from the marine environment) at between 2,500 and 3,500 years ago. ^{14}Carbon dating of marine bivalve shells collected near the shoreline elevation of Garrow Lake indicated a date of 3,350 years before present (BP). Isotopic examination of bottom water from Garrow Lake by Page et al. (1984) revealed that exposure of this water to air last took place at least 2,580 years ago. Using post-glacial rebound rates Thornsteinsson and Kerr (1968), Stewart and Platford (1986) and Fallis et al. (1987) independently estimated the age of Garrow Lake as 3,000, 2,600 and 2,500 – 3,000 years BP, respectively.

How the deep monimolimnion of Garrow Lake became to be nearly three times the salinity of sea water is a matter of some debate and several theories have been advanced to explain how this situation arose. Stuart and Platford (1986) favor the idea that brine currents were formed during the freeze-out of salts from surface waters that sank and, over time, accumulated to form the hypersaline monimolimnion. They contended that the ionic proportion and ratio between surface and deep waters was very similar and did not demonstrate the major differences that would necessarily occur if there was differential mineral precipitation in the monimolimnion or intrusion of hypersaline ground water from freeze-out. Furthermore, if freeze-out of salts beneath lakes was prevalent, this should be observed in many Arctic lakes, but it is not.

Alternatively, Ouellet and Dickman (1983) and Dickman and Ouellet (1987) hypothesized that after separation of Garrow Lake 3,000 years ago, gradually advancing permafrost froze out the freshwater, concentrating salts in deeper water of the lake over time. Ouellet et al. (1989) theorized that pore water trapped between sediment particles

would have been progressively frozen during isostatic rebound as Garrow Lake rose and "advanced" inland. The formation and presence of an unfrozen column of water or talik beneath Garrow Lake would favor the movement or displacement and gradual accumulation of frozen-out salts in the bottom of the lake. Based on their results and citing other similar studies on Antarctic lakes, Ouellet et al. (1989) concluded that cryogenic concentration of salts from surface waters or freeze-out of salts from surface soils over time were only of minor importance and refute the Stewart and Platford (1986) theory of major contribution by surface sources. This matter is still unresolved. A more thorough discussion of this can be found in the above papers and Fallis et al. (1987).

Fallis et al. (1987) and Ouellet et al. (1989) also offered an explanation as to why the monimolimnion is so warm relative to the mixolimnion. Lack of snow cover and clear ice allows light to penetrate through the mixolimnion and be absorbed by a bacterial layer within and just below the pycnocline boundary atop the monimnolimnion. The strong density difference between the surface and bottom layers does not allow mixing and allowed more heat to be absorbed within the deep layer than escapes. Over time, heat has been accumulated within the monimolimnion, eventually reaching an equilibrium temperature.

The chemical and thermal structure of the monimolimnion has been disturbed by the physical disturbance of tailings disposal into the mid-water column. Vertical mixing action within the monimolimnion caused by buoyant tailings water and tailings solids falling through the water column has gradually caused temperature and salinity profiles to become more uniform or homogeneous. This has also resulted in a less saline, slightly cooler and more uniformly mixed monimnolimnion than existed prior to mining (Figure 3; Appendix B).

3.1.2. pH, Temperature, Salinity and Oxygen

3.1.2.1. Pre-Mining Profiles

Pre-mining studies in 1976 and 1981 (Fallis et al., 1987), 1977 and 1980 (BC Research, 1978; 1981), and 1980 and 1981 (Dickman and Ouellet, 1987) recorded very similar vertical pH, temperature, oxygen and salinity profiles and stratification parameters in Garrow Lake. Studies conducted in 1982 (Stewart and Platford, 1986), and 1983 and 1984 (Ouellet and Dickman, 1987; Ouellet et al., 1989), shortly after commencement of mining, also reported similar results to pre-mining. In all studies, mixolimnion depth extended to about 12 m at which point temperature and salinity began to increase rapidly with increasing depth (the pycnocline) to reach a maximum at about 20 m, the top of the monimolimnion (Figure 3). This zone extended to the bottom of Garrow Lake at its deepest depth (46 m).

Water column pH typically ranged between 6.9 and 8.0 and tended to be slightly lower within the monimolimnion than in the mixolimnion (BC Research, 1977; Fallis et al., 1987).

Water temperature in the mixolimnion ranged between just above zero to four or five degrees Celsius, depending on the month (cold in June, warmer in August), and tended to gradually increase with depth towards the pycnocline (BC Research, 1978; Stewart and Platford, 1987; Ouellet et al., 1989). Wind mixing during open water conditions in late fall resulted in more uniform temperature between surface and deeper water of the mixolimnion (BC Research, 1978).

Oxygen concentration was always high, reflecting surface mixing in summer and biological activity by plankton in the mixolimnion. Fallis et al. (1987), Ouellet and Dickman (1987) and Stewart and Platford (1986) observed supersaturation (>100%) of normal oxygen solubility at deeper depths in the mixolimnion especially in spring. Supersaturation is believed to result from freezing-out of oxygen during ice formation and from biological productivity. A dense plate of photosynthetic bacteria exists just above the pycnocline (Fallis et al. 1987). During late winter and spring, these bacteria and phytoplankton produce an excess of oxygen that accumulates and is trapped in the water column beneath the ice cover.

Total suspended solids (TSS) concentration (mg/L) was measured in effluent from Garrow Lake, which represents concentrations found in the upper few meters of the mixolimnion. In all cases, TSS was less than detection limits (i.e., either 1 mg/L or 3 mg/L, depending on the laboratory). Visual observations of the lake from water sampling throughout the water column confirmed that there was no visible turbidity to the water, regardless of depth.

Salinity of the mixolimnion varied between slightly brackish at the surface to about 7 or 8 ppt in all studies showing slight vertical stratification (Table 2; Figure 2). Salinity in the upper water column is lower in summer and fall than in winter because of dilution by ice melt. Anion and cation concentrations and conductivity mirrored salinity and increased proportionately with depth (Ouellet et al., 1989). In January 1983, two years after commencement of tailings disposal, salinity of the mixolimnion was 4.8 ppt and did not differ from pre-mine conditions. Sampling of the water column beneath the ice in June 1984, three years after discharge of tailings, revealed dilute surface water salinity (0.5 ppt at 1 m) with uniform salinity to 12 m (5.7 ppt)(Ouellet et al. 1989).

Within the top of the pycnocline (12 – 14 m) oxygen concentration diminished while temperature and salinity increased with increasing depth. All researchers observed this trend. At the bottom of the pycnocline (18 m – 20 m), oxygen had diminished to zero while temperature had increased to 9°C in the upper monimolimnion. The bacterial plate near the bottom of the pycnocline observed by BC Research (1980) and Ouellet and

Dickman (1983) is likely responsible for increased turbidity at this depth as well as increased hydrogen sulphide concentration, which continued to increase with increasing depth. Salinity increased very strongly between 12 m (9 ppt) and 20 m (66 ppt)(Stewart and Platford, 1986; Fallis et al, 1987). Ouellet et al. (1989) also observed that salinity increased rapidly with increasing depth through the pycnocline from 5.7 ppt at 12 m to 35.2 ppt at 17 m and 76.7 ppt at 21 m. Stewart and Platform (1986) and Fallis et al. (1987) observed similar salinities at the same depths.

Within the monimolimnion extending from 20 m to the lake bottom, oxygen concentration was nil and water temperature decreased very gradually from 9°C to 5°C and did not differ among seasons or years (BC Research, 1977; 1981; Stewart and Platford, 1986; Fallis et al., 1987; Ouellet et al., 1989). Salinity also gradually increased with depth, reaching maximum salinity (between 80 and 90 ppt depending on the study) at the lake bottom (46 m). Because of the isolated, undisturbed nature of the monimolimnion prior to mining, temperature and salinity profiles were virtually identical among studies, regardless of season or year.

3.1.2.2. Post-Mining Profiles

BC Research (1988) analysed surveillance water quality data from Garrow Lake between 1982 and 1987 to evaluate changes in metals concentrations within the different layers during the period of discharge of mine tailings to the monimolimnion. Vertical temperature and conductivity profiles were essentially unchanged except for the fact that the salinity gradient within the monimolimnion was steeper, suggesting that stratification within this layer was disturbed. As expected, continuous discharge of tailings to 30 m depth, 12 m above the bottom, was causing vertical mixing within the monimolimnion beneath the pycnocline, resulting in more uniform salinity and temperature profile and raising metals concentrations. Teck Cominco continued to collect vertical temperature and salinity profiles of Garrow Lake during winter and summer periods to monitor the limnology of the lake in order to ensure that the integrity of the pycnocline was maintained and that mixing of the monimolimnion into surface water was not occurring.

In 2003, Garrow Lake was completely ice-covered until late-July. During mid- to late-August, the lake became mostly ice-free, although ice pans persisted over about 20% of the lake and shifted around according to wind direction. In 2004, the lake remained completely ice-covered and sampling was not possible. Effective mixing of surface waters is only possible during ice-free conditions when sufficient surface area of the lake is exposed to wind to cause turn-over and vertical mixing.

Teck Cominco staff sampled water during February and March 2003 from a single location near the middle of the lake. In August, we collected a single vertical profile from the lake from the deepest accessible location (42.5 m), GL-1-WQ (Figure 2). Winter and

summer vertical profiles of temperature, oxygen and salinity were very similar to pre-mining data (Figure 3) with two notable differences. Salinity of the monimolimnion and depth of the mixolimnion have both diminished, reflecting the physical effects of tailings deposition to the lake bottom.

Mixolimnion salinity ranged from 3.8 ppt (6.7 mS) at the surface to 7.1 ppt (12.5 mS) at the top of the pycnocline (9 m). Melting ice caused lower salinity and conductivity at the surface than at deeper depths, with a slight inverse stratification. In winter 2003, salinity and conductivity within the epilimnion was uniform (Appendix B). Oxygen concentration was stratified and high in winter (13 – 20 mg/L) and supersaturated, a condition also noted during pre-mine conditions, presumably from photosynthetic bacteria. In August oxygen was also high and uniform (11.5 mg/L), but was not supersaturated because absence of ice cover and mixing by wind allowed oxygen to escape to the atmosphere (Figure 3).

Winter and summer water temperatures were cold, ranging from –0.5 °C to 4 °C with very little difference between seasons. Surface water temperature (<2 m) was slightly warmer in summer than in winter. Below 2 m depth, water temperature ranged between 3° and 4°C. Field pH was 8.2 in the mixolimnion and declined through the pycnocline and monimolimnion to 7.35 that was unchanged with depth to the bottom (Appendix B). Limnological conditions within the mixolimnion were very similar in 2003 as pre-mining conditions and do not appear to have changed substantially.

Pycnocline depth below the surface is shallower and has become thinner compared to pre-mining profiles (BC Research, 1981; Fallis et al., 1987; Ouellet et al., 1989). The depth of the surface of the pycnocline, where large, rapid salinity increases occurred in 2003 was at 10 m, reaching near maximum salinity of the monimolimnion by 12 m, a thickness of only 2 m. Formerly, mixolimnion depth extended to 12 m and the bottom of the pycnocline ended at about 20 m. Salinity of the monimolimnion (field based Hydrolab data) was 58 ppt (Appendix B; Figure 3), which is about 32 ppt less than maximum salinity observed in pre-mining studies. Laboratory analysis of mixolimnion water showed a maximum salinity of 64 ppt. Nevertheless, salinity has diminished gradually over time as expected (AXYS, 2001) owing to the large amount of tailings deposited to the lake over more than 20 years, diluting bottom waters. Oxygen concentration was nil and there was a strong hydrogen sulphide odor to the water.

Tailings deposition between 1981 and 2002 has displaced the mixolimnion upwards and is 3 – 4 m shallower than pre-mining, beginning at 9 m, up from the pre-mine depth of about 12.5 m. However, lake elevation in 2003 was also about 2 m higher than pre-mine elevation because of the dam structure that was still in place at the lake outlet (Figure 2). The dam was installed in 1990 to increase water level of the lake to reduce zinc concentration in water discharged to Garrow Bay (see Section 1.3). Removal of the dam in spring 2004 will allow water level in the lake to return to near pre-dam elevations and

will reduce lake level and depth of the mixolimnion by a further 2 m, beginning at a depth of approximately 7 or 8 m.

In 2000, Teck Cominco commissioned AXYS (2001) to determine if diminishing mixolimnion depth would risk turnover and mixing of the mixolimnion and monimolimnion. If this occurred, water chemistry of the entire lake and Garrow Creek would be considerably altered. AXYS (2001) concluded that the density barrier of the pycnocline is strong enough that it cannot be broken down or compromised by wind and wave action after decommissioning of the dam and lake drawdown. Thus, no mixing of the mixolimnion and monimolimnion is possible. Furthermore, AXYS (2001) stated that zinc concentration in the mixolimnion will remain below 300 µg/L and that levels should decline over time, however, no time frame was given.

3.1.3. Metals

Between 1980 and 2002 approximately 15 million tonnes of tailings solids were deposited to the monimolimnion of Garrow Lake (Gartner-Lee, 2001). Tailings were discharged via a pipe suspended in the water column, well below the pycnocline at a depth of about 26 – 31 m. The location of the pipe was moved horizontally and laterally on an annual basis, to distribute tailings more evenly over the bottom. Small, discrete piles of tailings are evident from the bathymetric map of Garrow Lake (Figure 2). These piles are spread out over the deep basin opposite the tailings disposal line. Maximum depth of Garrow Lake has diminished to about 42 m, which is approximately equivalent to the depth that the mixolimnion has been displaced upwards.

Prior to mining, it was believed that discharging tailings to the monimolimnion of Garrow Lake would prevent dissolved metals from diffusing upwards through the pycnocline and into the mixolimnion. The high density of the pycnocline presents a physical barrier, while the abundance of sulphides would bind and scavenge metals from the water column and act as a chemical barrier. The tailings disposal system has been effective at preventing upward migration of metals. However, as discussed below, three spills of tailings into surface waters has been responsible for elevated metal concentrations in the mixolimnion.

In winter 1981 the tailings pipe became clogged and resulted in a small tailings spill on the ice surface near the northwest corner of the lake (Dickman and Ouellet, 1987). This material was deposited into nearshore water and may have contributed to elevated metal concentrations in surface waters. A more substantive spill occurred in the winter of 1984 – 1985. At that time, the down-leg section of the pipe broke at about 0.6 m depth and discharged a considerable amount of thickened tailings under the ice. The break was not detected for about three months until results of water sampling indicated elevated zinc (150 µg/L) at 10 m depth. Repairs were made in February 1985.

The total amount of zinc spilled into the mixolimnion was estimated by BC Research (1988) to be in the order of 800 tonnes, based on a zinc content of 0.5%, assuming a discharge rate of tailings at 1,600 tonnes/day. They further estimated that 42.7 tonnes of zinc was dissolved in the upper 20 m of Garrow Lake. Another spill occurred in the winter of 1989 (Gartner Lee, 2001), however we could not determine how much tailings were spilled or at what location. In 1992, a submerged, double-walled pipe was installed to eliminate the possibility of future spills.

The tailings spill caused a minor increase in lead concentration and a large increase in zinc concentration within the mixolimnion from 10 µg/L (1977) to 230 µg/L (1987) (BC Research, 1988). The extent of surface contamination was not realized because zinc concentration in Garrow Creek continued to be relatively low (61 µg/L) in summer 1986. However, vertical mixing of water during summer and under-ice caused zinc trapped above the pycnocline to become mixed into the mixolimnion, causing zinc to increase from 170 µg/L to 280 µg/L throughout the upper water column. Sampling of the lake beneath the ice in January 1988 revealed a sharp increase in zinc concentration in the upper pycnocline at 11 and 12 m depth (BC Research, 1988) and an increase in the mixolimnion to 310 µg/L. At the time, it was not known if the pycnocline would continue to be a "reservoir" of dissolved zinc or if zinc would be precipitated by sulphides within the pycnocline, and removed from the active mixolimnion by settling. Dissolved lead concentration continued to be low and was likely precipitated by sulphides. BC Research (1988) speculated that upward displacement of the pycnocline would increase average and peak zinc concentrations discharged from Garrow Lake over time, threatening to exceed Teck Cominco's permitted discharge concentration of 100 µg/L. Ice melt usually sufficiently diluted discharge of surface water to Garrow Creek such that limits were not exceeded except perhaps during first or last weeks of discharge from the lake.

In 1990 AXYS (1991) measured dissolved zinc concentrations of 410 µg/L and 1,800 µg/L within the mixolimnion and pycnocline respectively. Concentrations of total and dissolved zinc were very similar, suggesting that precipitation and loss to the monimolimnion was not occurring. These concentrations exceeded the discharge permit concentration. Therefore, Teck Cominco constructed a small dam across the creek in 1990 and 1991 about half way between the lake outlet and the creek mouth at Garrow Bay. The purpose of the dam was to prevent zinc contaminated surface water from reaching Garrow Bay by allowing lake level to increase by about 2.5 m and 10 Mm^3 in volume over a period of three years, diluting the mixolimnion and allowing tailings contaminated particulates in the lake to settle.

Water was not discharged from Garrow Lake until spring of 1994. During the intervening period several studies were undertaken to examine the effects of lead and zinc on receiving environment biota in Garrow Bay (AXYS, 1991; EVS, 1992). Results of these studies suggested that harmful effects of elevated zinc concentration were unlikely.

Consequently, the discharge limit for zinc was increased to 500 µg/L in 1992 (AXYS, 2001). This concentration was not exceeded during the remainder of mine life.

Subsequent to 1994, until removal of the dam, siphons were used to discharge water over the dam that allowed control over timing and volume of release. Gartner Lee (2001) reported that zinc concentration in the mixolimnion of Garrow Lake had gradually diminished from 400 µg/L in 1990 to 280 µg/L in 1999 and 2000. In 2003, mixolimnion dissolved zinc concentration was 240 µg/L, similar to 2000 data (Table 3).

Sampling of the water column at discrete depths in 2003 (GL-WQ-1) revealed that total metals concentrations within the mixolimnion (2 m and 6 m), pycnocline (11 m) upper monimolimnion (15 m) and deep monimolimnion (31 m) did not differ in concentration with the exception of lead and zinc (Table 3). Lead was more than an order of magnitude higher in concentration in the monimolimnion (12.1 µg/L) than the mixolimnion (0.8 µg/L). Zinc was higher in the monimolimnion (338 µg/L) than in the mixolimnion (240 µg/L) and highest within the pycnocline (1,140 µg/L), a pattern that was also observed in 1988 (1,800 µg/L at 16 m; BC Research, 1988) and 1990 (1,820 µg/L at 13 m; AXYS, 1991)(Table 2). Cadmium, lead and copper concentrations were also highest in the pycnocline. These data suggest that the pycnocline is a barrier, preventing transfer of metals from the monimolimnion upwards, but it also may prevent sinking of metals. Bacteria near the bottom of the pycnocline may be partly responsible for maintaining elevated metals in water owing to accumulation of zinc within the bacterial tissue.

Pre-mining, mining and post-mining water column metals data within the mixolimnion, pycnocline and monimolimnion are compared in Table 3. Concentrations of most metals, including arsenic, cadmium and copper, did not appear to change with any discernable pattern over mine life. Arsenic concentrations were low in the mixolimnion and pycnocline and were one to two orders of magnitude higher in the monimolimnion. Cadmium concentration was uniformly low and near detection limits in most water samples. Copper data were variable and did not demonstrate any trend or pattern over time or within discrete layers. Lead concentration in the mixolimnion increased after the metals spill in 1985 and has remained somewhat elevated since then, but has diminished over time.

Only zinc has demonstrated consistent trends in concentration over time and within discrete layers in Garrow Lake. During tailings discharge, prior to the spill, zinc concentration in the mixolimnion was low, less than 24 µg/L (0.024 mg/L) (Fallis et al., 1987; BC Research, 1978). BC Research (1981) measured higher concentrations in 1980, although Dickman and Ouellet (1987) measured low concentrations (16 µg/L) in 1981, the same year that tailings discharge was initiated. Zinc concentration increased in the monimolimnion shortly after tailings disposal was initiated, reflecting the addition of zinc rich material dispersed into the mid-water column. Zinc concentration in the monimolimnion has consistently been measured between 200 and 300 µg/L since tailings

disposal began. Note that this concentration is still below the discharge limit in Garrow Creek of 500 µg/L and is only slightly higher than zinc concentration in the mixolimnion.

As discussed above, the tailings spill into surface waters of Garrow Lake has caused dissolved zinc concentration to become and remain elevated (~250 µg/L) in the mixolimnion and especially the pycnocline layer (1,140 µg/L). This concentration has remained consistent since the mid-1990s. Elevated concentrations of dissolved zinc will likely be maintained for some time due to high concentration in the pycnocline, but also by elevated zinc concentration in the sediment due to the spill in 1985. The widespread zinc contamination throughout nearshore, littoral zone sediment of the lake (see following section) may present an on-going source of dissolved zinc to the mixolimnion.

3.2. Sediment Chemistry

No study has examined sediment chemistry of Garrow Lake since deposition of mine tailings was initiated. This is because tailings were especially deposited into the monimolimnion, which has proven to be an effective barrier at preventing movement of metals upwards through the pycnocline into surface waters (see Section 3.1). Despite the tailing spill to shallow sediment in 1984/85, no survey of sediment chemistry was undertaken.

In 1976, prior to mining, Fallis et al. (1987) collected sediment from 9 stations around Garrow Lake from depths ranging between 3 m and 48 m (Table 4). Six stations were situated within littoral zone sediments in depths of 12 m or less, within the mixolimnion. Three stations were in depths of greater than 12 m within the pycnocline or monimolimnion, in the anoxic, lifeless (except bacteria) zone of the lake. BC Research (1978) collected sediment from only two stations (12 m and 19 m) in 1977 and from 19 stations in May (5) and August (14) in 1980 (BC Research, 1981) at depths ranging from 5 – 48 m.

Concentrations of most metals including lead (<0.25 – 11 mg/kg), zinc (30 – 103 mg/kg), cadmium (0.25 – 3.1 mg/kg), arsenic (4.2 – 11.4 mg/kg), copper (15 – 31 mg/kg) and manganese (59 – 209 mg/kg) did not differ markedly with depth, even between littoral zone (<12 m) and monimolimnion zone sediment. Metal concentrations were only slightly higher in the deepest part of the lake, otherwise there were no meaningful differences among depths or between different areas of the lake in both the BC Research (1978 and 1981) and Fallis et al. (1987) studies. Interestingly, Fallis et al. (1987) found that metal concentration tended to be positively correlated with grain size.

Unfortunately, several spills of tailings (1981, 1985/85, 1989) introduced metals contaminated material to littoral zone sediment. The substantive spill under the ice during the winter of 1984 – 1985 discharged approximately 800 tonnes of zinc in thickened

tailings (BC Research, 1988). No study was conducted to determine the spatial extent and magnitude of contamination until the present study. However, given the designation of Garrow Lake as a tailings disposal facility, this was not necessary.

We sampled surface sediments from between 6 and 8 m within the mixolimnion at four locations around the lake, as well as two locations within the area of the 1984/85 tailings spill along the western shore of the lake (Figure 2). Grain size was predominantly silty-clay at all stations with a very fine, flocculent, oxidized surface layer with some organics, over grey colored sediment of uniform color, consistency and appearance (Table 1). With the exception of lead and zinc, sediment metal concentration throughout the littoral zone was no more than double pre-mining metal concentration (Table 5). Mean lead (137 µg/g dw) and zinc (742 µg/g dw) concentrations in littoral sediments from around the lake however, were considerably higher than pre-mine concentrations (0.25 µg/g and 61 µg/g dw respectively; Fallis et al., 1987) and are a reflection of the spill.

Given that sampling of sediment was conducted at similar depths over most of the lake that was accessible by boat (ice conditions permitting), these data indicate that the spill of metal contaminated tailings resulted in lake-wide contamination of surface sediment. Lead and zinc concentrations were only slightly higher at GL-2, nearest the historic spill area, than at the other three littoral stations. Suspended sediment introduced into the water column during the spill settled throughout most of the lake, causing contamination of surface (at least upper 1 – 2 cm) sediment in the littoral zone.

Two sediment samples collected from the immediate vicinity of the historic spill area had similar or lower concentrations for several metals (aluminum, barium, chromium, mercury, molybdenum, nickel, strontium) than littoral sediment and higher concentrations of lead (1,000 µg/g dw) and zinc (7360 µg/g dw)(Table 5). Most other metals for which pre-mine data were available are not substantially elevated or are lower than pre-mining concentrations.

3.3. Ecology

3.3.1. Zooplankton

No true zooplankton species were captured during the 2003 survey from the vertical tows at each of the four sediment stations (Figure 2), nor from a horizontal tow, conducted <1 m below the water surface. However, a single oligochaete worm and at least one cyclopoid copepod of benthic origin were sampled from each station.

Limnocalanus macrurus is the only species of zooplankton known to be present in Garrow Lake. This species was identified in 1976 by Fallis et al. (1987) and in 1977 and 1980 by BC Research (1978 and 1981 respectively). *L. macrurus* is a relatively common

species in the Arctic and is also present in many large, deep freshwater lakes. *L. macrurus* is known as a glacial relict species (Pennack, 1978). BC Research (1978) also captured or observed amphipods (*Gammarus* sp.) and a mysid species (*Mysis oculata*). Apparently, mysids were relatively abundant and of a large size, based on observations made during SCUBA surveys of Garrow Lake by BC Research (1978). Each of these species was also observed in nearby Frustration Lake in 1977 beach seines (BC Research, 1978).

In 1980, BC Research (1981) determined the density of plankton in vertical hauls from different depths (10 m, 15 m and 19 m, just above the pycnocline) and found that abundance of *L. macrurus* was much greater at the deepest depth, corresponding with the depth where the greatest abundance of phytoplankton was found.

It is not known why zooplankton were apparently absent from the lake during the present survey. Abundance of zooplankters is normally low in oligotrophic Arctic lakes, however, if plankton were present, at least a few individuals should have been captured. Perhaps plankton were situated at a deeper depth than was sampled in 2003 (8 m), or the mesh size used in the current study (250 µm) was too large; Fallis et al. (1987) used a 73 µm net. However, adult zooplankters of this species reach 2 mm in length (Pennack, 1978) so this may not explain their absence.

It is also possible that changes in water quality of the mixolimnion since pre-mine surveys have diminished abundance of the primary food source of *L. macrurus*, phytoplankton, or has directly affected zooplankton abundance. Phytoplankton were not collected during the 2003 survey.

3.3.2. Benthic Invertebrates

Oligochaete worms of the Family Enchytraidae, nematodes and Foraminifera were the only benthic invertebrates retained on a 250 µm sieve from petite ponar sampling in Garrow Lake in 2003 (Table 6). Abundance and density of oligochaetes was reasonably good, however, diversity of species was low. Chironomid larvae were present in the lake because several larvae were collected from the stomachs of fourhorn sculpin (see Section 3.3.3). However, density of chironomids in the lake appears to be quite low because none were collected from sieving of sediment. Given the high northern latitude and brief open water period, abundance of flying insects is naturally very low in this region. In fact, few flying insects were observed, with no mosquitoes or blackflies, which was a blessing.

Nematodes and Foraminifera were not included in the density estimate because these organisms are smaller than the mesh size used (250 µm) although they can be retained in small numbers. Nematodes and Foraminifera are very abundant and widespread in all lakes and their density is very infrequently estimated.

Fallis et al. (1987) also found a depauperate benthic fauna in Garrow Lake, dominated by Foraminifera. They identified 19 species with *Protelphidium orbiculare* being most abundant, followed by *Elphidium translucens*, *Ammotium cassis* and *Trochamina rotaliformis*. A single mollusk species, *Astarte warhami*, and an unidentified harpacticoid copepod were the only other species identified. Fossils of polychaetes, echinoderms and ostracods were identified in sediments, probably species that had been weathered out of historic, marine sediments as the lake has risen since the most recent glaciation.

BC Research (1978) identified nematodes, oligochaetes and harpacticoid copepods from Garrow Lake, although their abundance was not determined.

Garrow Creek sediment contained nematodes, oligochaetes a single mayfly (Ephemeroptera) species *Baetis bicaudatus* and several chironomid species (Table 6). These data indicate that, despite the ephemeral flow of the creek, it is capable of supporting aquatic life, dominated by oligochaetes. Chironomids were present in low abundance and their presence confirms that these organisms are capable of surviving in the creek and therefore, presumably Garrow Lake.

3.3.3. Fish

Nineteen fourhorn sculpins (*M. quadricornis*) were captured in gill nets and a prawn trap from Garrow Lake in 2003 (Table 7). Eleven sculpins were sacrificed to determine gender, sexual maturity, gut contents, age (using otoliths), internal condition and tissue metals concentration (whole fish). All 19 fish were measured for total length and weight to determine condition factor (Table 8) and length-weight relationship (Table 9).

Fallis et al. (1987) and BC Research (1978, 1980) were the first investigators to document sculpin biology (length, weight, growth, age, metals) prior to mining. No biological study of the sculpin population of Garrow Lake had been conducted until the present investigation. So, comparisons made here represent data collected prior to mining and after mining had ceased.

3.3.3.1. Size

All sculpins captured in 2003 appeared to be healthy with no external or internal tumors (Photo's 4 and 5), scars or other abnormalities (Table 7). Sculpins ranged from 85 mm to 184 mm (mean 149 mm) in length and 4.2 g to 40.3 g (mean 24.9 g) in weight. Mean condition factor (K) was 0.70 (Table 8). Fallis et al. (1987) captured 51 sculpins in 1976 using small-mesh, Swedish style gill nets, similar in size to the nets used in the current survey. All fish were acquired from above the pycnocline and none were found below 15 m. BC Research (1978) captured 137 sculpins using beach seines and observed that sculpins were found throughout the lake and appeared to be abundant and easily captured. Sculpins continued to be observed in the lake throughout the period of mining during

SCUBA maintenance of the tailings line (Gartner Lee, 2001; W. Gzowski, Arctic Divers Ltd., Yellowknife NWT personal communication, May 5, 2003), although no biological study was conducted.

Meristic data from 2003 were very similar to mean length (155 mm), weight (26.6 g) and condition factor (0.72) of sculpins captured by Fallis et al. (1987) using the same fishing gear (Table 8) prior to mining. Fish captured by BC Research (1978) in beach seines and nets had a wider size distribution (20 – 170 mm) and had a lower mean weight and condition factor.

Length – frequency distributions of sculpins from 1976 (Fallis et al. 1987), 1977 (BC Research, 1978) and 2003 demonstrate that the basic size distribution of adult sculpins has not changed markedly (Figure 4) since prior to mining. The maximum size of fish captured in 1976 was greater than in 2003, however, this is likely due to the small number of fish captured in 2003. Small, juvenile fish were collected, indicating that successful reproduction of fish had occurred and that recruitment of small fish into the population was occurring. Unfortunately, seining was not conducted, so many of the small fish captured in 1977 by BC Research (1978) were not represented here.

Length-weight relationships derived for each year (Table 9) were also quite similar suggesting that growth of sculpins, based on weight at length, has not changed since mining began. The 1976 data are most relevant to 2003 because similar fishing gear was used. Sculpins captured in 2003 (modal length of 155 mm) may have been slightly smaller than in 1976 (modal length of 175 mm). However, given the similarity in mean size and condition of fish caught in 1976 as in 2003 (Figure 4), suggests that the current size, size distribution and health of sculpins is similar to pre-mining conditions (Fallis et al. 1987).

3.3.3.2. Age

Mean age of sculpins captured in 2003 was 5.7 years, with a range of 3 – 9 years (Table 7). Fallis et al. (1987) and BC Research (1977) did not age sculpins. However, the small size, low lipid content (10%) and small size at age confirm that the sculpin population of Garrow Lake is very slow growing. Fallis et al. (1987) also stated that Garrow Lake sculpin have very slow growth rates relative to other Arctic sculpin populations (Bohn and Fallis, 1978), because of limited food as well as habitat. The deep, circular shape of the lake basin and the anoxic monimolimnion prevents sculpins from existing beneath the pycnocline, thus limiting benthic habitat for sculpins to littoral zone sediments. Given that 2 m of this shoreline habitat is eliminated during winter by ice, available habitat for food production is very limited indeed. The lack of food and cold water temperature explain their small size and slow growth rate relative to fish age.

3.3.3.3. Diet

Stomachs of 7 of 11 sculpins were empty. Of the four stomachs containing food, only a few chironomid larvae were distinguishable, as well as some unidentifiable plant matter and algae (Table 7). The presence of chironomids confirms that they do exist in Garrow Lake, despite the fact that chironomids were not identified from benthic grabs. This suggests that benthic productivity is very limited and even during the "height of summer" there is little food to be had.

Fallis et al. (1987) examined 27 sculpin stomachs of which half (14) were empty. Stomach contents included unidentified eggs, plant material, copepods and a few amphipods. BC Research (1977) found that the copepod *L. macrurus* dominated the diet. We did not identify copepods in the water column or in stomachs, suggesting that this species no longer comprises a significant portion of the sculpin diet. If the zooplankton community has diminished in Garrow Lake, and sculpins have been forced to become strictly dependent on benthic food sources, their population abundance would be expected to have declined. Although catch-per-unit-effort statistics were not recorded, Fallis et al. (1987) captured 51 sculpins in three net sets of 24 h each. The 2003 survey captured only 8 sculpins using gillnets over three days, with a baited prawn trap responsible for the remaining catch. Sculpins seemed to be more difficult to catch in 2003 and therefore may be less abundant than prior to mining (Fallis et al. 1987; BC Research, 1978). Given the lesser amount of habitat available to the population because of the reduced size of the mixolimnion, this result is not surprising.

3.3.3.4. Sex and Maturity

Sex ratio of sculpins captured in 2003 was split evenly between males and females and all fish autopsied appeared sexually mature, with nearly ripe gonads. Fallis et al. (1987) found that most sculpins were female (22 of 27) with 12 having developing eggs. Spawning by sculpins takes place in late fall or winter (Scott and Scott, 1988). Eggs are laid in a small clump within a shallow depression and are guarded by the male during incubation. Given the very slow growth rate and maturation of gonads, it is possible that all of the apparently mature sculpins may not have spawned in winter of 2003/2004 and some individuals may have waited an additional year. Nevertheless, the gonads of most individuals did appear to be quite ripe and these individuals would certainly spawn within the next few months. Fallis et al. (1987) observed eggs in sculpin stomachs in 1976. Presuming these were from sculpins, it is possible that some individuals may spawn during late summer.

3.3.3.5. *Tissue Metals*

Whole body concentrations of manganese, lead and zinc in sculpins were higher in 2003 than was measured in sculpin tissue prior to mining (Fallis et al., 1987; BC Research, 1978) (Appendix C; Table 10). Other metals including arsenic, cadmium, copper, mercury, and nickel were lower or did not differ among years. Elevated lead and zinc concentrations in sediment and the water column as a result of the spill have resulted in increased tissue metals concentrations, however the magnitude of increase is relatively small. Prior to mining, mean zinc concentration was about 30 mg/kg and increased to only 72 mg/kg in 2003. The magnitude increase in lead concentration between pre-mining (0.58 mg/kg) and post mining (0.81 mg/kg) was also similar (Fallis et al., 1987). Fallis et al. (1987) stated that only copper and iron were significantly positively correlated with fish size while all other metals showed no relationship or a declining trend.

Relative to metals in sculpins elsewhere, Bohn and Fallis (1978) found that Garrow Lake sculpins were higher in lead and zinc but lower in cadmium and arsenic than Strathcona Sound sculpins. Elevated lead and zinc concentration prior to mining is presumably due to naturally higher mineralization. The tailings spill has caused a further increase in lead and zinc concentration.

3.3.4. Summary

The sculpin community of Garrow Lake is unique and has survived in this small, brackish water meromictic lake since glacial uplift isolated it from the marine environment nearly 3,000 years ago. The sculpin population has survived twenty years of mining tailings disposal to the monimolimnion and at least one significant tailings spill into the mixolimnion.

Overall, it appears as if the size, distribution, growth rate and reproductive status of the sculpin community has not changed markedly since pre-mining studies by Fallis et al. (1987) and BC Research (1978; 1980) although population size appears to have diminished. Only concentrations of lead and zinc in tissue have increased over the course of mining, likely as a result of the tailings spill in 1984/85. However, based on a survey of the zooplankton and benthic communities and diet of sculpins, it appears that the planktonic invertebrate community of Garrow Lake may have declined since tailings deposition began and that sculpins may be relying solely on benthos as a food source.

Introduction of tailings into the monimolimnion of the lake has caused the bottom layer to become less saline, more homogeneous and has caused a gradual displacement of the pycnocline and mixolimnion upwards in the water column. In 2004, once the lake has been drawn down to its original level, the depth of the mixolimnion above the pycnocline should diminish to about 7.5 or 8 m. Although the magnitude of the thermal and salinity

difference between the mixolimnion and the monimolimnion in the lake will be sufficient to maintain separation of the two layers and prevent turnover and mixing (AXYS, 2001) the largest change in the limnology of the lake is the reduced depth of the mixolimnion and surface area of the littoral zone.

Garrow Lake is very unproductive with low water column nutrient concentrations, a depauperate planktonic community and a benthic community dominated by oligochaetes, with very few insect larvae. A reduction in the planktonic community and diminishment in mixolimnion depth and littoral zone area will necessarily reduce habitat area and benthic invertebrate abundance. This loss of habitat and diminishment of food resources will ultimately, reduce population abundance. Sculpins seemed to be more difficult to capture in 2003 than in fishing efforts by Fallis et al. (1987) and BC Research (1978; 1980), which supports the hypothesis of a smaller population size in 2003 than pre-mining.

Nevertheless, sculpins have survived in Garrow Lake throughout the history of mining and tailings deposition to the lake, which is still designated as a tailings disposal facility (DFO, 2002). Provided that sufficient habitat and food resources exist within the spatially small littoral zone, the sculpin population will be sustained through the future.

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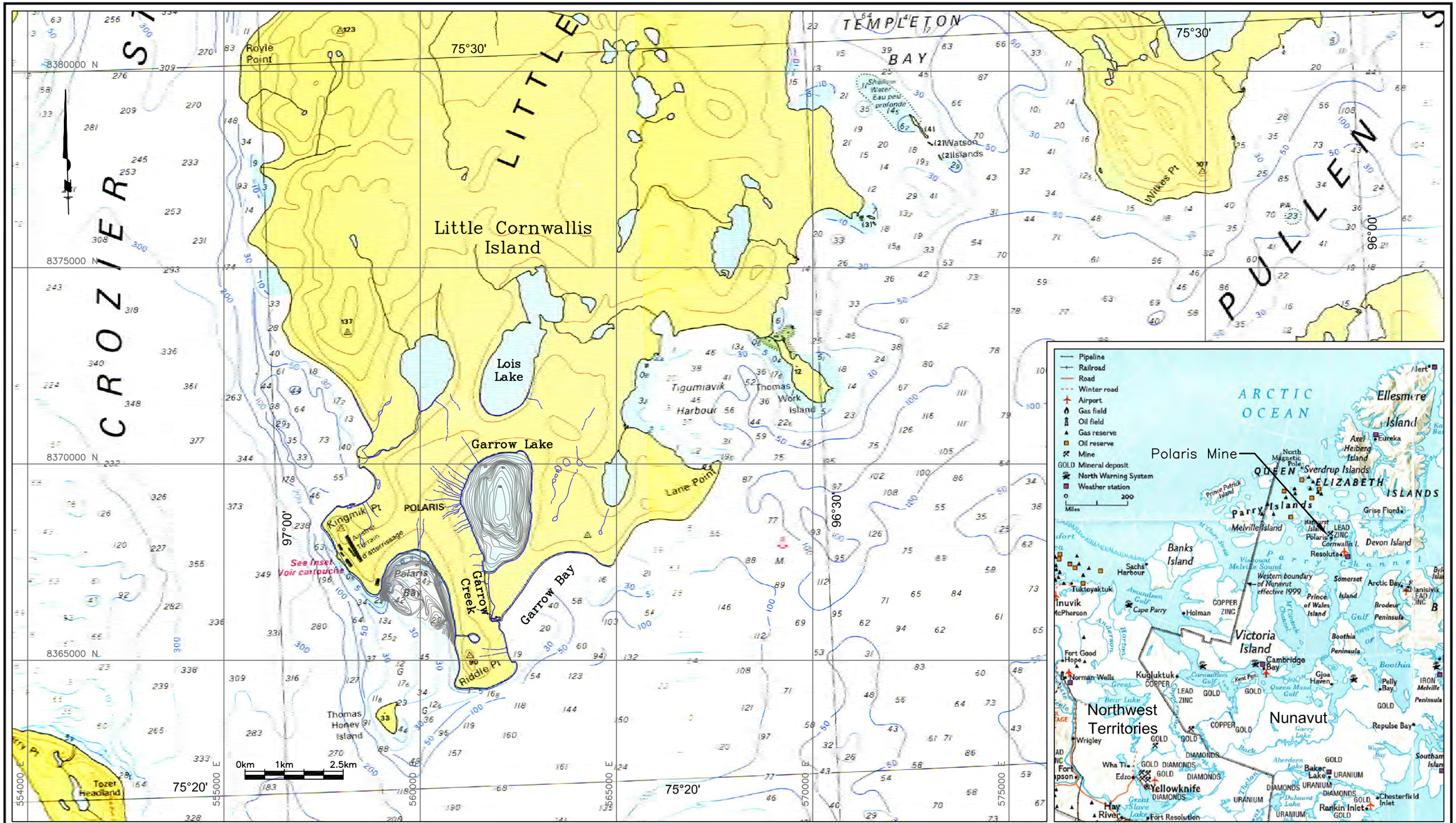
FIGURES



Carrow Lake, Polaris Bay contour data and surrounding creeks digitized from Map 1 Sampling Sites 1980 *prepared by B.C. Research January 1978*

Other data from Crozier Strait And/Et Pullen Strait 7935 *corrected 2003-03-28 published by the Canadian Hydrographic Service*

Insert Location Map from The Modern North: Roads, Radar Stations, and the End of Isolation, *Produced by National Geographic Maps for National Geographic Magazine, Sept. 1997*

AZIMUTH

Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver BC, V6K 2G8

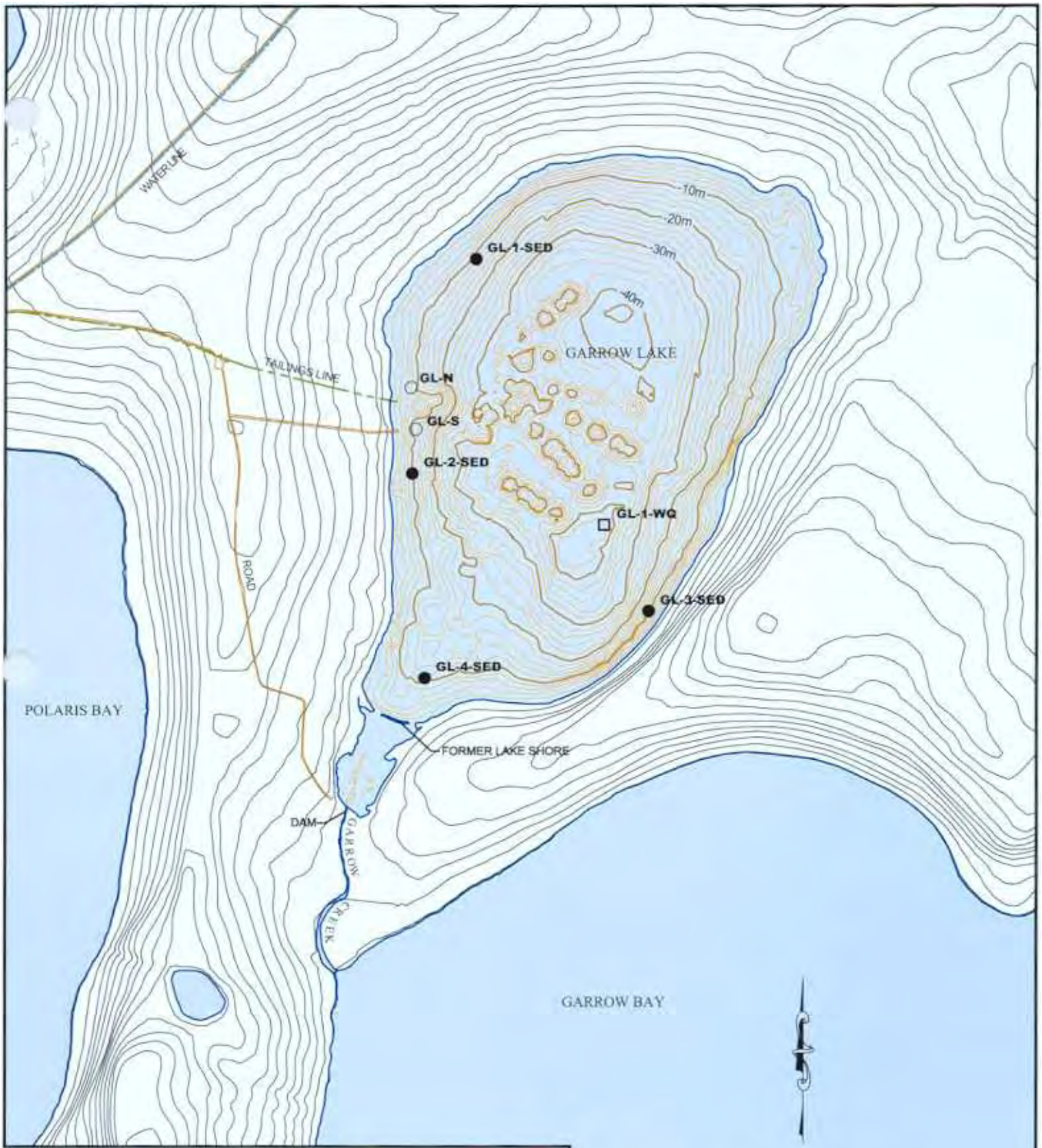
DRAWN BY:	CHK. BY:	PROJECT No:
BT	RB	TC-03-03
SCALE:	DATE: 6/10/2003 2:52 PM	

PROJECT: Polaris

TITLE: **Polaris Mine Study Area**

CLIENT: Teck Cominco

Figure 1-1



LEGEND

- BENTHOS, ZOOPLANKTON, SEDIMENT
- LAKE WATER (VERTICAL PROFILE)
- SEDIMENT

NOTE:

SURROUNDING CREEKS DIGITIZED FROM MAP 1 SAMPLING SITES 1980, PREPARED BY B.C. RESEARCH JANUARY 1978.

AZIMUTH

TECK COMINCO

LOCATION OF LITTORAL ZONE SEDIMENT / BIOTA STATIONS AND WATER QUALITY PROFILE STATION - GARROW LAKE, AUGUST 2003

POLARIS

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Figure 3a. Temperature (C) depth profile in Garrow Lake, 2003.

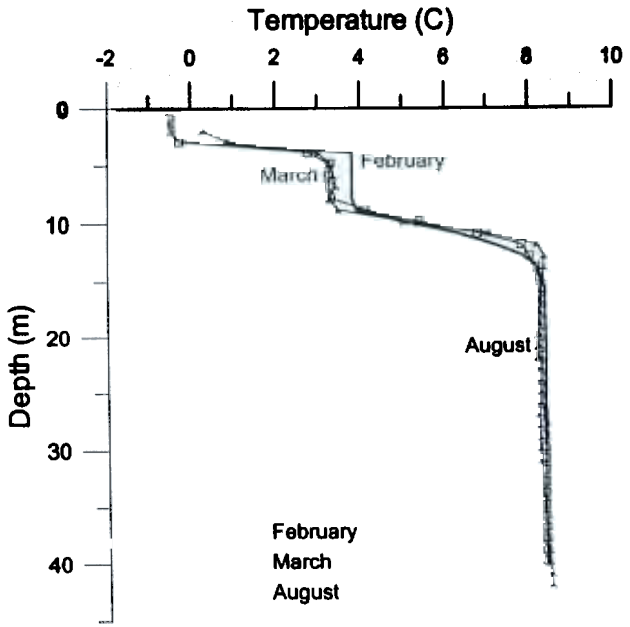


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 2003.

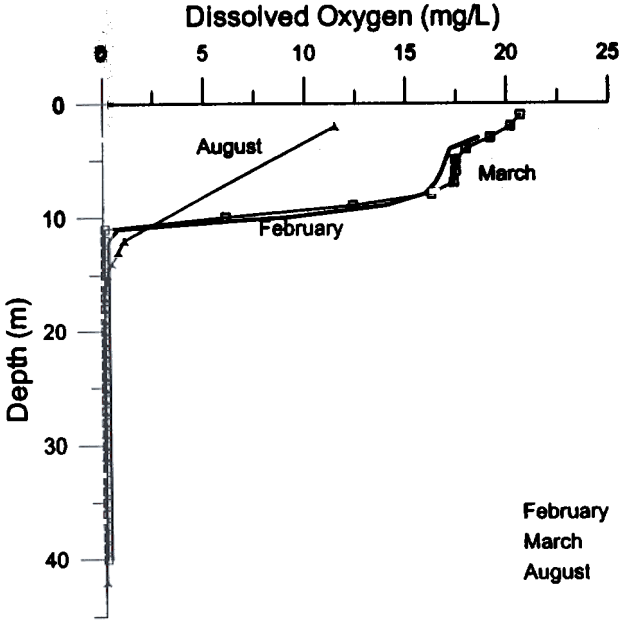


Figure 3a. Temperature (C) depth profile in Garrow Lake, 1976.

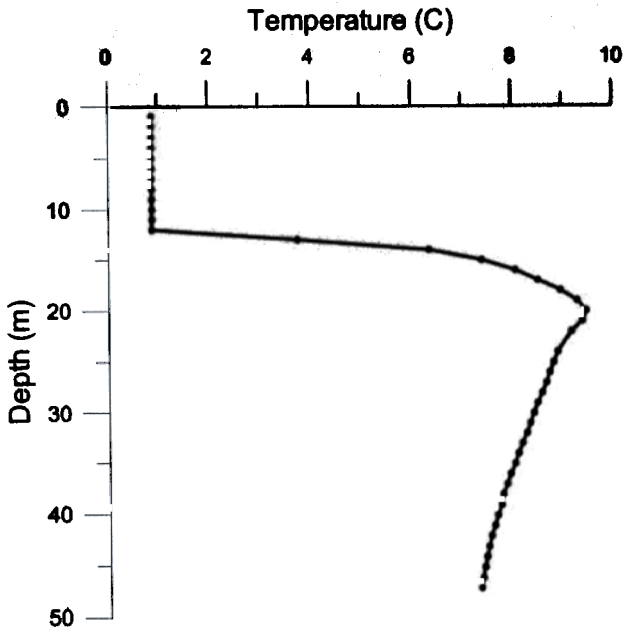
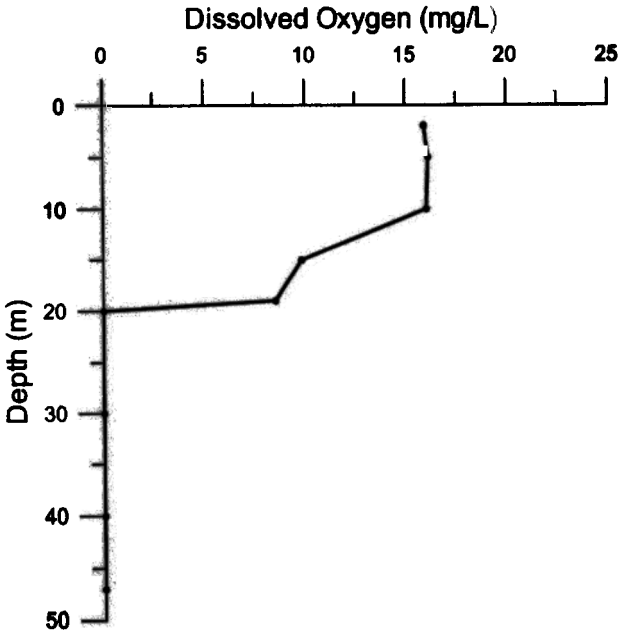
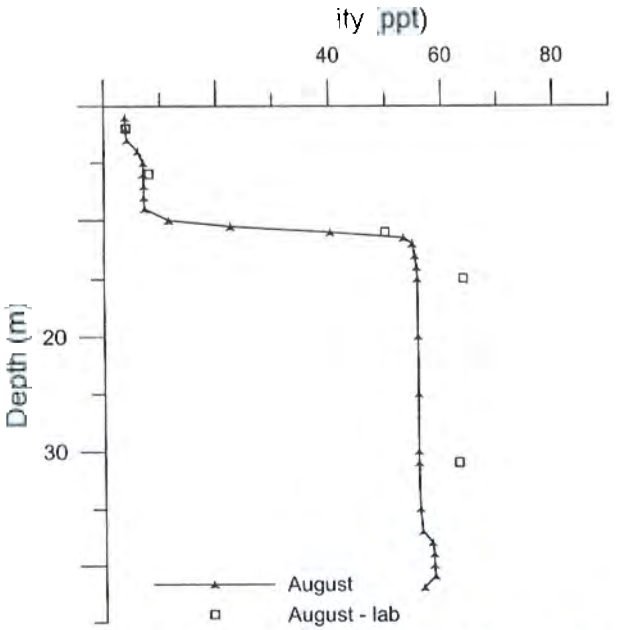


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 1976.



Figur 30 Salinity 20 profi Garr 03



igu 3c. Salinity (ppt) depth profile in Garrow Lake.

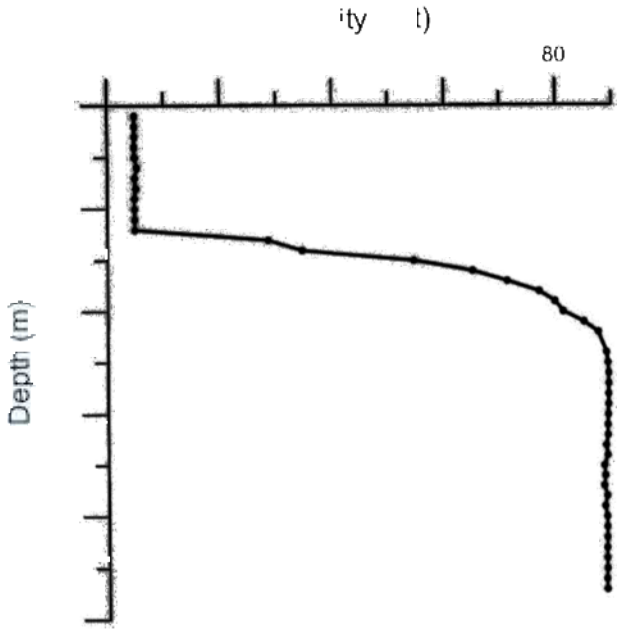
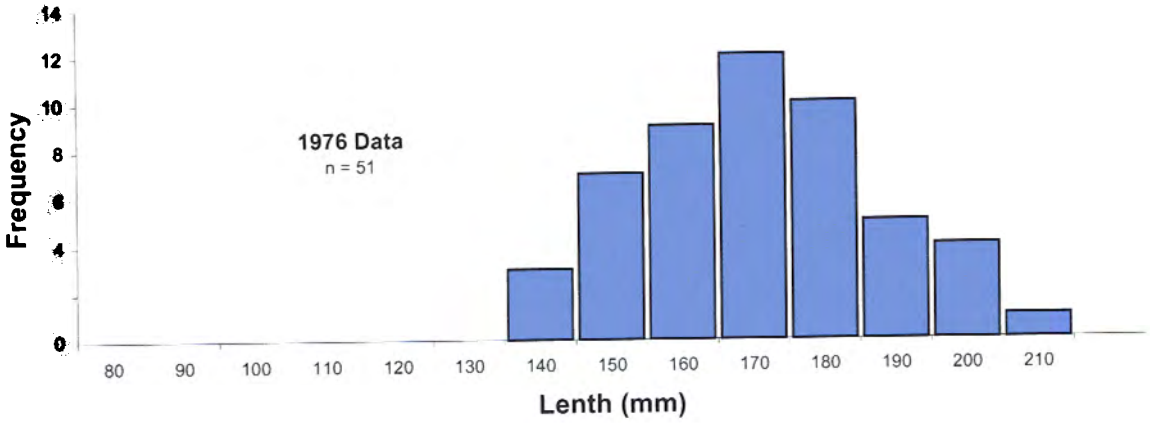
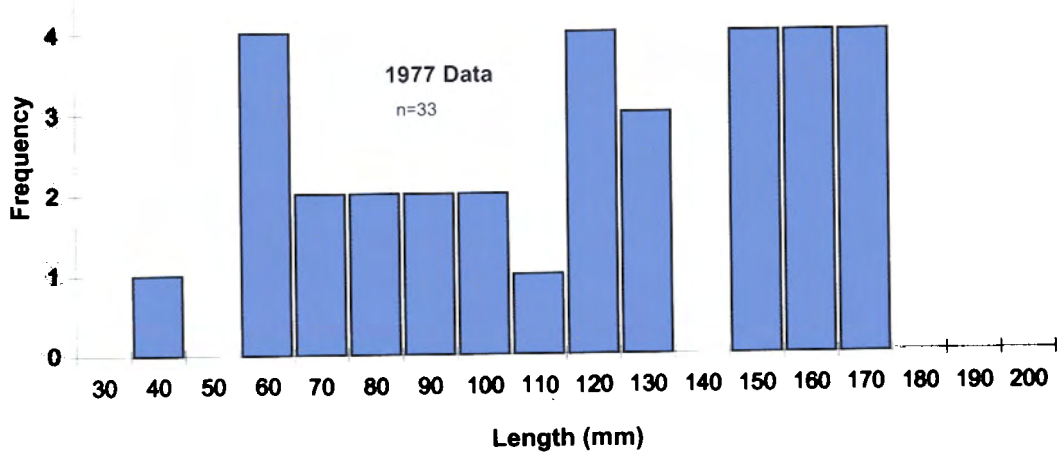
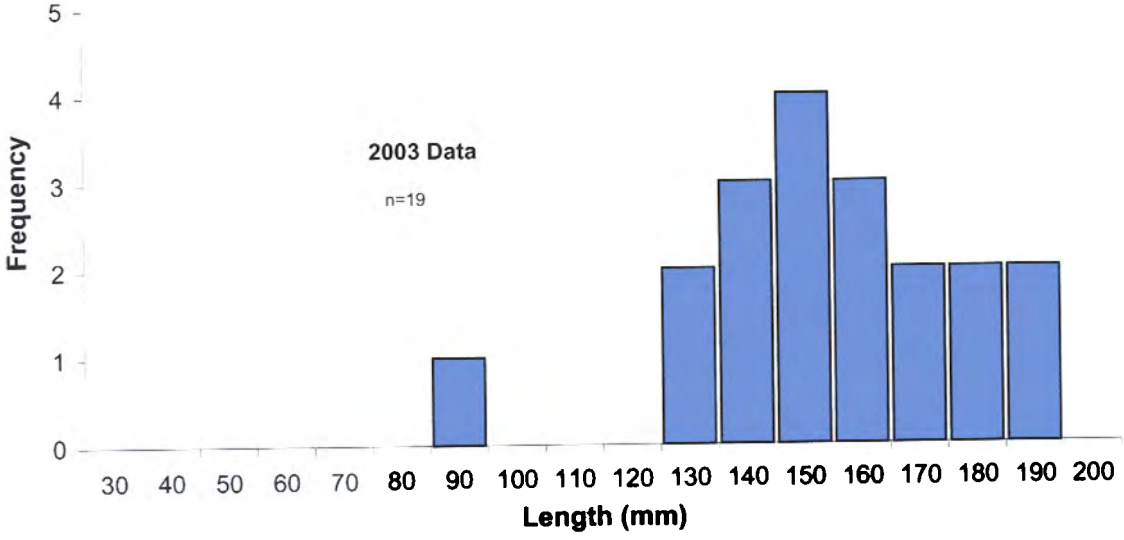


Figure 4. Comparison of length - frequency distribution of fourhorn sculpin from 1976 (Fallis et al., 1987) 1977 (BC Research (1978) and 2003.







TABLES

Table 1. Details of sediment, water and biota collections from Garrow Lake, August 8 – 10, 2003.

Station	UTM N	UTM E	Depth (m)	Parameter: Water	Benthos	Zooplankton	Sediment	Observations
GL-1-SED	8369695	0561130	7.5		X	X	X	Thin light brown soft flocculent surface layer. Some algal growth on surface. Beneath, sediment is uniform grey clay, uniform consistency and appearance.
GL-2-SED	8368612	0561266	6.5 – 8.5		X	X	X	Similar in appearance to SED-1; rusty oxidized, brown surface layer over battleship grey layer of uniform consistency with fine organic matter.
GL-3-SED	8368424	0562669	6 – 8		X	X	X	Fine brown organic 2 – 3 mm layer over grey-brown clay. Grab 3 different from 1 and 2 with darker sediment and more organically rich layer.
GL-4-SED	8367556	0561764	7		X	X	X	Fine orangey-brown layer (2 – 3 mm) over grey-brown silty clay. Benthos not apparent.
GL-N-SED			8				X	Sediment appeared to be consistent with tailings; chalky white, fine grain flocculent sediment throughout grab with black sticky varves.
GL-S-SED			8				X	
GL-1-WQ	8369695	0561130	0 – 42	X				

Table 2. Summary of Garrow Lake water column metals concentration (mean, range; ug/L), 1976 - present.

			Arsenic		Cadmium		Copper		Lead		Nickel		Zinc	
		n	mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
June 1976[AB]	Mixolimnion	19	0.3	0.1 - 1.1	0.3	0.1 - 1.3	1	0.2 - 2.7	0.3	0.1 - 0.5			3	1.3 - 6.7
(Fallis et al., 1987)	Pycnocline	4	1.9	0.3 - 3.5	0.2		2.8	1.5 - 4.1	0.4				2.9	1.9 - 3.8
	Monimolimnion	7	13.4	4.7 - 20.4	0.2	0.1 - 0.2	4	0.9 - 14.5	0.3	0.1 - 0.5			1	0.1 - 2.2
August 1977	Mixolimnion	12	<1		0.2	<0.1 - 0.6	10	1 - 60	5	<1 - 16			24	6 - 100
(BC Research 1978)	Pycnocline	17	<1		0.3	<0.1 - 0.6	12	2 - 22	3	<1 - 7			21	4 - 50
	Monimolimnion	13	4.6	<1 - 6.4	<0.5	<0.5	18	5 - 22	8	<5 - 27			18	8 - 28
May & August 1980	Mixolimnion	14	<1		>0.5		19	6 - 32	<1				49	20 - 95
(BC Research 1981)	Pycnocline	24	<1		>0.5		23	13 - 36	<5				46	28 - 85
	Monimolimnion	16	8	3.4 - 13	>0.5		16	3 - 50	<10				48	15 - 113
August 1981	Mixolimnion	2			>0.5		1.0		<10		7		10	9 - 12
(Ouellet & Dickman 87)	Pycnocline	1			1.0		>1		<10		10		9	
	Monimolimnion	7			<1.2		<2.4		<24		11		16	7 - 34
October 1981	Mixolimnion	2	0.06	0.06 - 0.06	0.06	0.06 - 0.06	0.35	0.3 - 0.4	0.35	0.3 - 0.4			3.3	2 - 4.6
(Fallis et al. 1987)	Pycnocline	3	0.29	0.17 - 0.34	0.3	0.2 - 0.4	5.5	1.5 - 8.9	1.0	0.8 - 1.2			5.7	4.2 - 6.8
	Monimolimnion	27	13.3	1.6 - 20	0.1	<0.05 - 0.2	1.3	<0.1 - 6.4	0.3	<0.1 - 1.8			4.1	1.2 - 6.3
September 1984	Mixolimnion	1							5				20	
(BC Research, 1988)	Pycnocline	1							5				40	
	Monimolimnion	1							14				30	
September 1987	Mixolimnion	1							7				230	
(BC Research, 1988)	Pycnocline	1							5				220	
	Monimolimnion	2							25				45	
May 1990	Mixolimnion	1							10				410	
(BC Research, 1988)	Pycnocline	1							21				1,820	
August 1998	Mixolimnion	4	<1		1.0	<1 - 1	1.0	<1 - 1	2	<1 - 5	<2		198	150 - 320
(Teck Cominco)														
August 1999	Mixolimnion	4	<1		1.0		2.3	<1 - 4	15.3	13 - 22	5	4 - 5	233	220 - 270
(Teck Cominco)														
August 2001	Mixolimnion	4	<1		<2		1.5	<1 - 2	1.8	<1 - 3	4	3 - 5	223	180 - 330
(Teck Cominco)														
August 2003	Mixolimnion	2	<1	<1 - 1	0.5	0.3 - 0.6	1	0.9 - 1.4	0.8		3	2.1 - 3.7	184	127 - 240
	Pycnocline	1	<1		2.5		7		4		9		1,140	
	Monimolimnion	2	1	<1 - 1	0.4	0.3 - 0.5	5	3.8 - 5.2	12	11.8 - 12.1	9	8.8 - 9.0	278	217 - 338

[A] Values below detection limit were treated as absolute values.

[B] Dissolved metals, otherwise, total metals

Table 3. Conventional parameters and total metal concentration (ug/L) in water samples collected from Garrow Lake, August 2003.

Sample ID	GL-1-WQ-2m	GL-1-WQ-6m	GL-1-WQ-11m	GL-1-WQ-15m	GL-1-WQ-31m
CONVENTIONAL PARAMETERS					
pH	8.2	8.0	7.2	7.3	7.4
Salinity o/oo	4.0	8.0	50.0	64.0	63.0
Temperature (C)	0.2	3.4	7.1	8.3	8.3
TOTAL METALS (µg/L)					
Aluminum	<100	<100	<100	<100	<100
Arsenic	<1	<1	<1	1.0	<1
Cadmium	0.3	0.6	2.5	0.3	0.5
Copper	0.9	1.4	7.1	5.2	3.8
Lead	0.8	0.8	4.3	11.8	12.1
Molybdenum	<2	3	2	4	<2
Nickel	2	4	9	9	9
Zinc	127	240	1140	338	217

Table 4. Total metals (mg/kg dw) in Garrow Lake sediment, prior to mining.

	Fallis et al. (1987) June 1976 (n=9)		BC Research (1978) August 1977 (n=2)		BC Research (1981) May and August 1980 (n~19)	
Total Metals	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Arsenic	6	2 - 11	5	4 - 6	4.7	3.2 - 57.6
Cadmium	1.00	<0.25 - 3.1	0.7	0.4 - 1.0	1.3	0.3 - 3.0
Copper	23	15 - 31	18.5	18 - 19	22	12 - 27
Lead	0.25	<0.25 - 0.75	8	8	8.4	5.9 - 11
Manganese	150	59 - 209				
Mercury	0.15	0.005 - 0.025			<0.05	<0.5 - 0.6
Nickel	19	12 - 39				
Zinc	61	30 - 103	65	59 - 70	84	52 - 96
Depth Range (m)		3 - 48		12 and 19		5 - 48

Table 5. Conventional sediment parameters and total metals concentration (mg/kg) in Garrow Lake littoral zone sediment.

Sample ID	Garrow Lake Stations (Aug 2003)					Tailings Spill Area		1976 (Pre-Mine)
	GL-1	GL-2	GL-3	GL-4		GL-N North	GL-S South	Fallis et al. 1987
Depth (m)	7.5	6.5 - 8.5	6 - 8	2 - 7	Mean	7 - 8	7 - 8	3 - 48
CONVENTIONAL PARAMETERS								
Organic Parameters								
Total Organic Carbon (% dw)	<0.8	1.2	<0.9	2.4	1.3			
Particle Size (%)								
Gravel (>2.00mm)	<0.1	<0.1	0.9	<0.1	0.3			
Sand (2.00mm - 0.063mm)	5.4	7.5	12.3	6.8	8.0			
Silt (0.063mm - 4um)	64.2	68.3	70.3	76.1	69.7			
Clay (<4um)	30.4	24.2	16.5	17.1	22.1			
Total Metals								
Aluminum	8560	7380	6030	6680	7162	781	547	
Antimony	<10	<10	<10	<10	<10	<20	<20	
Arsenic	11	9	<5	9	8.5	<10	<10	6
Barium	1420	1070	1040	1150	1170	122	124	
Beryllium	0.6	<0.5	<0.5	<0.5	0.5	<1	<1	
Cadmium	1.9	3	1.1	1.4	1.9	17	15	1.0
Chromium	19	18	15	16	17	22	9	
Cobalt	6	6	4	5	5.3	<4	<4	
Copper	31	32	17	24	26	68	24	23
Lead	114	308	47	78	137	1000	680	0.25
Manganese	183	222	175	172	188	487	493	150
Mercury	0.1	0.09	0.05	0.17	0.1	0.08	0.06	0.15
Molybdenum	4	<4	<4	<4	4	<8	<8	
Nickel	36	30	19	26	28	<10	<10	19
Strontium	268	209	217	289	246	64	52	
Zinc	700	1210	498	560	742	7360	5980	61

Table 6. Abundance and density of benthic invertebrates in Garrow Lake and Garrow Creek, Little Cornwallis Island, August, 2003.

Location		Creek-mid	Creek-up	GL-1	GL-2	GL-3	GL-4
Date		4-Aug-03	4-Aug-03	7-Aug-03	7-Aug-03	8-Aug-03	8-Aug-03
Species/Group	Stage**						
FORAMINIFERA							
Unidentified							350
NEMATODA							
Unidentified		5		1		20	
OLIGOCHAETA							
Unidentified	juv*	5		17	65	200	100
Enchytraidae		471	10	418	390	1470	550
COPEPODA							
Cyclopoida	juv*						
EPHEMEROPTERA							
Baetidae							
Baetis bicaudatus	N	2					
DIPTERA							
Chironomidae	P	1					
Tanypodinae							
Procladius	L	1					
Orthocladiinae							
Eukiefferiella	L	1					
Orthocladius	L						
Diamesinae							
Diamesa	L	4	1				
Total		491	11	436	455	1690	1001
Oligochaete Abundance				435	455	1670	650
Oligochaete Density (#/m^2)				18125	18958	69583	27083

**Key:

L = Larva

N = Nymph

P - Pupa

juv = Juvenile

* = Too small to be idetified further, damaged

Table 7. Biological data for fourhorn sculpin from Garrow Lake, August 2003.

Code	Total Length (mm)	Body Weight (g)	Lipid (%)	Age (yrs)	K[1]	Gender	Maturity	Stomach Content	Condition	
									Liver	External
SC-1-03	149	24.8	14.3	6	0.75	F	Ripe	1 chironomid and plant material	large, healthy	good
SC-2-03	129	16.0	8.8	5	0.75	F	Ripe	3 chironomids, small stomach	healthy, pink	good
SC-3-03	138	20.5	12.8	6	0.78	M	Ripe	Empty	large, healthy	good
SC-4-03	163	34.5	15.7	4	0.80	F	Ripe	Empty	healthy	healthy
SC-5-03	184	37.9	7.2	9	0.61	M	Ripe	Unidentified material in stomach	healthy	healthy
SC-6-03	160	25.7	8.9	6	0.63	M	Ripe	Empty	healthy	healthy
SC-7-03	121	12.2	10.6	4	0.69	M	Ripe	Empty	healthy	healthy
SC-8-03	182	40.3	7.8	6	0.67	F	Ripe,well-developed, large	Empty	healthy	healthy
SC-9-03	146	21.4	10.6	7	0.69	M	Ripe	Empty	healthy	healthy
SC-10-03	142	20.0	8.7	7	0.70	F	Ripe	Empty, algae lower in intestine	healthy	healthy
SC-11-03	85	4.2	9.9	3	0.68	F	Ripe, large GSI, may spawn.	Empty	healthy	healthy
SC-12-03	176	34.8	-	-	0.64	-	-	-	-	-
SC-13-03	157	31.3	-	-	0.81	-	-	-	-	-
SC-14-03	159	31.2	-	-	0.78	-	-	-	-	-
SC-15-03	141	21.2	-	-	0.76	-	-	-	-	-
SC-16-03	139	17.7	-	-	0.66	-	-	-	-	-
SC-17-03	174	41.2	-	-	0.78	-	-	-	-	-
SC-18-03	132	14.9	-	-	0.65	-	-	-	-	-
SC-19-03	161	24.0	-	-	0.58	-	-	-	-	-
Mean	149	24.9	10.5	5.7	0.70	-	-	-	-	-
SD	23.8	10.1	2.7	1.7	0.07	-	-	-	-	-

[1]K = Condition Factor = (body weight x 10^5) / total length^3

Note: SC-1-03 to SC-11-03 used for tissue chemistry analyses, the other 8 were measured live and released.

Table 8. Mean (range) total length (mm), weight (g) and condition (K) of Garrow Lake sculpin from pre-mine (1976, Fallis et al. 1987; 1977, BC Research 1978) and 2003.

Year	n	Total Length (mm)			Body Weight (g)			Condition Factor (K)		
		Mean	Range	SD	Mean	Range	SD	Mean	Range	SD
1976	51	155	120 - 194	2	26.6	10 - 45		- (0.72^)	-	-
1977	33	112	38 - 168	40	10.8	0.9 - 26.6	8.2	0.56# (0.77^)	(0.43 - 0.70)#	0.07#
2003	19	149	85 - 184	24	24.9	4.2 - 41.2	10.1	0.70 (0.75^)	(0.58 - 0.81)	0.07

[1]K = Condition Factor = (body weight x 10^5) / total length^3

^ calculated from mean length and weight

using fish with minimum length of 90mm

Table 9. Length - weight relationship for Garrow Lake sculpin, 1976, 1977 and 2003.

Year	n	Regression	R^2
1976[A]	51	$Log_{10}(weight) = 2.82 * Log_{10}(length) - 4.78$	0.99[A]
1977	33	$Log_{10}(weight) = 2.40 * Log_{10}(length) - 3.98$	0.97
2003	19	$Log_{10}(weight) = 2.96 * Log_{10}(length) - 5.06$	0.97

[A] Regression equation for 1976 data derived using curvilinear plot.
1976 (Fallis et al. 1987); 1977 (BC Research, 1978)

Table 10. Mean (range) of fourhorn sculpin whole body metal concentration (mg/kg ww) from Garrow Lake during pre-mine (1976, Fallis et al. 1987; 1977, BC Research 1978; 1980, BC Research 1981) and 2003 (post-mine).

	Pre - Mine						Post-Mine	
	1976 (n=10)		1977 (n=34)		1980 (n = 35)		2003 (n=11)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Body Length (mm)			112	38 - 168	132	78 - 164	145	85 - 184
Body Weight (g)			11	1 - 27	10	2 - 19.2	23	4 - 40
Total Metals (mg/kg ww)								
Aluminum							16	3 - 40
Antimony							<0.01	
Arsenic	0.74	0.47 - 1.18	1.15	0.53 - 2.58	0.55	0.22 - 1.1	0.88	0.53 - 1.48
Barium							3.33	1.59 - 5.36
Beryllium							<0.1	
Cadmium	0.07	0.04 - 0.12	0.11	0.01 - 0.24	0.1	0.02 - 0.33	0.057	0.026 - 0.103
Chromium							<0.1	
Cobalt							0.12	0.07 - 0.19
Copper	1.17	0.53 - 1.67	2.16	1.09 - 12.69	2.4	1.0 - 10.7	0.95	0.46 - 1.55
Lead	0.58	0.25 - 0.96	0.38	0.09 - 0.84	0.24	0.10 - 0.67	0.81	0.43 - 1.71
Manganese	0.77	0.56 - 1.03					3.15	1.24 - 6.46
Mercury	0.01	<0.01 - 0.02					0.006	<0.005 - 0.012
Molybdenum							<0.01	<0.01 - 0.01
Nickel	0.35	0.06 - 1.06					0.1	<0.1 - 0.2
Strontium							32	21 - 46.1
Zinc	28.9	15.6 - 41.8	34.4	16.0 - 66.7	34.5	16.3 - 55	72.3	50.4 - 120

PHOTOS

Photo 1 Garrow Lake showing ice cover August 4, 2003.

Photo 2 Launching the boat in Garrow Lake, August 8, 2003.

Photo 3 Garrow Lake showing gravel shoreline and mostly ice-free, August 8, 2003.

Photo 4 Garrow Lake Fourhorn sculpin *Myoxocephalus quadricornis*.

Photo 5 Garrow Lake fourhorn sculpin (140 mm total length) prior to dissection.

APPENDICES

Appendix A Department of Fisheries and Oceans Habitat Authorization

Fisheries and Oceans | Pêches et Océans

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

Authorization Issued To/Autorisation délivrée à

Name: Bruce Donald

Address: Teck Cominco Ltd.
Polaris Operations
Box 188
Resolute Bay, Nunavut
Canada X0A 0E0

Telephone: (867) 253-2201

Facsimile: (867) 253- 6862

Location of Project/Emplacement du projet

Polaris Mine is located on Little Cornwallis Island (centred at 391500 E, 8 369 000 degrees N UTM zone 15) in the Qikiqtalluk Region of Nunavut (approximately 100 km northwest of Resolute Bay). The project site encompasses fish habitat at Garrow Lake, Garrow Creek, and Crozier Strait.

Valid Authorization Period/Période de validité

From/De: June 2, 2003 **To/À:** October 30th , 2004

Description of HADD Works or Undertakings/Description des ouvrages ou entreprises

In order to decommission Teck Cominco's (TCL) Polaris Mine, draining of water from the surface layer of Garrow Lake (the mine's tailings facility) and partial removal of Garrow Lake Dam will be required. This will result in the harmful alteration, disruption and/or destruction of fish habitat (HADD) due to lowering of the level of the lake and excavation of benthic fish habitat adjacent to the dam. Partial removal of a sheet-pile dock on Crozier Strait, and excavation to contour the adjacent marine foreshore area will also temporarily alter fish habitat during construction. The above works will hereafter be referred to as the "Project Activities".

Summary of Habitat Loss

- Lowering the lake level of Garrow Lake and removal of the Garrow Lake Dam will dewater approximately 30 ha. of fish habitat. Garrow Lake has been documented to be habitat for fourhorn

sculpin *(Myoxocephalus quadricornus)* and has the potential to provide habitat for other fish species. Garrow Lake drains into Garrow Bay via Garrow Creek and provides supporting habitat for other fish species in Crozier Strait.

- Partial removal of the dock and excavation of the marine foreshore area at Polaris will alter 2512 m^2 of fish habitat. The marine foreshore area at Polaris is habitat for arctic charr, arctic cod, and marine mammals (e.g., narwhal, ringed seals, walrus).

Conditions of Authorization/Conditions de l'autorisation

1.0 All works and undertakings shall be undertaken in accordance with the documents approved by DFO entitled:

1.1 Application for Authorization for Works or Undertakings Affecting Fish Habitat submitted to DFO, dated October 5th, 2001 and signed by Bruce Donald, TCL.

1.2 The approved documents include the works or undertakings, proposed mitigative measures and compensation requirements (the *Project Plan*).

2.0 To compensate for the harmful alteration, disruption or destruction of fish habitat as a result of the Project Activities, the following shall be implemented, maintained and monitored by TCL, as indicated in the *Project Plan* or otherwise specified by DFO:

2.1 To rehabilitate and enhance fish habitat in Garrow Lake, upon completion of water withdrawal and dam removal, TCL shall conduct the following as indicated in the *Project Plan*:

Restore a natural stream channel to Garrow Bay by removing at least 19,000 cubic metres of dam fill material. The constructed 500 m long by 15 metre wide stream channel through the decommissioned dam will emulate natural stream conditions with a gravel/cobble streambed. Enhancement efforts will result in the banks of the remaining dam having a slope of at least 4:1.
The enhanced stream channel draining Garrow Lake will be on average 11 m wide and restore natural drainage patterns in the Garrow Lake area. Clean rock rip-rap will be placed to prevent erosion in the vicinity of the decommissioned dam;

2.1.3 A Fish Habitat Monitoring Report shall be submitted to DFO, including detailed photographs of Garrow Lake, stream channel development, prior to completion of the work. The intent of this Monitoring Report shall be to assess the success of fish habitat compensation upon implementation.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

2.2 To rehabilitate and enhance fish habitat in the area of the dock and marine foreshore area, TCL shall conduct the following as indicated in the *Project Plan*:

2.2.1 Partial removal of the dock pilings to a depth of 3m below the low tide water level will develop natural inter-tidal conditions with slope and substrate adequate to control erosion into Crozier Strait.

2.2.2 Excavation of the inter-tidal shoreline adjacent to the dock to develop 12,800 m^2 of marine nearshore habitat with a slope of less than 17.5:1 to prevent erosion.

2.2.3 A Fish Habitat Monitoring Report shall be submitted to DFO, including detailed photographs of the marine foreshore area adjacent to the dock. Underwater photographs or video footage of the dock will be provided to DFO. The intent of this Monitoring Report shall be to assess the success of fish habitat compensation upon implementation.

3.1 The following mitigation measures are intended to minimize or prevent further harmful alteration, disruption or destruction of fish habitat adjacent to Garrow Lake and Garrow Creek:

3.1.1 Excavation of the dam will be conducted prior to spring break-up in 2004 and all silt and loose fines shall be removed from the construction area prior to spring break-up.

3.1.2 Rock rip-rap will be placed on the banks of the stream channel adjacent to the dam to prevent erosion and sedimentation.

3.1.3 Appropriate mitigation measures will be implemented to control TSS, including the construction of a dam at the discharge of Garrow Lake, if water quality deteriorates due to release of sediment. Other contingencies may be required as mitigation measures to protect fish habitat such as silt fences.

3.2 Appropriate mitigation measures will be implemented in the marine foreshore area, at and adjacent to the dock, as follows:

3.2.1 To minimize erosion in the marine foreshore area mitigation measures will be implemented to prevent deposition of sediment into the marine waters by use of silt fences and a floating silt curtain along the perimeter of the marine foreshore area if this is deemed necessary.
Water quality sampling for turbidity will be conducted daily during work and mitigation measures will be implemented to address potential sediment release.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

4.0 Monitoring will be conducted to ensure that compensation measures are successfully implemented and identify potential long-term project effects:

4.1 Sampling of TSS and turbidity will be undertaken by TCL in different strata of Garrow Lake to monitor stability of the halocline and to confirm the absence of contaminants in the upper strata of the lake.

4.2 A study of the metal concentrations in sediments adjacent to the shore of Garrow Lake, Garrow Creek, and the centre of Garrow Bay will be commissioned by TCL. TCL will provide a study design prior to July 2003 for approval by DFO.

4.3 TCL will conduct a study on fish in Garrow Lake and Garrow Bay to examine metal levels in fish muscle tissue. A study design will be proposed by TCL to collect fish tissue samples for analysis by DFO. TCL will propose a sampling protocol for this study prior to July 2003.

4.4 Erosion will be monitored on the shore of Garrow Lake and Garrow Creek Stream channel. The study objective will be to quantify erosion rates adjacent to the lake and stream channel. This study will be proposed by TCL for DFO approval prior to July 2003.

4.5 TCL will conduct water quality sampling for TSS and turbidity at the Garrow Lake outflow in Garrow Creek. TCL will provide a Water Quality Sampling Report of TSS levels to the DFO Eastern Arctic Office on an annual basis for the duration of this authorization. Water quality sampling for TSS will not cease at the Garrow Lake outflow prior to 2004.

4.6 TCL will conduct water quality sampling for TSS and turbidity along the marine foreshore area prior to, during, and immediately following work in the inter-tidal zone. At least seven water quality samples will be routinely collected on a daily basis in the marine foreshore area during work in the inter-tidal zone. Two water quality samples per day will be collected adjacent to the dock.

5.0 A DFO Fishery Officer shall be notified at the Iqaluit Office ((867) 979-8000) of the proposed start time prior to commencement of the work.

6.0 Any deviation from the *Project Plan*, the construction schedule or the mitigation and compensation measures stated above that may potentially affect fish or fish habitat, must be discussed and approved in writing by DFO prior to implementation.

7.0 A copy of this Authorization shall be at the Polaris work site during all work periods. Work crews shall be made familiar with the conditions of this Authorization prior to implementation of the works or undertakings.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

The holder of this Authorization is hereby authorized under the authority of subsection 35(2) of the *Fisheries Act*, R.S.C., 1985, c. F. 14, to carry out the work or undertaking described herein. This Authorization is valid only with respect to fish habitat and for no other purposes. It does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

Failure to comply with any condition of this Authorization may result in charges being laid under the *Fisheries Act*.

This Authorization form should be held on site and work crews should be made familiar with the terms and conditions of this authorization.

Le détenteur de la présente est autorisé en vertu du paragraphe 35(2) de la *Loi sur les pêches*, L.R.C. 1985, ch. F. 14, à exploiter les ouvrages ou entreprises décrits aux présentes.
L'autorisation n'est valide qu'en ce qui concerne l'habitat du poisson et pour aucune autre fin. Elle ne dispense pas le requérant de l'obligation d'obtenir la permission d'autres organismes réglementaires concernés ou de se conformer à leurs exigences.

En vertu de la *Loi sur les pêches*, des accusations pourront être portées contre ceux qui ne respectent pas les conditions prévues dans la présente autorisation.

Cette autorisation doit être conservée sur les lieux des travaux, et les équipes de travail devraient en connaître les conditions.

Date of Issuance: Following NIRB Environmental Assessment

Signed by:

Burt Hunt
Area Director
Eastern Arctic Area
Fisheries and Oceans Canada
Central and Arctic Region

Prepared by:

Jordan DeGroot
Area Habitat Biologist
Fish Habitat Management
Eastern Arctic Area
Fisheries and Oceans Canada

Bruce Donald- Reclamation Manager, Environment and Corporate Affairs

Canada

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

Witness:

Teck Cominco Ltd.

Signature: Brian McKenzie

Teck Cominco Ltd.

Signature: B McDonald

Copy signed by TCL received by DFO

Signature: Stephanie Critch

Date: July 23, 2003

Canada

Appendix B Garrow Lake Water Chemistry Data

Appendix B. Vertical profile of water chemistry parameters pre-mining (Fallis et al. 1987) and in 2003, after mining.

	Pre-Mine Profile			Post-Mine Profile							
	June 1976 (Fallis et al. 1987)			Winter 2003 (Teck Cominco)			August 2003				
Depth (m)	Temperature (oC)	Salinity ppt	D.O. mg/L	Temperature (oC)	Conductivity (mS)	D.O. mg/L	Temperature (oC)	Conductivity (mS)	pH	Salinity ppt	D.O. mg/L
1	0.85	4.9		-0.5	14.5	20.7	0	6.74	8.18	3.8	11.5
2	0.85	4.9	15.9	-0.5	14.8	20.2	0.24	6.93	8.18	3.9	11.5
3	0.85	4.9		-0.3	13.8	18.9	0.86	7.38	8.14	4.1	11.5
4	0.85	4.8	16.1	3.3	14.6	17.6	3	11.45	7.98	6	11.5
5	0.85	4.9		3.5	14.5	17.2	3.28	12.18	8	7	11.5
6	0.85	5.3		3.5	14.5	17.1	3.35	12.28	8	7	11.5
7	0.85	4.9		3.5	14.6	16.9	3.42	12.37	8.07	7.1	11.5
8	0.85	5.1		3.6	14.6	16.1	3.25	12.43	8.08	7.1	11.5
9	0.85	4.8		4.0	15.3	13.2	3.45	12.51	8.07	7.2	11.5
10	0.85	4.8	16	5.2	27.1	7.7	5.01	18	7.83	11.5	11.5
10.5							6.0		7.26	22.5	6.7
11	0.85	4.9		6.6	77.4	0.4	7.05	65.6	7.16	40.2	4.3
12	0.85	4.9		7.5	94.0	0.2	8.2	78.9	7.2	54.9	1.1
13	3.76	28.6		8.0	94.2	0.2	8.37	79.8	7.24	55.3	0.8
14	6.34	34.6		8.2	94.4	0.2	8.37	80.1	7.26	55.6	0.45
15	7.4	54.6	9.8	8.3	94.4	0.2	8.33	80.3	7.27	55.7	0.23
16	8.06	65.2		8.4	94.5	0.2	8.28	80.4	7.3	55.7	0.0
17	8.51	71.3		8.4	94.5	0.2	8.27	80.4	7.3	55.7	0.0
18	8.96	77.0		8.4	94.5	0.2	8.25	80.5	7.31	55.7	0.0
19	9.29	79.8	8.5	8.4	94.5	0.2	8.25	80.5	7.31	55.7	0.0
20	9.47	81.3	0.0	8.4	94.5	0.2	8.24	80.5	7.32	55.8	0.0
21	9.39	85.0		8.4	94.5	0.2	8.24	80.4	7.33	55.8	0.0
22	9.18	87.5		8.4	94.5	0.2	8.24	80.5	7.33	55.8	0.0
23	9.0	88.8		8.4	94.5	0.2	8.24	80.5	7.33	55.8	0.0
24	8.9	89.0		8.4	94.5	0.2	8.24	80.5	7.34	55.8	0.0
25	8.82	89.2		8.4	94.6	0.2	8.24	80.5	7.34	55.8	0.0
26	8.74	89.4		8.4	94.6	0.2	8.24	80.5	7.34	55.8	0.0
27	8.68	89.3		8.4	94.6	0.2	8.22	80.5	7.35	55.8	0.0
28	8.59	89.3		8.4	94.6	0.2	8.23	80.5	7.35	55.8	0.0
29	8.5	89.3		8.4	94.5	0.2	8.24	80.5	7.35	55.8	0.0
30	8.42	89.2	0.0	8.4	94.7	0.2	8.25	80.5	7.35	55.8	0.0
31	8.35	89.1		8.4	94.6	0.2	8.25	80.5	7.35	55.8	0.0
32	8.28	89.1		8.4	94.6	0.2	8.25	80.5	7.35	55.8	0.0
33	8.19	88.8		8.4	94.7	0.2	8.25	80.5	7.35	55.8	0.0
34	8.11	89.1		8.4	94.7	0.2	8.25	80.5	7.35	55.8	0.0
35	8.04	88.5		8.4	94.6	0.2	8.27	80.5	7.35	55.8	0.0
36	7.95	88.7		8.4	94.6	0.2	8.27	80.5	7.35	56	0.0
37	7.88	88.4		8.4	94.7	0.2	8.27	80.5	7.35	56.4	0.0
38	7.8	89.0		8.4	94.7	0.2	8.4	83.4	7.35	58.1	0.0
39	7.76	88.6		8.4	94.7	0.2	8.43	83.9	7.35	58.4	0.0

Appendix C Fish Metals Concentrations, Garrow Lake 2003.

Appendix C. Total metal concentration (mg/kg ww) for individual fourhorn sculpin, Garrow Lake, August 2003.

Sample ID Total Metals (mg/kg ww)	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8	SC-9	SC-10	SC-11	Mean	SD	Range
Aluminum	20	13	21	19	5	9	23	3	21	40	7	16	10.61	3 - 40
Antimony	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Arsenic	0.59	0.93	0.59	1.10	1.42	1.48	0.66	0.82	0.77	0.81	0.53	0.88	0.33	0.53 - 1.48
Barium	3.63	2.93	3.70	3.00	2.55	2.32	2.83	1.59	5.36	5.15	3.61	3.33	1.14	1.59 - 5.36
Beryllium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	
Cadmium	0.087	0.051	0.044	0.038	0.062	0.042	0.103	0.026	0.051	0.075	0.043	0.057	0.023	0.026 - 0.103
Chromium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	
Cobalt	0.14	0.15	0.09	0.09	0.09	0.10	0.13	0.07	0.14	0.19	0.10	0.12	0.04	0.07 - 0.19
Copper	0.74	0.65	0.59	1.06	0.75	0.94	0.74	0.46	1.55	1.43	1.52	0.95	0.39	0.46 - 1.55
Lead	0.80	0.57	0.83	0.73	0.87	0.92	0.78	0.43	0.63	1.71	0.62	0.81	0.33	0.43 - 1.71
Manganese	3.37	6.46	2.29	3.15	1.24	2.78	3.34	1.60	3.36	4.31	2.77	3.15	1.40	1.24 - 6.46
Mercury	<0.005	<0.005	<0.005	0.005	0.012	0.006	<0.005	<0.005	<0.005	0.005	0.006	0.006	0.002	<0.005 - 0.012
Molybdenum	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	0.00	<0.01 - 0.01
Nickel	0.1	0.1	0.1	0.1	0.1	0.1	0.2	<0.1	0.2	0.2	0.2	0.1	0.1	<0.1 - 0.2
Strontium	21	30.4	27.9	36	46.1	41.5	25.1	35.7	30.8	29.8	25.6	31.8	7.4	21 - 46.1
Zinc	53.1	71.5	60.9	78.6	120	86.5	54.3	50.4	85.1	78	57.3	72.3	20.6	50.4 - 120