

### **Reporting Requirements for Reference Method EPS 1/RM/14**

- iii. Estimate of 48-h LC<sub>50</sub> and 95% confidence limits in multi-concentration tests, 48-h EC<sub>50</sub> for immobilization and 95% confidence limits, indication of statistical method on which results are based.
  - Test 1: 48-h LC<sub>50</sub> = > 100% effluent
  - Test 2: 48-h LC<sub>50</sub> = > 100% effluent
  - Test 3: 48-h LC<sub>50</sub> = > 100% effluent
- iv. Most recent 48-h LC<sub>50</sub> for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC<sub>50</sub> and warning limits.
  - Reference toxicity tests for Toxicant: Zinc
  - Test 1: (Aug-7-03) 96-h LC<sub>50</sub> = 453µg/L Zinc, 95% CL = 377-544µg/L
  - Test 2: (Aug-7-03) 96-h LC<sub>50</sub> = 453µg/L Zinc, 95% CL = 377-544µg/L
  - Test 3: (Sep-23-03) 96-h LC<sub>50</sub> = 429µg/L Zinc, 95% CL = 355-518µg/L

## **APPENDIX C**

### **7-d Topsmelt Growth and Survival Toxicity Test**

## **Reporting Requirements for Reference Method EPA/600/R-95/136**

### **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:  
Wednesday August 20, 2003 - 12:30 AM
- 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
  - Dennis Lu (Gartner Lee)

### **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
  - August 21, 2003
- 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
  - <10% mortality
- vii. Age at start of test
  - 10 days post-hatch
- viii. Unusual appearance, behaviour, or treatment of larvae before their use in the test
  - Nothing unusual, no excessive crowding of larvae, larvae appear healthy, disease-free, stress free,
- ix. Confirmation that larvae are actively feeding and swimbladders are not inflated
  - 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
  - Holding water conditions upon arrival were DO=supersaturated, pH=7.3, T=22°C
  - Organisms were acclimated slowly overnight
  - Addition of EVS lab seawater at intervals of 30 – 60min to reach acceptable conditions
  - Organisms were acclimated to DO=8mg/L, salinity=28ppt, T=20°C

## Reporting Requirements for Reference Method EPA/600/R-95/136

### 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. 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 was 5.3ppt
- iii. Date and time for start of definitive test
  - Friday August 22, 2003 - 5:00 PM
- iv. Test vessel description
  - 600mL beaker
- v. Person(s) performing the test and verifying the results
  - Kevin Goodearle, Julianna Kalocai, Sioe Lie Kwee, Rachel DeWynter, Edmund Canaria, and Armando Tang
- vi. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
  - pH - 7.9, T - 20.0°C, DO - 11.0mg/L, C - 9570µmhos/cm, (salinity - 5.3 ppt)
- vii. Confirmation that no adjustment of sample or solution pH occurred
  - No pH adjustment
- viii. Indication of aeration of test solutions before introduction of fish
  - Pre-aeration at 6.5mL/min/L for 30mins due to supersaturation of sample with O<sub>2</sub> when sample was heated to 20°C
  - DO was reduced from 11.0mg/L to 7.8 mg/L
- ix. Indication that EC guidance document for salinity adjustment was followed
  - No deviations from EC guidance document on preparation of hypersaline brine
  - HSB prepared from natural seawater concentrated to 90ppt (by freezing/refreezing to remove frozen layer and concentrate salts)
  - No deviations from EC guidance document for salinity adjustment of sample
  - HSB was added to samples to salinity adjust them from 5.3ppt to 30ppt
- x. Type and source of control/dilution water
  - UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium
- xi. Concentrations and volumes tested
  - Concentrations (% effluent volume / total volume) tested and total volumes used were:
  - Control (0%) - 200 mL
  - Salinity Control (0%) - 200 mL
  - 4.5% - 200mL
  - 9.0% - 200mL
  - 18.1% - 200mL
  - 36.2% - 200mL
  - 72.3% - 200mL
- xii. Number of replicates per concentration
  - 5 replicates per concentration
- xiii. Number of organisms added to each test vessel
  - 5 fish per vessel
- xiv. Manner and rate of exchange of test solutions
  - Daily renewal

## Reporting Requirements for Reference Method EPA/600/R-95/136

xv. Measurements of dissolved oxygen, pH and temperature

- DO: 6.6 - 7.8 mg/L, pH: 7.7 - 8.2, T: 19.0 - 20.0 °C, salinity: 29 - 31 ppt

### Results

- i. Number and % of mortalities of fish in each test solution
  - Totals from all 5 replicates are presented:
  - Control (0%) - 1/25 = 4%
  - Salinity Control - 0/25 = 0%
  - 4.5% - 0/25 = 0%
  - 9.0% - 0/25 = 0%
  - 18.1% - 0/25 = 0%
  - 36.2% - 0/25 = 0%
  - 72.3% - 1/25 = 4%
- ii. Average dry weight per original fish in test vessel
  - Means from all 5 replicates are presented:
  - Control (0%) - 1.18 mg
  - Salinity Control - 1.14 mg
  - 4.5% - 1.13 mg
  - 9.0% - 1.32 mg
  - 18.1% - 1.09 mg
  - 36.2% - 1.11 mg
  - 72.3% - 1.14 mg
- iii. Estimate of 7-d LC<sub>50</sub> (95% CL)
  - 7-d LC<sub>50</sub> concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
  - Quantal statistic methods not applicable
- iv. Estimate of 7-d IC<sub>25</sub> (95% CL) for growth
  - 7-d IC<sub>25</sub> concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
  - Quantal statistic methods not applicable
- v. Current reference toxicity tests (95% CL) for 7-d LC<sub>50</sub> for survival and 7-d IC<sub>50</sub> for growth
  - Reference toxicity tests for Toxicant: Copper
  - Test conducted on August 22, 2003, 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<sub>50</sub> survival = 122mg/L Cu, 95% CL = 111-135mg/L
  - 7-d IC<sub>50</sub> growth = 122mg/L Cu, 95% CL = 106-132mg/L
- vi. Reference toxicity warning limits (+/- SD) for 7-d LC<sub>50</sub> for survival and 7-d IC<sub>50</sub> for growth
  - Reference toxicity tests for Toxicant: Copper
  - 7-d LC<sub>50</sub> survival = 139 ± 63mg/L Cu,
  - 7-d IC<sub>50</sub> growth = 136 ± 52mg/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° 22' 32" N, 97° 48' 37" W.
- ii. Date & time of sampling
  - Samples for yearly sublethal toxicity testing were collected:  
Wednesday August 20, 2003 - 12:30 AM
- 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
  - Dennis Lu (Gartner Lee)

### **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
  - M-REP, Escondido, California
  - All adults providing gametes are from the same population and source
  - Gametes are spawned in-house at EVS
- iv. Date test species acquired on
  - August 22, 2003
- v. Holding time and conditions for adults
  - Adults received at the testing laboratory the day of the test, shipped overnight
- vi. Indications of deviations from EC guidance on the importation of test organisms
  - No deviations from EC requirements
- vii. Weekly percent mortality of adults being held over 7d preceding test
  - <2% per day over the 7 days preceding the test
- viii. Age of test organisms
  - < 4 hours after spawning
- ix. Unusual appearance, behaviour, or treatment of adults or gametes before test start
  - Organisms appear healthy

### **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
  - 10:10 min (10min sperm + 10min sperm & egg)
- iii. Date and time for start of definitive test

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

- Friday August 22, 2003 - 5:00 PM
- iv. Test vessel description
  - 16 x 125mm test tubes
- v. Person(s) performing the test and verifying the results
  - Kevin Goodearle, Julianna Kalocai, Sioe Lie Kwee, Rachel DeWynter, Edmund Canaria, and Armando Tang
- vi. Indication of rate and duration of pre-aeration of test solutions before initiation of test
  - No pre-aeration
- vii. Confirmation that no adjustment of sample or solution pH occurred
  - No pH adjustment
- viii. Procedure for sample filtration
  - No sample filtration
- ix. Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997
  - No deviations from EC guidance for salinity adjustment
- x. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997
  - No deviations from EC guidance for salinity adjustment
  - Salinity adjusted from 5ppt to 29ppt
- xi. Type and source of control/dilution water
  - UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium
- xii. Concentrations and volumes tested
  - 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
  - 36.5% - 10mL
  - 73.0% - 10mL
- xiii. Number of replicated per concentration
  - 4 replicates per treatment concentration
- xiv. Number of organisms per container
  - 2000 eggs per 10mL vessel
- xv. Measurements of pH and dissolved oxygen in sample water before use
  - pH - 8.3, DO - 8.4mg/L
- xvi. Measurements of pH, temperature, dissolved oxygen, and salinity during test
  - pH - 7.9-8.4, T - 15.0-15.5°C, DO - 8.1-8.4mg/L, salinity - 29ppt

### **Results**

- i. Number and % of fertilized eggs in each test concentration
  - (Number is equal to percent since totals were 100)
  - Control (0%): #F = 51, 50, 52, 54 #UF = 49, 50, 49, 46
  - Salinity Control: #F = 51, 52, 50, 51 #UF = 49, 48, 50, 49
  - 4.6%: #F = 35, 40, 29, 45 #UF = 65, 60, 71, 55
  - 9.1%: #F = 36, 28, 33, 25 #UF = 64, 72, 67, 75
  - 18.2%: #F = 22, 24, 18, 20 #UF = 78, 78, 82, 80
  - 36.5%: #F = 12, 8, 7, 10 #UF = 88, 92, 93, 90
  - 73.0%: #F = 1, 0, 2, 0 #UF = 99, 100, 98, 100



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

- ii. Estimate of  $IC_{25}$  (95% CL) for fertilization success
  - $IC_{25}$  concentration = 3.8 (1.1 - 7.2)% v/v effluent
  - Quantal statistic method = log linear interpolation
- iii. Current reference toxicity tests (95% CL) for  $IC_{50}$  for fertilization
  - Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on August 22, 2003, same day as effluent test
  - Reference test conducted under same conditions
  - $IC_{50}$  for fertilization = 1.3mg/L SDS, 95% CL = 1.1-1.5mg/L

## **APPENDIX E**

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

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

### 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:  
Wednesday August 20, 2003 - 12:30 AM
- 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
  - Dennis Lu (Gartner Lee)
- vii. Temperature of water upon receipt at lab
  - 13°C

### Test Organisms

- i. Species of test organism
  - Algae (*Champia parvula*)
- ii. Name and city of testing laboratory
  - Saskatchewan Research Council [SRC], Saskatoon, SK
- iii. Source of test species
  - Sexually mature male and female branches
  - Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995
  - Appear in good health
  - Females have trichogynes, males have sori with spermatia

### Test Facilities and Conditions

- i. Test type & method
  - *Champia parvula* sexual reproduction test
  - Static, non-renewal
  - 2-day exposure, followed by 5-7 day recovery period for cystocarp development
  - Reference Method - EPA/600/4-91/003, Method 1009.0
- ii. Date and time for start of definitive test
  - Friday August 22, 2003 – 10:00 AM
- iii. Test vessel description
  - 270mL transparent polystyrene cups with polystyrene lids
- iv. Person(s) performing the test and verifying the results
  - Mary Moody
- v. Indication of pre-aeration of test solutions
  - No pre-aeration
- vi. Confirmation that no pH adjustment of sample or solution occurred
  - No pH adjustment

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

- vii. Indication that EC guidance document for salinity adjustment was followed
  - No deviations from EC guidance document on preparation of hypersaline brine
  - HSB prepared from natural seawater at 90ppt
  - No deviations from EC guidance document for salinity adjustment of sample
  - Salinity adjustment: 642mL effluent + 258mL HSB + 9mL test nutrient solution
  - Salinity of samples adjusted from 5ppt to 30ppt
- viii. Type and source of control/dilution water
  - 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. Concentrations and volumes of test solutions
  - Concentrations (% effluent volume / total volume) tested and total volumes used were:
  - Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
  - Salinity Control Brine (0%) - 100mL, 4.5cm depth
  - 4.5% - 100mL, 4.5cm depth
  - 8.9% - 100mL, 4.5cm depth
  - 17.8% - 100mL, 4.5cm depth
  - 35.6% - 100mL, 4.5cm depth
  - 71.3% - 100mL, 4.5cm depth
- x. Number of replicated per concentration
  - 3 replicates per concentration
- xi. Number of organisms per test chamber
  - 5 female branches + 2 male branches per chamber
- xii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample before use
  - pH - 7.93, T - 23.5°C, DO - 9.4mg/L, salinity - 5ppt
- xiii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample during test
  - DO: 7.8 - 8.0 mg/L, pH: 7.74 - 8.98, T: 23°C, salinity: 30ppt

### **Results**

- i. Number and % mortality of female plants after recovery in each test solution
  - Totals from all 3 replicates are presented:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 4.5%: 0 (0%) mortality
  - 8.9%: 0 (0%) mortality
  - 17.8%: 0 (0%) mortality
  - 35.6%: 0 (0%) mortality
  - 71.3%: 0 (0%) mortality
- ii. Mean number of cystocarps per plant in each test concentration
  - Control (0%): 57.4; 49.6; 44.2
  - Salinity Control (0%): 66.4; 44.0; 45.2
  - 4.5%: 52.2; 51.4; 57.4
  - 8.9%: 61.2; 63.6; 41.2
  - 17.8%: 30.4; 34.4; 18.6
  - 35.6%: 6.6; 6.0; 7.6
  - 71.3%: 0.0; 2.4; 1.4

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

- iii. Estimate of  $IC_{25}$  (95% CL) for cystocarp development
  - $IC_{25}$  concentration = 13.6 (9.0-16.0)% effluent v/v
  - Quantal statistic method was linear interpolation
- iv. Current reference toxicity tests (95% CL) for  $IC_{50}$  for cystocarp development
  - Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on July 29, 2003, within 30 days of effluent test
  - Reference toxicant test was conducted under the same experimental conditions as the effluent test
  - $IC_{50}$  cystocarp development = 1.19mg/L SDS, 95% CL = 1.14-1.23mg/L
- v. Reference toxicity warning limits (+/- 2SD) for  $IC_{50}$  for cystocarp development
  - Reference toxicity tests for Toxicant: SDS
  - 7-d  $IC_{50}$  growth = 1.47 (1.17-1.84) mg/L SDS

## **APPENDIX F**

### **Effluent Metals Concentrations and Loadings**

**2003 3<sup>rd</sup> QUARTER MMR REPORT**  
**LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)**  
**CONCENTRATIONS OF EFFLUENT FOR MMR SCHEDULE 4 SAMPLED WEEKLY**

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L) <sup>1</sup>										pH <sup>1</sup>	Collection Method
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 <sup>1</sup>				
07-Jul-03	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>			na <sup>2</sup>	na <sup>2</sup>
14-Jul-03	na <sup>2</sup>												na <sup>2</sup>
21-Jul-03	25-Jul-03	0.0001	0.00122	0.005	0.00793	0.00126	0.0479	3	0.005			7.77	Water Pump
28-Jul-03	30-Jul-03	0.0004	0.00057	0.005	0.00319	0.00115	0.0625	3	0.005			7.84	Water Pump
04-Aug-03	05-Aug-03	0.0005	0.00068	0.005	0.00083	0.00144	0.0892	3	0.005			7.85	Water Pump
11-Aug-03	12-Aug-03	0.001	0.00091	0.005	0.00124	0.00256	0.151	3	0.005			7.94	Water Pump
18-Aug-03	19-Aug-03	0.001	0.00097	0.005	0.00046	0.00265	0.146	8	0.005			8.1	Water Pump
25-Aug-03	26-Aug-03	0.001	0.0009	0.005	0.00114	0.00261	0.16	3	0.005			7.96	Water Pump
01-Sep-03	02-Sep-03	0.0002	0.00089	0.005	0.00333	0.00274	0.15	10	0.005			8.06	Water Pump
08-Sep-03	09-Sep-03	0.002	0.00107	0.005	0.00117	0.00292	0.158	11	0.01			7.94	Water Pump
15-Sep-03	16-Sep-03	0.001	0.00099	-	0.00046	0.00365	0.186	5	0.005			7.96	Water Pump
22-Sep-03	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>			na <sup>2</sup>	na <sup>2</sup>
29-Sep-03	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>	na <sup>2</sup>			na <sup>2</sup>	na <sup>2</sup>

Note<sup>1</sup> - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note<sup>2</sup> - "na" refers to no effluent discharge to sample

Concentrations in red italics were set to the detection limit

**MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMR SCHEDULE 4**

MONTH OF	MONTHLY MEAN CONCENTRATION <sup>1</sup> OF DELETERIOUS SUBSTANCE <sup>2</sup>						
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	Radium 226
July/03	0.0003	0.00090	0.005	0.00556	0.00121	0.055	3
August/03	0.0009	0.00087	0.005	0.00092	0.00232	0.137	4
September/03	0.0011	0.00098	0.005	0.00165	0.00310	0.165	9

Note<sup>1</sup> - All concentrations are in mg/L except Radium 226 which is Bq/L

Note<sup>2</sup> - 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) <sup>1</sup>								Average Daily Flow Rate (m <sup>3</sup> /day)
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 <sup>2</sup>	
07-Jul-03	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>
14-Jul-03	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>
21-Jul-03	25-Jul-03	0.005	0.061	0.25	0.3965	0.063	2.395	150	250,000	50,000
28-Jul-03	30-Jul-03	0.027268	0.038857	0.34085	0.217462	0.078396	4.260625	204.51	340,850	68,170
04-Aug-03	05-Aug-03	0.0382705	0.052048	0.382705	0.063529	0.110219	6.827457	229.623	382,705	76,541
11-Aug-03	12-Aug-03	0.069936	0.063642	0.34968	0.086721	0.179036	10.56034	209.808	349,680	69,936
18-Aug-03	19-Aug-03	0.0636	0.061692	0.318	0.029256	0.16854	9.2856	508.8	318,000	63,600
25-Aug-03	26-Aug-03	0.079663	0.071697	0.398315	0.090816	0.20792	12.74608	238.989	398,315	79,663
01-Sep-03	02-Sep-03	0.0189928	0.084518	0.47482	0.31623	0.260201	14.2446	949.64	474,820	94,964
08-Sep-03	09-Sep-03	0.277646	0.148541	0.694115	0.162423	0.405363	21.93403	1527.053	1,388,230	138,823
15-Sep-03	16-Sep-03	0.081164	0.080352	-	0.037335	0.296249	15.0965	405.82	405,820	81,164
22-Sep-03	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>
29-Sep-03	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>	na <sup>3</sup>

Note<sup>1</sup> - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note<sup>2</sup> - Average Flow rate is the weekly flow as recorded by flow meter totalizers divided by 7

Note<sup>3</sup> - "na" refers to no effluent discharge to sample

## MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING <sup>1</sup> FOR DELETERIOUS SUBSTANCE (kg/month) <sup>2</sup>								Average Weekly Flow Rate <sup>3</sup> (m <sup>3</sup> /week)	Total Monthly Volume <sup>4</sup> (m <sup>3</sup> /month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 <sup>2</sup>		
July/03	0.50	1.55	9.16	9.52	2.19	103	5,495	9,158,175	340,023	594,222
August/03	1.95	1.93	11.23	2.09	5.16	306	9,201	11,227,425	510,583	2,261,153
September/03	3.78	3.13	17.53	5.16	9.62	513	28,825	22,688,700	762,676	1,961,166

Note<sup>1</sup> - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note<sup>2</sup> - Mass loading units are in kg per month except Radium 226, which is in Bq per month

Note<sup>3</sup> - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note<sup>4</sup> - Total Monthly Volume is the actual total volume as recorded by flow meter totalizers for each month.



## **APPENDIX G**

### **Results of Effluent Characterization**

## RESULTS OF EFFLUENT CHARACTERIZATION

### AS PER PARAGRAPH 15(1)(a)

Nine effluent samples were collected on a weekly basis during the 3<sup>rd</sup> Quarter of 2003 beginning on July 25, 2003 and ceasing on September 16, 2003. Three of the nine samples were “monthly” samples and analysed 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.

No holding times were missed for any of the water chemistry or toxicity testing samples.

Water samples for acute and sublethal toxicity testing were collected using a pump system from about 20 m downstream of the dam on Garrow Lake, within the main flow of the creek. Acute Lethality Testing was conducted during three months (July, August, and September) during the quarter. There were no adverse effects observed for either the 96-hr Rainbow Trout toxicity test, or the 48-hr *Daphnia magna* toxicity test. LC<sub>50</sub> values were >100% effluent for both species in all testing events.

Sublethal Toxicity Testing was conducted once during August 2003. As this is considered a marine discharge, marine species were used for sublethal testing following brine adjustment of the brackish effluent (as per test protocols). Testing for fish (7-d Topsmelt growth and survival) and invertebrates (Sand dollar) was conducted at EVS Environment Consultants, Vancouver, while algae (48-h *Champia*) testing was undertaken by the Saskatchewan Research Council, Saskatoon.

There were no effects observed in the Topsmelt Survival and Growth Test at 100% effluent v/v.

Sublethal effects were observed for the echinoid and algal tests and concentrations less than 100% effluent v/v. In the echinoid (*Dendraster excentricus*) fertilization test (EVS Consultants), the LOAEL was 4.6% v/v effluent, the IC<sub>25</sub> was 3.8% v/v, and the IC<sub>50</sub> was 13.0% v/v. In the *Champia parvula* sexual reproduction test (Saskatchewan Research Council) the LOAEL was 17.8% v/v effluent, the IC<sub>25</sub> 13.6% v/v, and the IC<sub>50</sub> was 18.8% v/v.

Zinc was the primary contaminant of potential concern (COPC) identified in mine effluent and is the only metal to consistently exceed BC Ambient Water Quality Guidelines (BC AWQG) in effluent. During the 9 week discharge period, effluent zinc concentration averaged  $128 \pm 49 \mu\text{g/L}$  (range 48 – 186  $\mu\text{g/L}$ ), which is well below the MMER effluent limit of 500  $\mu\text{g/L}$ . The BC AWQG is 10  $\mu\text{g/L}$ . On August 19, 2003, when the sublethal samples were collected, the concentration of Zn in the effluent was 146  $\mu\text{g/L}$ . Converting the echinoid test endpoints into Zn concentrations results in a Lowest Observed Adverse Effect Level (LOAEL) of 6.7  $\mu\text{g/L}$  Zinc, an IC<sub>25</sub> of 5.5  $\mu\text{g/L}$ , and an IC<sub>50</sub> of 19.0  $\mu\text{g/L}$ . Reference toxicity tests of zinc on *Dendraster* fertilization give mean EC<sub>50</sub> concentrations of 8.5-60  $\mu\text{g/L}$  (Dinnel et al. 1983). The concentration of zinc in the effluent that corresponds to the IC<sub>50</sub> (i.e., 19.0  $\mu\text{g/L}$ ) is within the effects range reported in reference *Dendraster* fertilization tests. Thus the echinoid test is quite sensitive to zinc, with the LOAEL being less than the BC AWQG concentration.

Endpoints for the *Champia* test in terms of zinc concentrations were 26.0µg/L Zn (LOAEL), 19.9µg/L (IC<sub>25</sub>), and 27.4µg/L (IC<sub>50</sub>). The reference IC<sub>25</sub> endpoint for zinc in the *Champia* test performed in-house at SRC was 27µg/L (95% confidence limits 16-42µg/L). This reference concentration is very similar to zinc concentrations in the mine effluent at the toxicity endpoints observed in the *Champia* test. *Champia* also appears to be sensitive to zinc concentrations at or below the BC AWQG.

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 21**

### **ELECTRONIC VERSION OF 3<sup>RD</sup> QUARTER 2003 RECLAMATION REPORT (PDF VERSION)**