Appendix C

Bioassay Data Report

January 1999

LABORATORY REPORT

SUPPLEMENTAL INVESTIGATION OF SURFACE SEDIMENTS
Boulevard Park/Starr Rock Project for Anchor Environmental (Project No. 98-007-03)
Marine Sediment Toxicity Testing

PREPARED FOR:

EVS Solutions Inc.
Seattle, Washington

PREPARED BY:

EVS ENVIRONMENT CONSULTANTS
North Vancouver, BC

TABLE OF CONTENTS

LIST OF TABLES ii
ACKNOWLEDGEMENTS iii

1.0
INTRODUCTION 1
1.1 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) 1

2.0
10-d *Eohaustorius estuarius* SEDIMENT TOXICITY TEST 3
2.1 METHODS 3
2.2 RESULTS 5
2.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) 5

3.0
20-d *Neanthes arenaceodentata* SEDIMENT TOXICITY TEST 7
3.1 METHODS 7
3.2 RESULTS 9
3.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) 9

4.0
48-h *Mytilus galloprovincialis* LARVAL DEVELOPMENT TOXICITY TEST 12
4.1 METHODS 12
4.2 RESULTS 14
4.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) 14

5.0
REFERENCES 16

Appendix A Chain-of-Custody Forms
Appendix B Raw Data for the 10-d *Eohaustorius estuarius* Sediment Toxicity Tests
Appendix C Raw Data for the 20-d *Neanthes arenaceodentata* Sediment Toxicity Tests
Appendix D Raw Data for the 48-h *Mytilus galloprovincialis* Larval Development Toxicity Tests

LIST OF TABLES

Table 2-1.	Summary of results of the 10-d *E. estuarius* sediment toxicity test.	6
Table 3-1.	Summary of results of the 20-d *N. arenaceodentata* sediment toxicity test.	11
Table 4-1.	Summary of results of the 48-h *M. galloprovincialis* larval development toxicity test.	15

Environmental Services for
Industry and Government

Vancouver, Canada
Seattle, U S A

EVS ENVIRONMENT CONSULTANTS

Our File: 9/852-01.1
Work Order: 9800686, 9800688, 9800689

February 19, 1999

Mr. Dan Hennessy
EVS Solutions Inc.
200 - West Mercer Street
Suite 401
Seattle, WA 98119
USA

Dear Mr. Hennessy:

Re: Supplemental Investigation of Surface Sediments, Boulevard Park/Starr Rock Project for Anchor Environmental (Project No. 98-007-03)

We are pleased to provide the results of the toxicity testing on marine sediment samples received by EVS Environment Consultants between October 28 and October 30, 1998.

We have completed marine toxicity testing on six (6) sediment samples and three (3) reference sediments collected between October 26 and October 29, 1998.

This report includes data and results for testing using the estuarine amphipod, *Eohaustorius estuarius,* the juvenile polychaete *Neanthes arenaceodentata*, and larvae of the mussel *Mytilus galloprovincialis.* The test methods, results and raw data including statistical printouts are provided in the following report. If you have any questions or comments, please do not hesitate to contact the undersigned at (604) 986-4331.

Yours truly,

EVS ENVIRONMENT CONSULTANTS

Jennifer V. Stewart, B.Sc.
Manager, Laboratory Services

BGM/eca

195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: (604) 986-4331
Fax: (604) 662-8548
evs_consultants@mindlink.bc.ca

200 West Mercer Street
Suite 403
Seattle, WA 98119
Tel: (206) 217-9337
Fax: (206) 217-9343
evswa@halcyon.com

ANCHOR ENVIRONMENTAL

BOULEVARD PARK/STARR ROCK PROJECT (PROJECT NO. 98-007-03) MARINE SEDIMENT TOXICITY TESTING

LABORATORY REPORT

Prepared for

EVS Solutions Inc.
Suite 401
200 West Mercer Street
Seattle, WA
98119 USA

Prepared by

EVS Environment Consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

9/852-01.1

January 1999

ACKNOWLEDGEMENTS

Sediment toxicity testing was conducted by Patricia Haynes, Julianna Kalocai, Amanda LaGrange, Bushra Jamil, Jennifer Stewart, Jacqueline Bell, Blair McDonald, Stefan Santos, Lori Suffredine, John Mohr, Candrina Bailey, Betty Yung and George Yang. The statistical analyses were conducted by Julianna Kalocai, Stefan Santos and Blair McDonald. The report was prepared by Blair McDonald and Patricia Haynes. Quality assurance and quality control (QA/QC) review of all data was conducted by Cathy McPherson, Julie Orban and Gary Lawrence. The report was reviewed by Jennifer Stewart. Elissa Amar was responsible for word processing. Analytical Service Laboratories (ASL) of Vancouver, BC were responsible for ammonia and sulphide analyses.

1.0
INTRODUCTION

Six (6) sediment samples identified as AN-SS-301 thru AN-SS-306 and three (3) reference sediments identified as CR-10, CR-22 and CR-23W collected between October 27 and 29, 1998 were received by the EVS Environment Consultants Laboratory between October 28 and 30, 1998 for toxicity testing using the following tests:

- 10-d *Eohaustorius estuarius* sediment toxicity test
- 20-d *Neanthes arenaceodentata* sediment toxicity test
- 48-h *Mytilus galloprovincialis* sediment toxicity test

This report describes the results of these tests. Chain-of-Custody forms submitted with the samples are provided in Appendix A. Test data and statistical printouts are provided in Appendices B, C and D, respectively.

Each sample was shipped in nine or ten 1-L glass jars. Sediments were stored in the dark at 4°C, prior to testing.

The *E. estuarius* tests were initiated on November 6, 1998, with field-collected immature adult amphipods. The exposure duration was 10 days, and the test endpoints were survival and behaviour (sediment avoidance and ability to rebury in clean sediment). The *N. arenaceodentata* tests were initiated on December 8, 1998 with juvenile polychaetes obtained from laboratory cultures and the exposure duration was 20 days. The test endpoints were survival and growth (change in dry weight). The *N. arenaceodentata* test failed to meet control criteria of ≥90% survival (PSEP, 1995). Based on the clients decision to accept the data, results of this testing have been included in this report. The *M. galloprovincialis* larvae tests were initiated November 25, 1998 with larvae that were within 2-h post-fertilization. The exposure duration was 48 h and the test endpoints were larval survival, normal development and survival/normal development.

1.1 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study was conducted under our comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The details of our QA/QC Program are documented in our Laboratory QA/QC Manual which describes all aspects of our program, including information on general laboratory procedures, sample handling, toxicity test procedures, data interpretation and management, and documentation of results. The following general QA/QC guidelines apply to all toxicity tests: use of negative controls, use of positive controls, replication, instrument calibration, water

quality maintenance and record-keeping, and use of standard operating procedures (SOPs). To ensure the highest quality of data and reporting, all data and statistical analyses for each toxicity test are reviewed by a member of our QA/QC Committee prior to the report being released.

2.0
10-d *Eohaustorius estuarius* SEDIMENT TOXICITY TEST

2.1 METHODS

Ten-day toxicity tests using the estuarine amphipod, *Eohaustorius estuarius*, were conducted according to EVS Environment Consultants Ltd. Standard Operating Procedures (SOP) 1077-2 (EVS Environment Consultants, 1998), which is based on methods described in PSEP (1995). Amphipods were collected intertidally from Beaver Creek, Oregon, using a shovel. Amphipods were sieved from the sediments, counted and then transferred to small sandwich containers containing approximately a 1-cm layer of collection site sediment. Each container held approximately 100 amphipods. Sediment from the collection site was also retained for use as a clean control sediment for the toxicity tests. This material was sieved (500-μm screen), placed in a clean container and stored at 4°C in the dark prior to testing.

The amphipods were acclimated to laboratory conditions for two days prior to testing. During this time, amphipods received aeration but were not fed. The amphipods were kept in large plastic basins each holding about 12 sandwich containers. Each basin was filled with seawater (28 ± 1 ppt salinity) and maintained at 15 ± 1°C under continuous light. Seawater in the holding containers was replaced every two days. The seawater was obtained from Burrard Inlet, Vancouver, BC, at a depth of 12 m. This water was passed through a sand filter, a 0.5-μm filter and an ultraviolet light sterilizer, aerated vigorously and used within 2 d of collection. Water quality was measured before the water change and dead amphipods were removed.

Prior to test initiation the bulk sediments were homogenized and a portion of the sediment from each sample was centrifuged and sent to ASL for bulk interstitial ammonia and sulphide analysis. Tests were conducted in 1-L glass jars. Five replicates were prepared for each sample, and the negative control sediment. Three additional jars were prepared as sacrificial replicates for Days 0, 5 and 10 interstitial ammonia measurements, one of which was designated specifically for daily water quality measurements (temperature, pH, salinity, dissolved oxygen). Sediments were distributed to the test containers the day before test initiation (Day -1). Each test sediment was homogenized by thorough manual mixing. Large pieces of organic material (e.g., grasses, algae) and any live animals were removed at this time. A 175-mL volume (representing a 2-cm layer) of test sediment was added to each jar. Approximately 800 mL of seawater (28 ± 1 ppt salinity) was added to each jar. The jars were covered with clean plastic lids, fitted with aeration lines, and left to settle overnight. The following day (Day 0) the jars were seeded with 20 amphipods each. The amphipods were not fed during the tests.

Tests were conducted in a constant environment chamber at 15 ± 1°C under continuous light. Test jars were gently aerated. Water quality parameters (temperature, pH, dissolved oxygen, salinity) were measured daily in the water quality jar. Test containers were checked daily for emergent amphipods, indicating sediment avoidance or mortality. Amphipods which had left the sediment and become trapped by surface tension at the air/water interface were re-submerged with a glass rod. Composite subsamples of the overlying water were taken from each of the samples and the negative control on Days 0 and 10 for sulphide analysis. Interstitial water was collected on Days 0, 5 and 10 by centrifugation of the sediment from one of the sacrificial replicates from each of the samples and the negative control for ammonia analysis. Ammonia and sulphide samples were sent to ASL for analysis.

At the end of the 10-d exposure, the sediments were sieved through a 500-μm screen, and the number of live, dead and missing amphipods were counted in each replicate. Amphipods were presumed dead if there was no response to physical stimulation or examination revealed no evidence of pleopod movement. Missing amphipods were presumed to have died and decomposed prior to the termination of the test (Swartz et al., 1985). Surviving amphipods were transferred to plastic weighboats containing control sediment and seawater. The number of animals able to rebury within 1 h was recorded. For the test to be considered valid, mean survival in the control sediment had to be ≥90% (PSEP, 1995).

Mean responses (± SD) and statistical analysis for survival were calculated for each sediment using the TOXCALC Computer program (Tidepool Scientific Software, 1994). The survival data were tested for normality and homogeneity of variance. If the survival data did not pass the tests for normality and homogeneity of variance, then the data were transformed. If transformation did not allow the data to pass these tests, untransformed data were used. Homoscedastic *t*-tests or the non-parametric heteroscedastic *t*-tests were then performed to determine if any of the test sediments were significantly different ($p \leq 0.05$) from the negative control with respect to survival. Using the same analyses, all samples were then compared with reference sediments (CR-10, CR-22, and CR-23W). Amphipod mean avoidance was determined from daily counts of amphipods that had emerged from the sediments. After 10 d, the total number of amphipods emerged was divided by 50 (5 replicates x 10 d), to give mean avoidance (per jar per day). Percent reburial was calculated by dividing the total number of amphipods that did rebury within 1 h by the total number of surviving amphipods

To assess the relative sensitivity of the test organisms, a concurrent 96-h reference toxica test was conducted with cadmium (prepared from cadmium chloride, $CdCl_2 \cdot 2½H_2O$) w 900 mL of test solution containing 10 amphipods per concentration. A series of concentrations (1.8, 3.2, 5.6, 10.0, 18.0 mg/L Cd), were prepared in 1-L glass jars fr 1,000 mg/L cadmium stock solution. Water quality measurements and mortalities recorded daily. The 96-h LC50 value (expressed as mg/L Cd) was calculated usi TOXCALC program. This test was used to assess the relative health and sensitivity

amphipods by comparing the results to a range (mean ± 2SD) obtained by this laboratory in previous testing.

2.2 RESULTS

Results of the 10-d *Eohaustorius* test are summarized in Table 2-1. Complete results including raw data and statistical printouts are provided in Appendix B.

Mean survival in the negative control was 98.0%. Mean survival in the test and reference samples ranged from 91.0 to 97.0%.

Homoscedastic *t*-tests indicated significant differences ($p \leq 0.05$) with respect to survival when the samples were compared to the negative control and all three reference sediments.

Mean avoidance (expressed as amphipods/jar/day) in the control sediment was 0.14 amphipods/jar/day. Mean avoidance in the reference sediments ranged from 0.02 to 0.08 amphipods/ jar/day. Mean avoidance in the test sediments ranged from 0.06 to 0.38 amphipods/jar/day. The percentage of surviving amphipods able to rebury in clean sediment and seawater within 1 h was 100% in the negative control and ranged from 99 to 100% in the reference samples. The percentage of surviving amphipods able to rebury in clean sediment and seawater with 1-h ranged from 99 to 100% in the test samples.

2.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Mean survival responses in the negative control met the criterion for test acceptability as outlined in PSEP, 1995.

Water quality parameters measured during the 10-d exposure period were within the following ranges: temperature, 15.0°C; pH, 7.7 - 8.6 dissolved oxygen, 7.6 - 8.4 mg/L; salinity, 29 - 30 ppt; overlying sulfides <0.02 - 0.03 mg/L S; and interstitial ammonia, 0.09 - 11.5 mg/L N.

Salinity values slightly exceeded the recommended range of 27 - 29 ppt (PSEP, 1995), however, it is unlikely that this exceedance affected the test results.

The LC50 for the cadmium reference toxicant (initiated concurrently on November 6, 1998) was determined using the TOXCALC computer program. The 96-h LC50 value for Cd was 10.8 mg/L Cd (95% confidence limits: 8.4 and 13.8 mg/L Cd) which was within the range of 8.0 ± 6.9 mg/L Cd (mean ± 2SD) obtained by this laboratory. Water quality parameters

measured during the 96-h exposure period were within the following ranges: temperature, 15.0 - 15.5 °C; pH, 7.4 - 8.1; dissolved oxygen, 8.0 - 8.4 mg/L; and salinity, 28 ppt.

Table 2-1. Summary of results of the 10-d *E. estuarius* sediment toxicity test.

SAMPLE ID	% SURVIVAL[1] (MEAN ± SD)	AVOIDANCE[2] (MEAN ± SD)	% REBURIAL[3]
Negative control	98.0 ± 2.7	0.14 ± 0.13	100
CR-10	91.0 ± 4.2*°△	0.02 ± 0.04	99
CR-22	97.0 ± 4.5	0.02 ± 0.04	100
CR-23W	96.0 ± 2.2	0.08 ± 0.18	99
AN-SS-301	83.0 ± 6.7*□°△	0.06 ± 0.05	100
AN-SS-302	77.0 ± 14.8*°△	0.08 ± 0.08	100
AN-SS-303	85.0 ± 11.2*°△	0.16 ± 0.13	99
AN-SS-304	97.0 ± 4.5	0.06 ± 0.09	100
AN-SS-305	91.0 ± 4.2*°△	0.10 ± 0.12	100
AN-SS-306	76.0 ± 22.2*°△	0.38 ± 0.28	99

1 n = 5 replicates; 20 amphipods seeded per replicate.
2 Number of amphipods on the sediment surface per jar per day (out of a maximum of 20.0).
3 Percentage of surviving amphipods able to rebury in clean sediment and seawater within 1 h after a 10-d exposure.
* Indicates significant difference when compared to the negative control.
° Indicates significant difference when compared to reference sediment CR-22.
△ Indicates significant difference when compared to reference sediment CR-23W.
□ Indicates significant difference when compared to reference sediment CR-10.

3.0
20-d *Neanthes arenaceodentata* SEDIMENT TOXICITY TEST

3.1 METHODS

The 20-d static-renewal juvenile polychaete (*Neanthes arenaceodentata*) sediment toxicity test was conducted according to EVS SOP 1078-1 (EVS, 1995a), which is based on methods described by PSEP (1995). Juvenile worms (2-3 weeks post-emergence) were obtained from a supplier in California and acclimated for six days before use. Worms were held in an aquarium, without sediment, at 20°C until used for testing. Gentle aeration was provided and the worms were fed ground TetraMarin® fish flakes during acclimation. Injured, unhealthy or dead worms were discarded prior to testing.

Seawater used for acclimation and toxicity testing was obtained from Burrard Inlet, Vancouver BC at a depth of 12 m and used within 2 d of collection. This water was passed through a sand filter, a 0.5-μm particle filter, and an ultraviolet sterilizer and aerated vigorously prior to use. Silica sediment was used as the control sediment.

Tests were conducted in 1-L glass jars. Five replicates were prepared for each sample and the negative control sediment. Three additional jars were prepared as sacrificial replicates for Days 0, 10, and 20 interstitial ammonia measurements, one of which was designated specifically for daily water quality measurements (temperature, pH, salinity and dissolved oxygen). Sediments were distributed to the test containers the day before test initiation (Day -1). Each test sediment was homogenized by thorough manual mixing. Large pieces of organic material (e.g., grasses, algae) and any live animals were removed at this time. A 175-mL volume (representing a 2-cm layer) of test sediment was added to each jar. Approximately 800 mL of seawater (28 ± 1 ppt salinity) was added to each jar. The jars were covered with clean plastic lids, fitted with aeration lines, and left to settle overnight. The following day (Day 0), each jar was seeded with five juvenile worms. The worms were removed from their holding containers, sorted by size and randomly distributed to small vials containing seawater. When there were five worms in each vial, counts were confirmed and the worms were randomly distributed among the test containers. Three additional replicates of five worms were also set aside for determination of initial (Day 0) dry weight.

Tests were conducted in a constant environment chamber at 20 ± 1°C under continuous light. Aeration was provided for the duration of the test. Every three days, approximately one-third of the water in each jar was removed and replaced with clean seawater, taking care not to disturb the sediments. Water quality parameters (pH, dissolved oxygen and salinity) were recorded in the water quality jar in each treatment just prior to each water renewal (i.e., every three days). The temperature was recorded daily. The worms were fed ground

TetraMarin® fish flakes (8 mg per worm) every two days during testing. Interstitial water was collected on Days 0, 10 and 20 by centrifugation of the sediment from the sacrificial replicate for each of the samples and the negative control for ammonia analysis. Composite subsamples of the overlying water were taken from each of the samples and the negative control on Days 0 and 10 for sulfide analysis. Ammonia and sulfide samples were sent to ASL for analysis.

At the end of the 20-d exposure, the sediments were sieved through a 500-μm screen, and the number of live, dead and missing worms in each replicate was counted. Worms were considered dead when there was no response to physical stimulation and examination revealed no evidence of movement. Missing worms were assumed to have died and decomposed prior to the termination of the test. Surviving worms from each replicate were rinsed in distilled water, transferred to pre-weighed aluminum pans (one per replicate), dried at 60°C overnight, and then weighed to determine dry weight. For the test to be considered valid, mean survival in the negative controls had to be ≥90% and mean growth had to be ≥0.38 mg/worm/day (PSEP, 1995). For the reference sediments to be considered valid, survival had to be ≥80% (PSDDA, 1989).

The mean survival and dry weight responses in the treatments were calculated using the TOXCALC computer program (Tidepool Scientific Software, 1994). All data were tested for normality and homogeneity of variance. If the data did not pass the tests for normality and homogeneity of variance, then the data were transformed. If transformation did not allow the data to pass these tests, untransformed data were used. Homoscedastic *t*-tests or the non-parametric heteroscedastic *t*-tests were performed to determine if any of the test sediments were significantly different ($p \leq 0.05$) from the negative control with respect to survival, individual dry weight, growth rate and total dry weight. The same statistical analyses were used to compare the samples to each of the reference sediments (CR-10, CR-22 and CR-23W).

A positive (toxic) control was conducted using the standard reference toxicant, cadmium (prepared from cadmium chloride, $CdCl_2 \cdot 2½H_2O$). A 96-h LC50 test was conducted without sediment in 1-L glass jars containing 900 mL of test solution and 10 worms. Five concentrations (3.2, 5.6, 10.0, 18.0 and 32.0), plus a negative control, one replicate each, were prepared from a 1,000 mg/L Cd stock solution. Water quality measurements and mortalities were recorded every day. The 96-h LC50 value (expressed as mg/L Cd) was calculated using the TOXCALC program. The results of the reference toxicant test were then compared to the laboratory value (mean ± 2SD) to assess the health and sensitivity of the organisms.

3.2 RESULTS

Results of the 20-d *Neanthes* tests are summarized in Table 3-1. Complete results including raw data and statistical printouts are provided in Appendix C.

Mean survival in the negative control was 60.0% and ranged from 80.0 to 92.0 in the reference sediments. Mean survival in the samples ranged from 68.0 to 96.0%. The average individual dry weight (based on three replicates of five worms) at test initiation (Day 0) was 0.50 mg/worm.

Average individual dry weight on Day 20 was 9.1 mg in the negative control and ranged from 9.1 to 12.2 mg in the reference sediments. Individual growth rate was 0.43 mg/worm/day in the negative control and ranged from 0.43 to 0.59 mg/worm/day in the reference sediments. Total dry weight was 31.9 mg in the negative control and ranged from 42.8 to 51.7 mg in the reference sediments.

Average individual dry weight on Day 20 ranged from 10.2 to 13.9 mg/worm in the test sediments. Individual growth rate ranged from 0.49 to 0.67 mg/worm/day in the test sediments. Total dry weight ranged from 43.2 to 59.6 mg in the test sediments.

Homoscedastic *t*-tests indicated significant differences in survival when compared to reference sediment CR-10. There were no significant differences when compared to the negative control or the reference sediments, CR-22 or CR-23W.

3.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Mean survival in the negative control failed to meet the criteria of ≥90% for the test acceptability outlined in PSEP, 1995. Growth responses in the negative control and mean survival responses in the reference sediment met the criterion of ≥0.38 mg/worm/day and ≥80% survival respectively for test acceptability outlined in PSEP, 1995 and PSDDA, 1989.

Low control survival results may be attributed to anoxic conditions observed within the control sediment of two replicates. The colour of these replicates was dark grey as opposed to the pale cream colour of the other replicates which performed well.

Water quality parameters measured during the 20-d exposure period were within the following ranges: temperature, 20.5 - 21.0°C; pH, 7.0 - 8.2; dissolved oxygen, 0.5 - 7.2 mg/L; salinity, 29 - 30 ppt; overlying sulphides, <0.02 - 0.6 mg/L S; and interstitial ammonia, 0.17 - 24.4 mg/L N.

The dissolved oxygen measurements fell below the range of ≥60% of saturation (ASTM, 1997). The pH measurements slightly exceeded the recommended range of 7.5 - 8.5 (EVS, 1995a). Low pH measurements may be the result of low dissolved oxygen measurements. However, low dissolved oxygen levels in some replicates is unlikely to have substantially affected the outcome of the test. Since aeration was checked daily, low oxygen levels could not have persisted for longer than 24-h in any one jar. Also the effects of low dissolved oxygen levels in one jar would be compensated by the effects of relatively high dissolved oxygen levels in the remaining four replicates. Finally, low dissolved oxygen does not necessarily impact the endpoints of the test; Day 10 dissolved oxygen levels dropped to 0.9 and 0.8 in the two replicates of CR-10, yet mean survival remained high at 92%.

The 96-h LC50 for the cadmium reference toxicant test (initiated concurrently on December 8, 1998) was 4.2 mg/L Cd (95% confidence limits: 3.2 and 5.6 mg/L Cd). This value was slightly outside the laboratory range (mean ± 2SD) of 9.6 ± 4.7 mg/L Cd but was within the laboratory control limits (mean ± 3SD) of 9.6 ± 6.9 mg/L Cd. Normally, test results should be within two standard deviations (SD) of the mean LC50 (calculated from the last 20 tests performed by this laboratory). However, test results within 3SD are acceptable under certain circumstances. In this case, the upper 95% confidence limits (5.6 mg/L Cd) falls well within 2SD of the laboratory mean, and a QA/QC review found no contributing factors that would indicate technician errors. Water quality parameters measured in the reference toxicant test ranged as follows: temperature, 19.5 - 21.0°C; pH, 7.6 - 8.0; dissolved oxygen, 7.1 - 7.5 mg/L; and salinity, 30 ppt.

Table 3-1. Summary of results of the 20-d *N. arenaceodentata* sediment toxicity test.

Sample ID	Mean ± SD[1]			
	Survival (%)	Individual Dry Weight (mg/worm)	Individual Growth Rate (mg/worm/day)	Total Dry Weight (mg)
Negative control	60.0 ± 46.9	9.1 ± 4.3	0.43 ± 0.22	31.9 ± 28.5
CR-10	92.0 ± 11.0	9.1 ± 3.3	0.43 ± 0.16	42.8 ± 17.5
CR-22	88.0 ± 17.9	11.9 ± 1.0	0.57 ± 0.05	51.7 ± 8.3
CR-23-W	80.0 ± 14.1	12.2 ± 4.2	0.59 ± 0.21	48.0 ± 16.6
AN-SS-301	68.0 ± 17.9 □	13.9 ± 5.0	0.67 ± 0.25	43.7 ± 5.5
AN-SS-302	84.0 ± 26.1	10.2 ± 4.8	0.49 ± 0.24	45.8 ± 29.8
AN-SS-303	80.0 ± 14.1	10.8 ± 3.2	0.52 ± 0.16	43.2 ± 14.7
AN-SS-304	80.0 ± 28.3	11.1 ± 3.8	0.53 ± 0.19	44.0 ± 24.0
AN-SS-305	96.0 ± 8.9	12.4 ± 1.8	0.60 ± 0.09	59.6 ± 10.0
AN-SS-306	96.0 ± 8.9	12.4 ± 2.1	0.60 ± 0.11	59.0 ± 8.0

[1] n=5 replicates; 5 worms seeded per replicate.

□ Indicates significant difference when compared to reference sediment CR-10.

4.0
48-h *Mytilus galloprovincialis* LARVAL DEVELOPMENT TOXICITY TEST

4.1 METHODS

The 48-h static toxicity test using larvae of the mussel *Mytilus galloprovincialis* was conducted according to EVS SOP 1057-2 (EVS, 1995b) which is based on PSEP (1995). Tests were conducted at 16 ± 1 °C in a constant environment room equipped with a max-min thermometer to record temperature fluctuations. A 14:10 h light:dark photoperiod was maintained during the 48-h exposure. Clean seawater used for testing was obtained from Burrard Inlet, BC at a depth of 12 m, passed through a sand filter, a 0.5 μm filter and an ultraviolet sterilizer, aerated vigorously and used within 24 h of collection. Mussels were obtained from a supplier in California and used the day they arrived. The tests were conducted in clean 1-L glass jars containing 18 g of test sediment overlain by 900 mL of seawater. The contents in each container were stirred for ten seconds and then allowed to settle for 4 h prior to adding the larvae. A seawater control was tested concurrently with the sample sediments.

Six replicates were prepared for the control seawater and for the test sediments. One replicate was designated for daily measurements of water quality parameters (pH, dissolved oxygen, salinity and temperature). Extra "zero-time" seawater controls were used to confirm embryo inoculation density and to monitor larval development without disturbing the actual negative controls.

Spawning of mussels was induced by thermal stimulation. Mussels were placed in a water bath filled with UV-sterilized, filtered seawater. The temperature was increased to approximately 23 °C over a 40-min period. Fertilization was accomplished by combining the eggs from several females and 10 - 15 mL of sperm from several male mussels in a 2-L beaker. The fertilized eggs were washed through a 250-μm Nitex screen to remove excess gonadal material, and suspended in filtered seawater at test temperature. The embryos were kept in suspension by aeration and gentle agitation with a perforated plunger. Embryo density was determined by making triplicate counts of the number of embryos in 1.0-mL samples of a 1:99 dilution of homogeneous embryo suspension.

Within 2 h of fertilization, each container was inoculated with approximately 20,000 to 40,000 developing embryos using an automatic pipette. The number of embryos introduced was confirmed by removing 10-mL subsamples from the five "zero-time" controls immediately after inoculation, preserving them in formalin and counting the number of embryos under a microscope.

After 48 h, the overlying water from each replicate was poured off, collected, and then mixed to re-suspend the larvae. A 10-mL subsample of larvae was quantitatively transferred to a test tube using an automatic pipette, and preserved in 50% buffered formalin. Another subsample was also collected as a back-up to confirm results if needed. The preserved samples were later examined in Sedgewick-Rafter counting chambers under 40X magnification. Samples collected from the "zero-time" controls on Day 0 were counted to confirm the number of embryos introduced. Salinity, dissolved oxygen, temperature and pH were measured in each container at the termination of the larval toxicity test.

Adverse effects on development were determined on the basis of normal shell development to the 48-h prodissoconch I stage. Normal and abnormal prodissoconch I larvae were recorded in each replicate to determine percent normality. Larvae which failed to transform to the fully shelled, straight hinged "D" shaped prodissoconch I stage were considered abnormal. Normal and abnormal prodissoconch I larvae were enumerated for each replicate, and mean percent normal larvae was calculated using the following equation:

$$Mean\ Normal\ Larvae\ (\%) = \frac{mean\ no.\ normal\ larvae}{mean\ no.\ of\ total\ larvae} \times 100$$

Mean survival was calculated using the following equation:

$$Mean\ Survival\ (\%) = \frac{mean\ no.\ of\ total\ larvae}{no.\ of\ embryos\ introduced} \times 100$$

Mean survival/normal larvae was calculated using the following equation:

$$Mean\ Survival/Normal\ Larvae\ (\%) = \frac{mean\ no.\ of\ normal\ larvae}{no.\ of\ embryos\ introduced} \times 100$$

The survival/normal larvae endpoint uses data from both endpoints to determine the percentage of larvae which survive ***and*** develop normally. Percent normal larvae, survival and survival/normal larvae data were analyzed using the TOXCALC computer program (Tidepool Scientific Software, 1994). The responses in the test sediments were compared to the negative control and reference sediments (CR-10, CR-22 and CR-23W). Survival, normal and survival/normal data were first transformed using an arcsine square root transformation and then tested for normality (Shapiro-Wilks' Test) and homogeneity of variance (Bartlett's Test). Homoscedastic *t*-tests or the non-parametric heteroscedastic *t*-tests were then performed to determine if any of the test sediments were significantly different ($p \leq 0.05$) from the negative control and reference sediments (CR-10, CR-22 and CR-23W). For the test to be considered valid, mean control performance must be ≥70% mean survival/normal larvae (PSEP, 1995).

To assess the relative sensitivity of the test organisms a separate positive (toxic) control test was conducted, using sodium dodecyl sulphate (SDS) in a 48-h reference toxicant test. This was set up in the same manner as the test except that it was conducted without sediment. A series of five test concentrations (1.0, 1.8, 3.2, 5.6 and 10.0 mg/L SDS), with three replicates each, was prepared from a 1,000 mg/L SDS stock solution. This test was used to assess the relative health and sensitivity of the larvae by comparing the results to ranges (mean ± 2SD) obtained by this laboratory in previous testing.

4.2 RESULTS

The results of the bivalve larvae toxicity test are summarized in Table 4-1. Complete results including raw data and statistical printouts, are provided in Appendix D.

The initial density of embryos introduced into each test container was determined to be 285 embryos/10 mL. Mean percent survival/normal larvae in the seawater control was 91.8% and ranged between 68.6 and 70.0% in the reference sediments. In the test sediments, mean percent survival/normal larvae ranged from 58.5 and 73.2%. Mean percent normal larvae ranged from 92.9 to 97.4% in the reference sediments and was 94.1% in the seawater control. In the test sediments, mean percent normal larvae ranged from 84.6 and 96.9%. Mean percent survival ranged from 70.4 to 75.5% in the reference sediments and was 96.8% in the seawater control. In the test sediments, mean percent survival ranged from 69.0 and 76.8%.

Homoscedastic t-tests indicated significant differences ($p \leq 0.05$) with respect to all three endpoints when the samples were compared to the negative control. Homoscedastic t-tests indicated significant differences ($p \leq 0.05$) in normality and the normal/survival endpoint when the samples were compared to all three reference sediments.

4.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Mean percent survival/normal larvae in the seawater control met the criterion for test acceptability (PSEP, 1995).

Water quality parameters measured during the test were within the following acceptable ranges: temperature, 15.0 - 17.0°C; pH, 7.7 - 8.0; dissolved oxygen, 4.4 - 8.0 mg/L; salinity, 29 - 31 ppt; overlying ammonia, <0.02 - 0.37 mg/L S; and overlying sulfides, <0.02 - 0.10 mg/L N.

The 48-h EC50 value for the sodium dodecyl sulphate (SDS) reference toxicant (initiated concurrently November 25, 1998) was 3.3 mg/L SDS (95% confidence limits: 3.2 and 3.4 mg/L SDS). This value was within the laboratory range of 3.7 ± 1.6 mg/L SDS (mean ±

2SD). Water quality parameters measured in the reference toxicant test were within the following ranges: temperature, 15.0 - 16.0°C; pH, 7.5 - 8.1; dissolved oxygen, 2.0 - 8.1 mg/L; and salinity, 28 - 31 ppt.

Table 4-1. Summary of results of the 48-h *M. galloprovincialis* larval development toxicity test.

SAMPLE ID	% NORMAL (MEAN ± SD)	% SURVIVAL (MEAN ± SD)	%SURVIVAL/NORMAL (MEAN ± SD)
Negative control	94.1 ± 1.1	96.8 ± 3.6	91.8 ± 5.0
CR-10	92.9 ± 4.0	75.5 ± 8.9*	70.0 ± 7.5*
CR-22	97.4 ± 2.0	70.4 ± 6.1*	68.6 ± 5.7*
CR-23W	95.9 ± 0.8	71.6 ± 3.6*	68.7 ± 3.6*
AN-SS-301	95.3 ± 0.7+^{O}	76.8 ± 3.4*	73.2 ± 3.4*
AN-SS-302	95.7± 1.3	71.9 ± 3.7*	68.8 ± 3.9*
AN-SS-303	96.9 ± 1.1	73.1 ± 3.9*	70.8 ± 3.4*
AN-SS-304	84.6 ± 3.0*$^{\Delta O\square}$	69.0 ± 2.6*	58.5 ± 3.4*$^{\Delta O\square}$
AN-SS-305	94.1 ± 1.1 $^{\Delta O}$	72.6 ± 3.5*	68.4 ± 2.9*
AN-SS-306	89.5 ± 3.1*$^{\Delta O}$	71.6 ± 2.4*	64.1 ± 3.4*$^{\Delta}$

n= 5 replicates.

* Indicates significant difference ($p \leq 0.05$) when compared to the negative control.

□ Indicates significant difference ($p \leq 0.05$) when compared to reference sediment CR-10.

O Indicates significant difference ($p \leq 0.05$) when compared to reference sediment CR-22.

Δ Indicates significant difference ($p \leq 0.05$) when compared to reference sediment CR-23W.

5.0
REFERENCES

ASTM (American Society for Testing and Materials). 1997. Standard guide for conducting sediment toxicity tests with marine and estuarine polychaetous annelids. Method 1611-94. In: 1997 Annual Book of ASTM Standards, Water and Environmental Technology, Volume 11.05. American Society for Testing and Materials, Philadelphia, PA.

EVS (EVS Environment Consultants). 1998. *Eohaustorius estuarius* 10-d amphipod toxicity test. EVS SOP 1077-2. In: EVS Consultants Laboratory Standard Operating Procedures (SOPs) Manual. Volume III: Sediment. EVS Environment Consultants, North Vancouver, BC.

EVS. 1995a. *Neanthes* 20-d sediment toxicity test. EVS SOP 1078-1. In: EVS Consultants Laboratory Standard Operating Procedures (SOPs) Manual. Volume III: Sediment. EVS Environment Consultants, North Vancouver, BC.

EVS. 1995b. Bivalve larvae whole sediment toxicity test. EVS SOP 1057-2. In: EVS Consultants Laboratory Standard Operating Procedures (SOPs) Manual. Volume III: Sediment. EVS Environment Consultants, North Vancouver, BC.

PSDDA (Puget Sound Dredged Disposal Analysis). 1989. Management plan report (MPR) - Phase II. U.S. Army Corps of Engineers, Seattle District; U.S. Environmental Protection Agency, Region X; Seattle, WA. Washington State Department of Natural Resources; and Washington State Department of Ecology. September 1989.

PSEP (Puget Sound Estuary Program). 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, WA. July 1995. 85 pp.

Swartz, R.C., W.A. DeBen, J.K. Phillips, J.O. Lamberson and F.A. Cole. 1985. Phoxocephalid amphipod bioassay for marine sediment toxicity. R.D. Cardwell, R. Purdy and R.C. Bahner (eds). In: Aquatic Toxicology and Hazard Assessment: Proceedings of the Seventh Annual Symposium ASTM STP 854, American Society for Testing and Materials, Philadelphia, PA.

Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0. Tidepool Scientific Software, McKinleyville, CA. 80pp.

EVS CONSULTANTS

10-d MARINE AMPHIPOD SEDIMENT TOXICITY TEST - DAILY WATER QUALITY MONITORING

Client Anchor Environmental (Boulevard Park / Starr Rock)
EVS Project No. 91852-01.1
EVS Work Order No. 9800686

Test Initiation Date (Day 0) 06-NOV-98
Test Termination Date (Day 10) 16-NOV-98
Test Species E. estuarius
Source/Collection Date NAS / Oct. 29 - Nov. 1, 1998

Sample ID	Salinity (ppt)											Dissolved Oxygen (mg/L)										
	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
AN-SS-301	30	30	30	30	30	30	30	30	30	30	30	8.3	8.2	8.1	7.7	8.1	8.0	8.2	7.6	8.1	8.0	8.1
AN-SS-302	30	30	30	30	30	30	30	30	30	30	30	8.3	8.2	8.1	7.7	8.1	7.9	8.2	7.6	8.1	8.0	8.2
AN-SS-303	30	30	30	30	30	30	30	30	30	30	30	8.4	8.2	8.0	7.8	8.0	8.0	8.1	7.6	7.7	7.9	8.2
AN-SS-304	30	30	30	30	30	30 29	30 29	30	30	30	30	8.4	8.2	8.1	7.8	8.2	7.9	8.1	7.6	8.0	7.8	7.8
AN-SS-305	30	30	30	30	30	30	30	30	30	30	30	8.3	8.2	8.1	7.7	8.1	8.0	8.2	7.6	7.7	7.9	8.2
AN-SS-306	30	30	30	30	30	30	30	30	30	30	30	8.3	8.2	8.1	7.6	8.1	8.1	8.1	7.7	8.1	8.0	8.2
Technician's Initials	BGM CNB	JKM	CNB	BGM CNB	BGM	CNB	BGM CNB	BGM CNB	BGM	BGM	BGM	BGM CNB	JKM	CNB	BGM CNB	BGM CNB	CNB	BGM CNB	BGM CNB	BGM	BGM	CNB JKM

WQ Instruments Used: Salinity II-C-22 DO II-A-19
Comments

Test Set Up By PAH / JKM / CNB / BGM Data Verified By [signature] Date Verified Dec 3, 1998

EVS CONSULTANTS
10-d MARINE AMPHIPOD SEDIMENT TOXICITY TEST - DAILY WATER QUALITY MONITORING

Client ~~Battelle~~ Marine Environmental (Boulevard Storm)
EVS Project No. 91852-01.1
EVS Work Order No. 98006086

Test Initiation Date (Day 0) 06-NOV-98
Test Termination Date (Day 10) 16-NOV-98
Test Species E. estuarius
Source/Collection Date NAS / Oct. 29 - Nov. 1, 1998

Sample ID	Temperature (°C)											pH										
	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
CR-10	15	15	15	15	15	15	15	15	15	15	15	7.8	7.9	8.0	8.0	8.2	8.2	8.1	8.1	7.9	8.0	8.1
CR-22	15	15	15	15	15	15	15	15	15	15	15	7.8	8.1	8.1	8.1	8.3	8.1	8.2	8.3	8.1	8.0	8.2
CR-23W	15	15	15	15	15	15	15	15	15	15	15	7.8	8.0	8.0	8.1	8.2	8.2	8.1	8.2	8.0	8.0	8.1
Negative Control	15	15	15	15	15	15	15	15	15	15	15	7.9	8.1	8.1	8.1	8.3	8.2	8.1	8.2	8.0	8.0	8.0
Technician's Initials	BKM CMB	JRM	GP	BKM CMB	BKM CMB	GP	BKM	CMB CMB	BM	DD	DOH	BKM CMB	JRM	GP	BKM CMB	BKM CMB	GP	BKM CMB	BKM CMB	BM	DD	DOH

WQ Instruments Used: Temp. Cal. Hg Therm. pH II-A-26
Comments

Test Set Up By PAH / JRM / CNB / BGM Data Verified By Julie Orlan Date Verified NOV 24/98

EVS CONSULTANTS

10-d MARINE AMPHIPOD SEDIMENT TOXICITY TEST - DAILY WATER QUALITY MONITORING

Client (Boulevard Park / Starr Rock)
EVS Project No. 91852-01.1
EVS Work Order No. 98001686

Test Initiation Date (Day 0) 06-Nov-98
Test Termination Date (Day 10) 16-Nov-98
Test Species E. estuarius
Source/Collection Date NAS | Oct. 29 - Nov. 1, 1998

Sample ID	Temperature (°C)											pH										
	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
AN-SS-301	15	15	15	15	15	15	15	15	15	15	15	7.8	8.0	8.1	8.0	8.2	8.1	8.1	8.3	8.4	8.2	8.4
AN-SS-302	15	15	15	15	15	15	15	15	15	15	15	7.8	8.0	8.1	8.0	8.2	8.2	8.1	8.1	8.0	8.1	8.1
AN-SS-303	15	15	15	15	15	15	15	15	15	15	15	7.8	8.0	8.0	8.1	8.3	8.2	8.1	8.2	7.9	7.8	8.2
AN-SS-304	15	15	15	15	15	15	15	15	15	15	15	7.9	8.1	8.1	8.1	8.3	8.2	8.1	8.3	8.3	8.2	8.6 (1)
AN-SS-305	15	15	15	15	15	15	15	15	15	15	15	7.9	8.0	8.0	8.1	8.3	8.2	8.1	8.1	7.9	8.1	8.1
AN-SS-306	15	15	15	15	15	15	15	15	15	15	15	7.7	8.0	8.1	8.1	8.2	8.1	8.1	8.2	8.0	8.0	8.1
Technician's Initials	JRM/CNB	JRM	RP	JRM/CNB	JRM/CNB	RP	BJM	JRM/CNB	JRM/CNB	SD	RJM	JRM/CNB	JRM	RP	JRM/CNB	JRM/CNB	RP	JRM/CNB	JRM/CNB	BJ	SD	RJM

WQ Instruments Used: Temp. Cal. Hg Therm. pH II-A-2C
Comments Dilution double checked.

Test Set Up By RAH | JRM | CNB | BJM
Data Verified By Julie Oban
Date Verified NOV 24 98

EVS CONSULTANTS
SEDIMENT DESCRIPTION AND CHARACTERIZATION

Client: Anchor Environmental (Boulevard Park)
EVS Project No.: 9/852-01.1
EVS Work Order No.: 9800686; 9800687

Test Species: E. estuarius
Test Type/Duration: 10 d marine sediment
Day 0: Various

Sample ID	Colour	Grain Size	Smell	Shells/ Debris	Other Observations	Tech. Initial
AN-SS-301	grey/black	silt/sand	none	twigs		BGM
AN-SS-302	dark brown	silt	none	none		ALG
AN-SS-303	Dark Brown	Silt	None	twigs.		ALG
AN-SS-304	grey	Sand	sulphides	shells		BGM
AN-SS-305	Brown/Black	Sand/Silt	None	small wood chunks		CLB
AN-SS-306	Black	Sand/Silt	None	None		BGM

Be descriptive when you characterize the sediments. Colour and grain size information must be complete. If the sediment has an odour, describe the type of smell. Note any shells or debris that are present. Be sure to record anything else in the Observations section.

Data Verified By: G. Lauren Date Verified: Dec 3, 1998

EVS CONSULTANTS
SEDIMENT DESCRIPTION AND CHARACTERIZATION

Client Anchor Environmental (Boulevard Park)
EVS Project No. 9/852-01.1
EVS Work Order No. 9800666; 9800687

Test Species E. estuarius
Test Type/Duration 10 d marine sediment
Day 0 Valois

Sample ID	Colour	Grain Size	Smell	Shells/ Debris	Other Observations	Tech. Initial
CR10	brown	sand/silt	slight hydrocarbons	none		Bym
CR22	brown	Sand	—	none		Jm
CR23W	black/brown	sand/silt	slight hydrocarbons	none		Bym

Be descriptive when you characterize the sediments. Colour and grain size information must be complete. If the sediment has an odour, describe the type of smell. Note any shells or debris that are present. Be sure to record anything else in the Observations section.

Data Verified By C Lawrence Date Verified Dec 3, 1998

EVS CONSULTANTS
MARINE AMPHIPOD TOXICITY TEST DATA SUMMARY

Client ANCHOR ENVIRONMENTAL (BOULEVARD/STARR) EVS Analysts BWY, CNB, BGM, PAH, SFM, GSY, SUS

EVS Project No. 9/852-01.1

Test Type 10 d marine sediment

EVS Work Order No. 9800686.

Test Initiation Date (Day 0) 06 Nov 98

SAMPLE

Identification Various

Amount Received 7-10 x 1L

Date Collected 26-29 Oct 98

Date Received 28-30 Oct 98.

TEST SPECIES INFORMATION

Organism E. estuarius

Source/Collection Date ~~3-5 mm~~ NAS / 29 Oct-C

Amplipod Size (Day 0) BGM ~~Est~~ 3-5 mm

Reference Toxicant cadmium.

Current Reference Toxicant Result 10.8 mg/L Cd

(96-h LC50 and 95% CL) 95% CL: 8.4 and 13.8 m

Reference Toxicant Warning Limits (mean ± 2SD)

8.0 ± 6.9

TEST CONDITIONS

Temperature Range (°C) 15

pH Range 7.7 - 8.6

Dissolved Oxygen Range (mg/L) 7.6 - 8.4

Salinity Range (ppt) 29 - 30

Photoperiod (L:D h) 24:0

Ammonia Type and Ranges (mg/L N)

☐ Inter: Day 0 ~~2.67~~ PAH ~~7.44~~ 0.16 - 10.2 Day 5 ~~2.28 - 5.39~~ BGM 0.16 - 11.5 Day 10 ~~0.62~~ BGM ~~10~~ 0.09 - 10.6

☐ Over: Day 0 — Day 5 — Day 10 —

Sulphide Type and Ranges (mg/L S)

☐ Inter: Day 0 — Day 5 — Day 10 —

☐ Over: Day 0 <0.02 - 0.03 Day 5 — Day 10 <0.02

BULK (W): N = 1.86 - 23.2 mg/L; S = <0.05 - 1.0 mg/L

DILUTION AND CONTROL MEDIUM

Water Type UV sterilized filtered seawater

Temperature (°C) 15

pH 7.9

Dissolved Oxygen (mg/L) 8.5

Salinity (ppt) 30

Other

Sample ID	Survival (%) Mean ± SD	Avoidance (Amphipods/jar/day) Mean ± SD	Reburial (%)
AN-SS-301 x ⊖ Δ ⊖	BGM ~~0~~ 83.0 ± 6.7	0.06 ± 0.05	100
AN-SS-302 x Δ ⊖	77.0 ± 14.8	0.08 ± 0.08	100
AN-SS-303 x Δ ⊖	85.0 ± 11.2	0.16 ± 0.13	99
AN-SS-304	97.0 ± 4.5	0.06 ± 0.09	100
AN-SS-305 x Δ ⊖	91.0 ± 4.2	0.10 ± 0.12	100
AN-SS-306 x Δ ⊖	76.0 ± 22.2	0.38 ± 0.28	99
control	98.0 ± 2.7	0.14 ± 0.13	100
CR-10 x Δ ⊖	91.0 ± 4.2	0.02 ± 0.04	99
CR-22	97.0 ± 4.4	0.02 ± 0.04	100
CR-23W	96.0 ± 2.2	0.08 ± 0.18	99

x significant difference when compared to control ○ significant difference when compared to CR-10
Δ significant difference when compared to CR-22
⊖ significant difference when compared to CR-23W

Data Verified By

Date Verified G. Lawrence

Form\Lab\Datasheets\Sediment\Marine\Amphipod\SUMMARY.WPD May 27, 1998

Note: Significant difference applies to survival. Dec 8, 1998

APPENDIX B

Raw Data for the 10-d *Eohaustorius estuarius* Sediment Toxicity Tests

CHAIN-OF-CUSTODY/TEST REQUEST FORM

Project/Client Name: STARR ROCK / EVS
EVS Project Number: 98-007-03 (ANCHOR #)
Contact Name: JULIE VIVEIROS
Sampled By: KIM MAGRUDER

Ship to: EVS 195 PEMBERTON AVE, N. VANCOUVER, B.C., V7P 2R4
Attn: JENNIFER STEWART
Shipper: BOOMER CARGO
Form filled out by: KIM MAGRUDER

Shipping Date: 10/27/98
Airbill Number: B21045

Sample Collection Date (m/d/y)	Time	Sample Identification	Volume of Sample / # of Containers	Matrix	Test(s) Requested (check test(s) required)							Comments / Instructions [Jar tag number(s)]
					LARVAL	POLYCHAETE	AMPHIPOD					
10/26/98	1740	~~ASSK~~ AN-SS-301	3208/7	SEDIMENT	1	2	4					TAG # 5058, 5059, 5060, 5061, 5062 5063, 5064
		Total Number of Containers	7		Purchase Order / Statement of Work #							

1) Released by:	1) Rec'd by:	2) Released by:	1) Rec'd by:
Print name: Juliana Viveiros		Print name:	
Signature: Juliana Viveiros		Signature:	
Company: EVS	Company:	Company:	Company:
Date/Time: 10-27-98 16:25	Date/Time:	Date/Time:	Date/Time:

* Distribution: White and yellow copies accompany shipment; pink-consignor's copy; white-consignee return with results; yellow-consignee's copy.

* Instructions for completion of Chain-of-Custody/Test Request Form on back.

EVS ENVIRONMENT CONSULTANTS

- 195 Pemberton Avenue, North Vancouver, B.C., Canada, V7P 2R4, Tel: (604) 986-4331, Fax: (604) 662-8548
- 200 West Mercer Street, Suite 403, Seattle, WA 98119, Tel: (206) 217-9337, Fax: (206) 217-9343

To be completed by Laboratory upon sample receipt:

Date of receipt: 10/28/98
Condition upon receipt:
Cooler temperature: 7°C

Laboratory W.O. #: 9800686-689
Time of receipt: 0950
Received by: AW

4 of 10

CHAIN-OF-CUSTODY/TEST REQUEST FORM

J04

Project/Client Name: STARR ROCK / EVS
EVS Project Number: 98-007-03 (ANCHOR #)
Contact Name: JULIE VIVEIROS
Sampled By: JULIE VIVEIROS, STEFAN WODZICKI, KIM MAGRUDER, KATHERINE LARM

Ship to: EVS 195 PEMBERTON AVE, N. VANCOUVER, B.C V7P 2R4
Attn: JENNIFER STEWART
Shipper: BORDER CARGO
Form filled out by: K. MAGRUDER

Shipping Date: 10/27/98
Airbill Number: B21045

Sample Collection Date (m/d/y)	Time	Sample Identification	Volume of Sample / # of Containers	Matrix	Test(s) Requested (check test(s) required)							Comments / Instructions [Jar tag number(s)]
					LARVAL	POLYCHAETE	AMPHIPOD					
~~10/24/98~~ 10/24/98	1711	AN-SS-302	3203 / 7	SED	1	2	4					TAG # 5047, 5048, 5049, 5050, 5051, 5052, 5053
Total Number of Containers			7	Purchase Order / Statement of Work #								

1) Released by:	1) Rec'd by:	2) Released by:	1) Rec'd by:
Print name: Juliana Viveiros		Print name:	
Signature: Juliana Viveiros		Signature:	
Company: EVS	Company:	Company:	Company:
Date/Time: 10-27-98 16:25	Date/Time:	Date/Time:	Date/Time:

* Distribution: White and yellow copies accompany shipment; pink-consignor's copy; white-consignee return with results; yellow-consignee's copy.

* Instructions for completion of Chain-of-Custody/Test Request Form on back.

EVS ENVIRONMENT CONSULTANTS

- 195 Pemberton Avenue, North Vancouver, B.C., Canada, V7P 2R4, Tel: (604) 986-4331, Fax: (604) 662-8548
- 200 West Mercer Street, Suite 403, Seattle, WA 98119, Tel: (206) 217-9337, Fax: (206) 9343

To be completed by Laboratory upon sample receipt:

Date of receipt: Oct 28/98	Laboratory W.O. #: 9800686-689
Condition upon receipt:	Time of receipt: 0950
Cooler temperature: 7°C	Received by: ajt

3 of 10

CHAIN-OF-CUSTODY/TEST REQUEST FORM

Project/Client Name: STARR ROCK /EVS
EVS Project Number: 98-007-03 (ANCHOR #)
Contact Name: JULIE VIVEIROS
Sampled By: JULIE VIVEIROS, STEFAN WODZICKI, KIM MAGRUDER, KATHERINE LARM

Ship to: EVS 195 PEMBERTON AVE., N. VANCOUVER BC V7P 2R4
Attn: JENNIFER STEWART
Shipper: BORDER CARGO
Form filled out by: KIM MAGRUDER

Shipping Date: 10/27/98
Airbill Number: B21045

Sample Collection Date (m/d/y)	Time	Sample Identification	Volume of Sample / # of Containers	Matrix	Test(s) Requested (check test(s) required) LARVAL	POLYCHAETE	AMPHIPOD					Comments / Instructions [Jar tag number(s)]
												Tag #
10/26/98	1550	AN-SS-303	3208/7	SED	1	2	4					5036, 5037, 5038, 5039, 5040 5041, 5042
Total Number of Containers			7	Purchase Order / Statement of Work #								

1) Released by:	1) Rec'd by:	2) Released by:	1) Rec'd by:
Print name: Juliana Viveiros		Print name:	
Signature: Juliana Viveiros	Company:	Signature:	Company:
Company: EVS		Company:	
Date/Time: 10-27-98 16:25	Date/Time:	Date/Time:	Date/Time:

* Distribution: White and yellow copies accompany shipment; pink-consignor's copy; white-consignee return with results; yellow-consignee's copy.
* Instructions for completion of Chain-of-Custody/Test Request Form on back.

EVS ENVIRONMENT CONSULTANTS

- 195 Pemberton Avenue, North Vancouver, B.C., Canada, V7P 2R4, Tel: (604) 986-4331, Fax: (604) 662-8548
- 200 West Mercer Street, Suite 403, Seattle, WA 98119, Tel: (206) 217-9337, Fax: (206) 217-9343

To be completed by Laboratory upon sample receipt:

Date of receipt: 28 Oct 98	Laboratory W.O. #: 9800686-689
Condition upon receipt: 9°C	Time of receipt: 0950
Cooler temperature:	Received by: (AH)

CHAIN-OF-CUSTODY/TEST REQUEST FORM

u02

Project/Client Name: ~~WWADDENDUM#3~~ STAR ROCK / EVS

EVS Project Number: 98-007-03 (ANCHOR #)

Contact Name: JULIE VIVEIROS

Sampled By: KIM MADRUDER, JULIE VIVEIROS STEFAN WODZICKI KATHERINE LARM

Ship to: EVS LABORATORY 195 PEMBERTON AVE, N. VANCOUVER, BC V7P 2R4

Attn: JENNIFER STEWART

Shipping Date: 10/27/98

Shipper: BORDER CARGO

Airbill Number: B21045

Form filled out by: KIM MADRUDER

Sample Collection Date (m/d/y)	Time	Sample Identification	Volume of Sample / # of Containers	Matrix	Test(s) Requested (check test(s) required) LARVAL	BODY/CHAETE	AMPHIPOD					Comments / Instructions [Jar tag number(s)] TAG #S
10/26/98	11:47	AN-SS-305	3208 / 4	SED		2	2					5014, 5015, 5017, 5019
10/26/98	15:08	AN-SS-306	3208 / 7	SED	1	2	4					5024, 5025, 5026, 5027, 5028, 5029, 5030
Total Number of Containers			11	Purchase Order / Statement of Work #								

1) Released by:	1) Rec'd by:	2) Released by:	1) Rec'd by:
Print name: Juliana Viveiros		Print name:	
Signature: Juliana Viveiros		Signature:	
Company: EVS	Company:	Company:	Company:
Date/Time: 10-27-98 16:25	Date/Time:	Date/Time:	Date/Time:

* Distribution: White and yellow copies accompany shipment; pink-consignor's copy; white-consignee return with results; yellow-consignee's copy.

* Instructions for completion of Chain-of-Custody/Test Request Form on back.

EVS ENVIRONMENT CONSULTANTS

- 195 Pemberton Avenue, North Vancouver, B.C., Canada, V7P 2R4, Tel: (604) 986-4331, Fax: (604) 662-8548
- 200 West Mercer Street, Suite 403, Seattle, WA 98119, Tel: (206) 217-9337, Fax: (206) 9343

To be completed by Laboratory upon sample receipt:

Date of receipt: Oct 28/98	Laboratory W.O. #: 9800686-689
Condition upon receipt:	Time of receipt: 0950
Cooler temperature: 9°C	Received by: BV

CHAIN-OF-CUSTODY/TEST REQUEST FORM

001

Project/Client name: STARR ROCK / EVS
EVS Project Number: 98-007-03 (ANCHOR PROJECT #)
Contact Name: JULIE VIVEIROS
Sampled By: KIM MAGRUDER, JULIE VIVEIROS, STEFAN WODZICKI, KATHERINE DARM

Ship to: EVS LABORATORY, 195 PEMBERTON AVE, N. VANCOUVER, BC V7P 2R4
Attn: JENNIFER STEWART
Shipper: BORDER CARGO
Form filled out by: KIM MAGRUDER
Shipping Date: 10/27/98
Airbill Number: B21045

Sample Collection Date (m/d/y)	Time	Sample Identification	Volume of Sample / # of Containers	Matrix	Test(s) Requested: LARVAL BIOASSAY	AMPHIPOD BIOASSAY	POLYCHAETE BIOASSAY					Comments / Instructions [Jar tag number(s)] TAG #
10-26-98	10:32	AN-SS-304	32-oz / 7	SEDIMENT	1	4	2					5001, 5002, 5003, 5004, 5005, 5006, 5007
" "	11:47	AN-SS-305	32-oz / 3	"	1	2	2					5012, 5016, 5018
		Total Number of Containers	10	Purchase Order / Statement of Work #								

1) Released by:	1) Rec'd by:	2) Released by:	1) Rec'd by:
Print name: Juliana Viveiros		Print name:	
Signature: Juliana Viveiros		Signature:	
Company: EVS	Company:	Company:	Company:
Date/Time: 10-27-98 16:25	Date/Time:	Date/Time:	Date/Time:

* Distribution: White and yellow copies accompany shipment; pink-consignor's copy; white-consignee return with results; yellow-consignee's copy.

* Instructions for completion of Chain-of-Custody/Test Request Form on back.

To be completed by Laboratory upon sample receipt:

Date of receipt: Oct 28/98
Condition upon receipt:
Cooler temperature: 4°C
Laboratory W.O. #: 9800686-689
Time of receipt: 0950
Received by: [signature]

EVS ENVIRONMENT CONSULTANTS
195 Pemberton Avenue, North Vancouver, B.C., Canada, V7P 2R4, Tel: (604) 986-4331, Fax: (604) 662-8548
200 West Mercer Street, Suite 403, Seattle, WA 98119, Tel: (206) 217-9337, Fax: (206) 217-9343

1 of 1

CHAIN-OF-CUSTODY/TEST REQUEST FORM

041

Project/Client Name: Anchor Environmental
EVS Project Number:
Contact Name: Kim Magruder / Dan Hennessy (ESI)
Sampled By: Charlie Eaton

Ship to: EVS N-Vancouver Lab
Attn: Jennifer Stewart
Shipper: Border Cargo
Form filled out by: Dan Hennessy

Shipping Date: 10/30/98
Airbill Number: N/A

Sample Collection Date (m/d/y)	Time	Sample Identification	Volume of Sample / # of Containers	Matrix	Test(s) Requested (check test(s) required) 10-day	20-day	PAH					Comments / Instructions [Jar tag number(s)]
10/29/98	1102	CR-10	33 64oz/10	Sediment	X	X	X					10x1L
10/29/98	1243	CR-22	32 64oz/9	Sediment	X	X	X					9x1L
10/29/98	1426	CR23W	33 64oz/9* JMB	Sediment	X	X	X			9x1L		*This jars only labeled on lid with sample ID, sample ID left blank on labels
Total Number of Containers			3	Purchase Order / Statement of Work #								

1) Released by:	1) Rec'd by:	2) Released by:	1) Rec'd by:
Print name: Daniel P. Hennessy	Company:	Print name:	Company:
Signature:	Date/Time:	Signature:	Date/Time:
Company: ESI		Company:	
Date/Time: 10/30/98 0835		Date/Time:	

* Distribution: White and yellow copies accompany shipment; pink-consignor's copy; white-consignee return with results; yellow-consignee's copy.
* Instructions for completion of Chain-of-Custody/Test Request Form on back.

Samples arrived w/ ice

EVS ENVIRONMENT CONSULTANTS

- 195 Pemberton Avenue, North Vancouver, B.C., Canada, V7P 2R4, Tel: (604) 986-4331, Fax: (604) 662-8548
- 200 West Mercer Street, Suite 403, Seattle, WA 98119, Tel: (206) 217-9337, Fax: (206) 217-9343

To be completed by Laboratory upon sample receipt:

Date of receipt: 30 oct 98	Laboratory W.O. #: 9810686-689
Condition upon receipt: Good	Time of receipt: 1746
Cooler temperature: 5°C	Received by:

APPENDIX A

Chain Of Custody Forms

EVS CONSULTANTS

10-d MARINE AMPHIPOD SEDIMENT TOXICITY TEST - DAILY WATER QUALITY MONITORING

Client ~~Pan~~ Anchor Environmental (Boulevard Steel)
EVS Project No. 91852-01.1
EVS Work Order No. 98006806

Test Initiation Date (Day 0) 06-NOV-98
Test Termination Date (Day 10) 16-NOV-98
Test Species E. estuarius
Source/Collection Date NAS. 1 Oct. 29 - Nov. 1, 1998

Sample ID	Salinity (ppt)											Dissolved Oxygen (mg/L)										
	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
CR-10	30	30	30	30	30	30	30	30	30	30	30	8.4	8.2	8.0	7.7	8.1	8.0	8.2	7.6	8.2	8.1	8.1
CR-22	30	30	30	30	30	30	30	30	30	30	30	8.5	8.2	8.1	7.7	8.1	7.9	8.2	7.7	8.2	8.0	8.2
CR-230	30	30	30	30	30	30	30	30	30	30	30	8.3	8.2	8.1	7.8	8.1	8.0	8.2	7.7	8.1	8.1	8.1
Negative control	30	29	29	30	30	30	30	30	30	30	30	8.5	8.3	8.2	7.9	8.2	8.1	8.2	7.7	8.2	7.9	8.2
Technician's Initials	BKM CWB	JKM	QP	BKM CWB	BKM CWB	QP	BKM	CWB	BKM	JKS	POH	BKM CWB	JKM	QP	BKM CWB	BKM CWB	QP	BKM CWB	BKM CWB	BKM	JKS	DAH

WQ Instruments Used: Salinity II-C-22 DO II-A-19
Comments

Test Set Up By PAH/JKM/CNB/BKM Data Verified By [signature] Date Verified Dec 3, 1998

EVS CONSULTANTS - AMPHIPOD SEDIMENT TOXICITY TESTS
EMERGENCE, SURVIVAL AND DAY 10 WATER QUALITY

Client: (Boulevard Park (Starr Rock) for Anchor Environmental) PAH

EVS Project No. 91852-01.1

EVS Work Order No. 9800686

Test Initiation Date (Day 0) 06-NOV-98

Test Termination Date (Day 10) 16-NOV-98

Test Species E. estuarius

Source/Collection Date NAS/ Oct 29 - Nov 1, 1998

SAMPLE ID AN-SS-304

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	0	0	0	20	0	15	8.4	30	7.4
B	0	0	0	0	0	0	0	0	0	0	20	0	15	8.4	30	7.4
C	0	0	0	0	0	0	0	0	0	0	20	0	15	8.4	30	7.7
D	0	0	0	0	0	1	0	0	0	0	19	0	15	8.4	30	7.7
E	0	1	0	0	0	1	0	0	0	0	18	0	15	8.3	30	7.8
Tech'n	JRM	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB

(# dead:# missing) - A(0:0) B(0:0) C(0:0) D(0:1) E(0:2)

SAMPLE ID AN-SS-305

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	0	1	0	19	0	15	8.1	29	7.8
B	1	0	0	0	0	0	0	0	0	0	18	0	15	8.2	29	7.8
C	0	0	0	0	0	0	0	0	0	0	18	0	15	8.2	29	7.9
D	0	2①	0	0	0	0	0	0	0	0	19	0	15	8.2	29	7.9
E	0	0	0	0	0	0	0	0	0	0	17	0	15	8.2	29	7.9
Tech'n	JRM	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB

① jar contains a snail

(# dead:# missing) - A(0:1) B(0:2) C(0:2) D(0:1) E(0:3)

SAMPLE ID AN-SS-306

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	2	4	0	0	0	1	0	1	0	0	20	0	15	8.0	29	7.8
B	0	1	0	0	0	1	1	1	1	0	17	0	15	8.0	29	8.0
C	1	0	1	0	0	0	0	0	0	0	11①②	0	15	8.0	29	8.0
D	0	1	0	0	0	0	0	0	1	1	18①	1	15	8.0	29	8.0
E	0	0	0	0	0	0	0	0	0	1	10③	0	15	8.0	29	8.0
Tech'n	JRM	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	CAB	JRM	JRM	CAB	CAB	CAB	CAB

① mollusc present in jar (size ~ 3cm²) → removed w/ pabula. Eroded when waters - like substance upon removal of mollusc emergence in jar ② crab present ③ confirmed by GAU

(# dead:# missing) - A(0:0) B(0:3) C(0:9) D(1:1) E(0:10)

WQ Instruments Used: Temp. Cal. Hg Therm. pH II-A-26 Salinity II-C-22 DO II-A-19

Data Verified By [signature] Date Verified 11/24/98

EVS CONSULTANTS - AMPHIPOD SEDIMENT TOXICITY TESTS
EMERGENCE, SURVIVAL AND DAY 10 WATER QUALITY

Client (Anchor - Environmental Boulevard Park (Starr Rock))
EVS Project No. 91852-01.1
EVS Work Order No. 9800686

Test Initiation Date (Day 0) 06-NOV-98
Test Termination Date (Day 10) 16-NOV-98
Test Species E. estuarius
Source/Collection Date NAS/ Oct 29 - Nov 1, 1998

SAMPLE ID AN-SS-301

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	0	1	0	15 ①	0	15	8.2	29	7.4
B	0	0	0	0	0	0	0	0	1	0	16	0	15	8.1	29	7.4
C	0	0	0	0	0	0	0	0	0	0	18	0	15	8.2	29	7.6
D	0	0	0	0	0	0	0	0	1	0	18	0	15	8.1	29	7.6
E	0	0	0	0	0	0	0	0	0	0	16	0	15	8.1	29	7.6
Tech'n	JMM	JP	CMB	CMB	JP	CMB	CMB	PH	PH	CMB	CMB	CMB	CMB	CMB	CMB	CMB

① confirmed by PAH

(# dead:# missing) - A(0:5) B(0:4) C(0:2) D(0:2) E(0:4)

SAMPLE ID AN-SS-302

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	1	1	0	20	0	15	8.0	30	7.6
B	0	0	0	0	0	0	0	0	0	0	16	0	15	8.0	30	7.8
C	0	0	0	0	0	1	0	0	0	0	15 ①②	0	15	8.0	30	7.8
D	0	0	0	0	1	0	0	0	0	0	14 ①②	0	15	8.0	30	7.8
E	0	0	0	0	0	0	0	0	0	0	12 ①②	0	15	8.0	30	7.8
Tech'n	JMM	JP	CMB	CMB	JP	CMB	CMB	PH	PH	CMB	JP	JP	CMB	CMB	CMB	CMB

① confirmed by PAH ② jars contain several small crabs

(# dead:# missing) - A(0:0) B(1:3) C(0:5) D(0:6) E(1:7)

SAMPLE ID AN-SS-303

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	1	1	1	0	0	16	0	15	8.0	30	7.6
B	0	1	0	0	0	0	0	0	0	0	17	0	15	8.0	30	7.6
C	1	0	0	0	0	2	0	0	0	0	18	1	15	8.0	30	7.6
D	0	0	0	0	0	0	0	0	0	0	20	0	15	8.1	30	7.8
E	0	1	0	0	0	0	0	0	0	0	14 ①	0	15	8.0	30	8.0
Tech'n	JMM	JP	CMB	CMB	JP	CMB	CMB	PH	PH	CMB	CMB	JMM	CMB	CMB	CMB	CMB

① confirmed by ASH

(# dead:# missing) - A(0:4) B(0:3) C(0:2) D(0:0) E(0:6)

WQ Instruments Used: Temp. Cal. Hg Therm. pH II-A-26 Salinity II-C-22 DO II-A-19

Data Verified By JMM Date Verified NOV/24/98

EVS CONSULTANTS - AMPHIPOD SEDIMENT TOXICITY TESTS
EMERGENCE, SURVIVAL AND DAY 10 WATER QUALITY

Client Anchor Environmental (Boulevard/Stevens) PAH

EVS Project No. 91852-01.1

EVS Work Order No. 9800686

Test Initiation Date (Day 0) 06-NOV-98

Test Termination Date (Day 10) 16-NOV-98

Test Species E. estuarius

Source/Collection Date NAS/Oct. 29-Nov. 1, 1998

SAMPLE ID CR-10

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	0	0	0	19	0	15	8.0	30	8.1
B	0	0	0	0	0	0	0	0	0	0	19	0	15	8.0	30	7.9
C	0	0	0	0	0	0	0	0	0	0	18	0	15	8.0	30	8.1
D	0	0	0	0	0	1	0	0	0	0	17	0	15	8.0	30	8.1
E	0	0	0	0	0	0	0	0	0	0	18	1	15	8.0	30	8.1
Tech'n	JHM	PAH	MB/JHM	MB/JHM	JHM	PAH	MB	PAH	BM	BM	PAH	PAH	PAH	PAH	PAH	PAH	PAH

(# dead:# missing) - A(0:1) B(1:0) C(1:1) D(1:2) E(0:2)

SAMPLE ID CR-22

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	0	0	0	19 20	0	15	8.1	30	8.1
B	0	0	0	0	0	0	0	0	0	0	19	0	15	8.1 8.0	30	7.9 8.1
C	0	0	0	0	0	0	0	0	0	0	20	0	15	8.1	30	8.1
D	0	0	0	0	0	0	0	0	0	0	19 20	0	15	8.0	30 31	7.9
E	0	0	0	0	0	1	0	0	0	0	18 19	0	15	8.1	30	8.1
Tech'n	JHM	PAH	MB/JHM	MB/JHM	PAH	MB	MB	BM	BM	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH

(# dead:# missing) - A(0:0) B(1:0) C(0:0) D(0:0) E(0:1)

SAMPLE ID CR-23 W

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	4	0	0	0	0	19	0	15	8.1 8.0	30	8.1
B	0	0	0	0	0	0	0	0	0	0	19 20	0	15	8.0	30	7.9
C	0	0	0	0	0	0	0	0	0	0	20 19	1 PAH	15	8.1	30	8.1
D	0	0	0	0	0	0	0	0	0	0	19 20	0	15	8.1	30	8.1
E	0	0	0	0	0	0	0	0	0	0	19	0	15	8.1 8.0	30	8.1
Tech'n	JHM	PAH	MB/JHM	MB/JHM	JHM	PAH	MB	BM	BM	JHM	PAH	PAH	PAH	PAH	PAH	PAH	PAH

(# dead:# missing) - A(0:0) B(0:0) C(0:0) D(0:0) E(0:1)

WQ Instruments Used: Temp. Cal. Hg Therm. pH II-A-26 Salinity II-C-22 DO II-A-19

Data Verified By G. Lauren Date Verified Dec 3, 1998

EVS CONSULTANTS - AMPHIPOD SEDIMENT TOXICITY TESTS
EMERGENCE, SURVIVAL AND DAY 10 WATER QUALITY

Client Anchor Environmental (Boulevard Island)
EVS Project No. 91852-01.1
EVS Work Order No. 9800686

Test Initiation Date (Day 0) 06-NOV-98
Test Termination Date (Day 10) 16-NOV-98
Test Species E. estuarius
Source/Collection Date NMS/Oct. 29-Nov. 1, 1998

SAMPLE ID Negative control

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
A	0	0	0	0	0	0	0	0	0	0	20	0	15	8.0	29	8.2
B	1	1	0	0	0	0	0	0	0	0	20	0	15	8.1	29	8.2
C	0	0	0	0	0	0	0	0	0	0	19	0	15	8.0	30	8.2
D	0	1	0	0	1	0	0	0	0	0	20	0	15	8.0	29	8.2
E	1	1	0	0	0	0	0	0	1	0	19	0	15	8.0	30	8.2
Tech'n	JMM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	PAH	PAH	PAH	PAH	PAH	PAH

(1) Appears dead

(# dead:# missing) - A(0 :0) B(0 :0) C(1 :0) D(0 :0) E(0 :1)

SAMPLE ID _____

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
Tech'n																

(# dead:# missing) - A(:) B(:) C(:) D(:) E(:)

SAMPLE ID _____

Rep.	Number of Amphipods Emerged From Sediment at Days 1-10										Number Alive at Day 10	Number Not Reburying at Day 10	Water Chemistry at Day 10			
	1	2	3	4	5	6	7	8	9	10			Temp. (°C)	pH	Sal. (ppt)	DO (mg/L)
Tech'n																

(# dead:# missing) - A(:) B(:) C(:) D(:) E(:)

WQ Instruments Used: Temp. Cal. Hg Therm pH II-19-26 Salinity II-C-22 DO II-19-19

Data Verified By Julie Ocran Date Verified NOV/24/98

Test: AM-Amphipod Survival and Avoidance Test Test ID: EVS8418b
Species: EE-Eohaustorius estuarius Protocol: PSEP 95
Sample ID: VARIOUS Sample Type: SEDIMENT1-Marine
Start Date: 11/6/98 End Date: 11/16/98 Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Survival Day 0	Survival Day 10	Avoidance Days 0 - 10	No. Failing to Reburrow	Notes
	1	1	S-Control	20	20	0	0	
	2	2	S-Control	20	20	2	0	
	3	3	S-Control	20	19	0	0	
	4	4	S-Control	20	20	2	0	
	5	5	S-Control	20	19	3	0	
	6	1	CR-23W	20	19	4	0	
	7	2	CR-23W	20	19	0	0	
	8	3	CR-23W	20	20	0	1	
	9	4	CR-23W	20	19	0	0	
	10	5	CR-23W	20	19	0	0	
	11	1	CR-10	20	19	0	0	
	12	2	CR-10	20	19	0	0	
	13	3	CR-10	20	18	0	0	
	14	4	CR-10	20	17	1	0	
	15	5	CR-10	20	18	0	1	
	16	1	CR-22	20	20	0	0	
	17	2	CR-22	20	19	0	0	
	18	3	CR-22	20	20	0	0	
	19	4	CR-22	20	20	0	0	
	20	5	CR-22	20	18	1	0	
	21	1	AN-SS-301	20	15	1	0	
	22	2	AN-SS-301	20	16	1	0	
	23	3	AN-SS-301	20	18	0	0	
	24	4	AN-SS-301	20	18	1	0	
	25	5	AN-SS-301	20	16	0	0	
	26	1	AN-SS-302	20	20	2	0	
	27	2	AN-SS-302	20	16	0	0	
	28	3	AN-SS-302	20	15	1	0	
	29	4	AN-SS-302	20	14	1	0	
	30	5	AN-SS-302	20	12	0	0	
	31	1	AN-SS-303	20	16	3	0	
	32	2	AN-SS-303	20	17	1	0	
	33	3	AN-SS-303	20	18	3	1	
	34	4	AN-SS-303	20	20	0	0	
	35	5	AN-SS-303	20	14	1	0	
	36	1	AN-SS-304	20	20	0	0	
	37	2	AN-SS-304	20	20	0	0	
	38	3	AN-SS-304	20	20	0	0	
	39	4	AN-SS-304	20	19	1	0	
	40	5	AN-SS-304	20	18	2	0	
	41	1	AN-SS-305	20	19	1	0	
	42	2	AN-SS-305	20	18	1	0	
	43	3	AN-SS-305	20	18	0	0	
	44	4	AN-SS-305	20	19	3	0	
	45	5	AN-SS-305	20	17	0	0	
	46	1	AN-SS-306	20	20	8	0	
	47	2	AN-SS-306	20	17	5	0	
	48	3	AN-SS-306	20	11	2	0	
	49	4	AN-SS-306	20	18	3	1	
	50	5	AN-SS-306	20	10	1	0	

Comments: Boulevard Park/Starr Rock; 9/852-01.1; 9800686

Amphipod Survival and Avoidance Test-10 Day Survival

Start Date:	11/6/98	Test ID:	EVS8418b	Sample ID:	VARIOUS
End Date:	11/16/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800686				

Conc-%	1	2	3	4	5
S-Control	1.0000	1.0000	0.9500	1.0000	0.9500
CR-23W	0.9500	0.9500	1.0000	0.9500	0.9500
CR-10	0.9500	0.9500	0.9000	0.8500	0.9000
CR-22	1.0000	0.9500	1.0000	1.0000	0.9000
AN-SS-301	0.7500	0.8000	0.9000	0.9000	0.8000
AN-SS-302	1.0000	0.8000	0.7500	0.7000	0.6000
AN-SS-303	0.8000	0.8500	0.9000	1.0000	0.7000
AN-SS-304	1.0000	1.0000	1.0000	0.9500	0.9000
AN-SS-305	0.9500	0.9000	0.9000	0.9500	0.8500
AN-SS-306	1.0000	0.8500	0.5500	0.9000	0.5000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
S-Control	0.9800	0.0274	1.4134	1.3453	1.4588	4.398	5			
CR-23W	0.9600	0.0224	1.3680	1.3453	1.4588	3.710	5	1.265	1.860	0.0024
*CR-10	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	3.277	1.860	0.0034
CR-22	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	0.380	1.860	0.0048
*AN-SS-301	0.8300	0.0671	1.1519	1.0472	1.2490	7.985	5	5.266	1.860	0.0046
*AN-SS-302	0.7700	0.1483	1.0981	0.8861	1.4588	19.803	5	3.117	1.860	0.0190
*AN-SS-303	0.8500	0.1118	1.1958	0.9912	1.4588	14.618	5	2.622	1.860	0.0128
AN-SS-304	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	0.380	1.860	0.0048
*AN-SS-305	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	3.277	1.860	0.0034
*AN-SS-306	0.7600	0.2219	1.1004	0.7854	1.4588	25.913	5	2.398	1.860	0.0317

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93798	0.93	0.40565	1.78968
Bartlett's Test indicates unequal variances (p = 6.62E-03)	22.817	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* Indicates significant difference when compared to the ~~control~~ S-Control. Bum

Amphipod Survival and Avoidance Test-10 Day Survival

Start Date:	11/6/98	Test ID:	EVS8418b	Sample ID:	VARIOUS
End Date:	11/16/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800686				

Conc-%	1	2	3	4	5
S-Control	1.0000	1.0000	0.9500	1.0000	0.9500
CR-10	0.9500	0.9500	0.9000	0.8500	0.9000
CR-23W	0.9500	0.9500	1.0000	0.9500	0.9500
CR-22	1.0000	0.9500	1.0000	1.0000	0.9000
AN-SS-301	0.7500	0.8000	0.9000	0.9000	0.8000
AN-SS-302	1.0000	0.8000	0.7500	0.7000	0.6000
AN-SS-303	0.8000	0.8500	0.9000	1.0000	0.7000
AN-SS-304	1.0000	1.0000	1.0000	0.9500	0.9000
AN-SS-305	0.9500	0.9000	0.9000	0.9500	0.8500
AN-SS-306	1.0000	0.8500	0.5500	0.9000	0.5000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
S-Control	0.9800	0.0274	1.4134	1.3453	1.4588	4.398	5			
CR-10	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5			
CR-23W	0.9600	0.0224	1.3680	1.3453	1.4588	3.710	5	-2.395	1.860	0.0030
CR-22	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	-2.270	1.860	0.0054
*AN-SS-301	0.8300	0.0671	1.1519	1.0472	1.2490	7.985	5	2.288	1.860	0.0052
AN-SS-302	0.7700	0.1483	1.0981	0.8861	1.4588	19.803	5	1.698	1.860	0.0196
AN-SS-303	0.8500	0.1118	1.1958	0.9912	1.4588	14.618	5	0.902	1.860	0.0134
AN-SS-304	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	-2.270	1.860	0.0054
AN-SS-305	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	0.000	1.860	0.0040
AN-SS-306	0.7600	0.2219	1.1004	0.7854	1.4588	25.913	5	1.306	1.860	0.0322

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93974	0.926	0.40091	1.49437
Bartlett's Test indicates equal variances (p = 0.01)	19.5646	20.0902		
The control means are significantly different (p = 0.01)	3.27736	2.30601		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* Indicates significant difference when compared to Reference Sediment CR-10.

Amphipod Survival and Avoidance Test-10 Day Survival

Start Date:	11/6/98	Test ID:	EVS8418b	Sample ID:	VARIOUS
End Date:	11/16/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800686				

Conc-%	1	2	3	4	5
S-Control	1.0000	1.0000	0.9500	1.0000	0.9500
CR-22	1.0000	0.9500	1.0000	1.0000	0.9000
CR-23W	0.9500	0.9500	1.0000	0.9500	0.9500
CR-10	0.9500	0.9500	0.9000	0.8500	0.9000
AN-SS-301	0.7500	0.8000	0.9000	0.9000	0.8000
AN-SS-302	1.0000	0.8000	0.7500	0.7000	0.6000
AN-SS-303	0.8000	0.8500	0.9000	1.0000	0.7000
AN-SS-304	1.0000	1.0000	1.0000	0.9500	0.9000
AN-SS-305	0.9500	0.9000	0.9000	0.9500	0.8500
AN-SS-306	1.0000	0.8500	0.5500	0.9000	0.5000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
S-Control	0.9800	0.0274	1.4134	1.3453	1.4588	4.398	5			
CR-22	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5			
CR-23W	0.9600	0.0224	1.3680	1.3453	1.4588	3.710	5	0.544	1.860	0.0043
*CR-10	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	2.270	1.860	0.0054
*AN-SS-301	0.8300	0.0671	1.1519	1.0472	1.2490	7.985	5	4.100	1.860	0.0065
*AN-SS-302	0.7700	0.1483	1.0981	0.8861	1.4588	19.803	5	2.791	1.860	0.0209
*AN-SS-303	0.8500	0.1118	1.1958	0.9912	1.4588	14.618	5	2.229	1.860	0.0147
AN-SS-304	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	0.000	1.860	0.0067
*AN-SS-305	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	2.270	1.860	0.0054
*AN-SS-306	0.7600	0.2219	1.1004	0.7854	1.4588	25.913	5	2.186	1.860	0.0336

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93974	0.926	0.40091	1.49437
Bartlett's Test indicates equal variances (p = 0.01)	19.5646	20.0902		
The control means are not significantly different (p = 0.71)	0.3796	2.30601		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* Indicates significant difference when compared to Reference Sediment CR-22.

Amphipod Survival and Avoidance Test-10 Day Survival

Start Date:	11/6/98	Test ID:	EVS8418b	Sample ID:	VARIOUS
End Date:	11/16/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800686				

Conc-%	1	2	3	4	5
S-Control	1.0000	1.0000	0.9500	1.0000	0.9500
CR-23W	0.9500	0.9500	1.0000	0.9500	0.9500
CR-10	0.9500	0.9500	0.9000	0.8500	0.9000
CR-22	1.0000	0.9500	1.0000	1.0000	0.9000
AN-SS-301	0.7500	0.8000	0.9000	0.9000	0.8000
AN-SS-302	1.0000	0.8000	0.7500	0.7000	0.6000
AN-SS-303	0.8000	0.8500	0.9000	1.0000	0.7000
AN-SS-304	1.0000	1.0000	1.0000	0.9500	0.9000
AN-SS-305	0.9500	0.9000	0.9000	0.9500	0.8500
AN-SS-306	1.0000	0.8500	0.5500	0.9000	0.5000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
S-Control	0.9800	0.0274	1.4134	1.3453	1.4588	4.398	5			
CR-23W	0.9600	0.0224	1.3680	1.3453	1.4588	3.710	5			
*CR-10	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	2.395	1.860	0.0030
CR-22	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	-0.544	1.860	0.0043
*AN-SS-301	0.8300	0.0671	1.1519	1.0472	1.2490	7.985	5	4.599	1.860	0.0041
*AN-SS-302	0.7700	0.1483	1.0981	0.8861	1.4588	19.803	5	2.703	1.860	0.0185
*AN-SS-303	0.8500	0.1118	1.1958	0.9912	1.4588	14.618	5	2.115	1.860	0.0123
AN-SS-304	0.9700	0.0447	1.3941	1.2490	1.4588	6.802	5	-0.544	1.860	0.0043
*AN-SS-305	0.9100	0.0418	1.2724	1.1731	1.3453	5.772	5	2.395	1.860	0.0030
*AN-SS-306	0.7600	0.2219	1.1004	0.7854	1.4588	25.913	5	2.066	1.860	0.0312

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93974	0.926	0.40091	1.49437
Bartlett's Test indicates equal variances (p = 0.01)	19.5646	20.0902		
The control means are not significantly different (p = 0.24)	1.26491	2.30601		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* Indicates significant difference when compared to Reference Sediment CR-23W.

Reviewed by: GSL

Amphipod Survival and Avoidance Test-Avoidance

Start Date:	11/6/98	Test ID:	EVS8418b	Sample ID:	VARIOUS
End Date:	11/16/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius

Comments: Boulevard Park/Starr Rock; 9/852-01.1; 9800686

Conc-%	1	2	3	4	5
S-Control	0.0000	0.2000	0.0000	0.2000	0.3000
CR-22	0.0000	0.0000	0.0000	0.0000	0.1000
CR-23W	0.4000	0.0000	0.0000	0.0000	0.0000
CR-10	0.0000	0.0000	0.0000	0.1000	0.0000
AN-SS-301	0.1000	0.1000	0.0000	0.1000	0.0000
AN-SS-302	0.2000	0.0000	0.1000	0.1000	0.0000
AN-SS-303	0.3000	0.1000	0.3000	0.0000	0.1000
AN-SS-304	0.0000	0.0000	0.0000	0.1000	0.2000
AN-SS-305	0.1000	0.1000	0.0000	0.3000	0.0000
AN-SS-306	0.8000	0.5000	0.2000	0.3000	0.1000

Transform: Untransformed

Conc-%	Mean	SD	Mean	Min	Max	CV%	N
S-Control	0.1400	0.1342	0.1400	0.0000	0.3000	95.831	5
CR-22	0.0200	0.0447	0.0200	0.0000	0.1000	223.607	5
CR-23W	0.0800	0.1789	0.0800	0.0000	0.4000	223.607	5
CR-10	0.0200	0.0447	0.0200	0.0000	0.1000	223.607	5
AN-SS-301	0.0600	0.0548	0.0600	0.0000	0.1000	91.287	5
AN-SS-302	0.0800	0.0837	0.0800	0.0000	0.2000	104.583	5
AN-SS-303	0.1600	0.1342	0.1600	0.0000	0.3000	83.853	5
AN-SS-304	0.0600	0.0894	0.0600	0.0000	0.2000	149.071	5
AN-SS-305	0.1000	0.1225	0.1000	0.0000	0.3000	122.474	5
AN-SS-306	0.3800	0.2775	0.3800	0.1000	0.8000	73.023	5

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93607	0.93	1.03115	2.528
Bartlett's Test indicates unequal variances (p = 6.81E-03)	22.7382	21.666		

Reviewed by: GSL

Amphipod Survival and Avoidance Test-Reburial

Start Date:	11/6/98	Test ID:	EVS8418b	Sample ID:	VARIOUS
End Date:	11/16/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800686				

Conc-%	1	2	3	4	5
S-Control	100.00	100.00	100.00	100.00	100.00
CR-22	100.00	100.00	100.00	100.00	100.00
CR-23W	100.00	100.00	95.00	100.00	100.00
CR-10	100.00	100.00	100.00	100.00	94.44
AN-SS-301	100.00	100.00	100.00	100.00	100.00
AN-SS-302	100.00	100.00	100.00	100.00	100.00
AN-SS-303	100.00	100.00	94.44	100.00	100.00
AN-SS-304	100.00	100.00	100.00	100.00	100.00
AN-SS-305	100.00	100.00	100.00	100.00	100.00
AN-SS-306	100.00	100.00	100.00	94.44	100.00

			Transform: Untransformed				
Conc-%	Mean	SD	Mean	Min	Max	CV%	N
S-Control	100.00	0.00	100.00	100.00	100.00	0.000	5
CR-22	100.00	0.00	100.00	100.00	100.00	0.000	5
CR-23W	99.00	2.24	99.00	95.00	100.00	2.259	5
CR-10	98.89	2.48	98.89	94.44	100.00	2.512	5
AN-SS-301	100.00	0.00	100.00	100.00	100.00	0.000	5
AN-SS-302	100.00	0.00	100.00	100.00	100.00	0.000	5
AN-SS-303	98.89	2.48	98.89	94.44	100.00	2.512	5
AN-SS-304	100.00	0.00	100.00	100.00	100.00	0.000	5
AN-SS-305	100.00	0.00	100.00	100.00	100.00	0.000	5
AN-SS-306	98.89	2.48	98.89	94.44	100.00	2.512	5

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.57792	0.93	-2.4527	5.87449
Equality of variance cannot be confirmed				

EVS CONSULTANTS

MARINE SPECIES REFERENCE TOXICANT TEST DATA

Client Anchor Environmental (Lombard, Illinois)

EVS Project No. 9185Z-01.1

EVS Work Order No. 98006686

Test Initiation Date Nov 8/98 BH

Reference Toxicant Cadmium

EVS Stock ID/Preparation Date 98-C-005 / Oct. 02 1998

Test Species E. estuarius

Source/Collection Date NAS / Oct. 29 - Nov. 1, 1998 BH

No. Organisms/Test Volume 10 / 900 ml

Concentration (mg/L Cd)	Number of Survivors (24 to 96 hours)				Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Salinity (ppt)	
	24	48	72	96	0	24	48	72 (5)	96	0	24	48	72	96	0	24	48	72	96	0	96
18.0	10	10 (1)	5 (1)	1	8.4	8.2	8.1	8.1	8.0	15.5	15	15	15	15	7.4	8.0	8.0	8.0	8.0	28	28
10.0	10	10	10 (3) (5)	6	8.4	8.2	8.1	8.1	8.0	15.5	15	15	15	15	7.4	8.0	8.0	8.0	8.0	28	28
5.6	10	10	10	9	8.4	8.2	8.2	8.1	8.1	15.5	15	15	15	15	7.4	7.9	8.0	8.0	8.0	28	28
3.2	10	10	10	10	8.4	8.2	8.1	8.1	8.1	15.5	15	15	15	15	7.4	8.0	8.0	8.0	8.1	28	28
1.8	10	10	10	10	8.4	8.2	8.1	8.1	8.1	15.5	15	15	15	15	7.4	8.0	8.0	8.0	8.0	28	28
Control	10	10	10	10	8.4	8.2	8.1	8.1	8.1	15.5	15	15	15	15	7.4	8.0	8.0	8.0	8.0	28	28
Technician	JTM	BGM	BGM	BGM	BGM	JTM	BGM	BGM	BGM	BGM	JTM	BGM	BGM	BGM	BGM	JTM	BGM	BGM	BGM	BGM	BGM

WQ Instruments Used: Temperature cal Hg thermometer pH II-A-26 DO II-A-19. Salinity II-C-22

Comments (1) two animals weak (2) aeration line reset -- worm not fully emerged. (3) three animals weak. (4) all 5 animals (alive) are weak. (5) Recalibrated meter.

WQ Ranges: Temp(°C): 15 - 15.5 ; pH: 7.4 - 8.1 ; D.O.(mg/L): 8.0 - 8.4 ; Sal(ppt): 28

Test Set Up By PAH PAH / BGM Data Verified By G. Lawton Date Verified Dec 3, 1998

Amphipod Acute Reftox-96 Hr Survival

Start Date:	06/11/98	Test ID:	RTEECD26	Sample ID:	REF-Ref Toxicant
End Date:	10/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CD-Cadmium
Sample Date:	Boule Darrell Starr	Protocol:	PSEP 95	Test Species:	EE-Eohaustorius estuarius
Comments:	[redacted] (Non-Purge) Ser Anchor (Shared [redacted] test)				

Conc-mg/L	1
D-Control	1.0000
1.8	1.0000
3.2	1.0000
5.6	0.9000
10	0.6000
18	0.1000

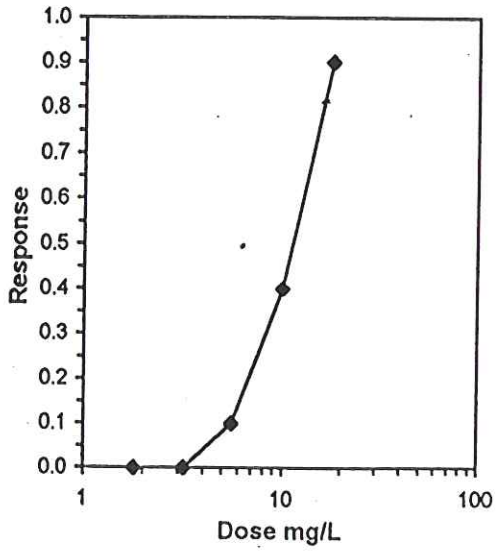
			Transform: Untransformed					Number	Total
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	Resp	Number
D-Control	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	1	0	10
1.8	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	1	0	10
3.2	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	1	0	10
5.6	0.9000	0.0000	0.9000	0.9000	0.9000	0.000	1	1	10
10	0.6000	0.0000	0.6000	0.6000	0.6000	0.000	1	4	10
18	0.1000	0.0000	0.1000	0.1000	0.1000	0.000	1	9	10

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Normality of the data set cannot be confirmed				
Equality of variance cannot be confirmed				

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%			
5.0%			
10.0%	10.778	8.425	13.790
20.0%	10.967	7.962	15.107
Auto-10.0%	10.778	8.425	13.790

mg/L Cd



Reviewed by: GSL

REMARKS

File No. K1118

The detection limit for Sulphide has been increased for the samples in the following data tables due to the turbidity of the samples.

RESULTS OF ANALYSIS - Water

File No. K1118

		CR-10	CR-22	CR-23W
		98 11 03	98 11 03	98 11 03
Nutrients				
Ammonia Nitrogen	N	6.25	23.2	22.8
Inorganic Parameters				
Sulphide	S	<0.05	<0.05	<0.05

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Bulk, interstitial water.

EVS CONSULTANTS
SEDIMENT TOXICITY TESTS - SURVIVAL AND FINAL WATER QUALITY DATA

Client: Boulevard Park / Starr Rock
EVS Project No.: 9852-01.1
EVS Work Order No.: 9800688

Test Type: 20-d survival and growth
Test Species: Heanthes arenaceodentata
Test Initiation Date (Day 0): Dec. 8, 1998
Test Termination Date: Dec. 28, 1998

Sample ID	Rep.	Pan No.	No. Alive	No. Dead	Total Recovered	No. Missing	Tech. Init.	Temp. (°C)	pH	Cond. (µmhos/cm) ☐ Salinity (ppt) ☑	DO (mg/L)
AN-SS-304	A	106	5	0	5	0	CWS	21.0	7.5	30	1.4
	B	107	2	0	2	3	CWS	21.0	7.6	30	3.2
	C	108	5	0	5	0	CWS	21.0	8.0	30	3.8
	D	109	3①	0	3	2	CWS	21.0	7.8	30	3.4
	E	110	5	0	5	0	CWS	21.0	7.5	30	0.8
AN-SS-305	A	111	5	0	5	0	CWS	21.0	8.0	30	5.0
	B	112	4	0	4	1	CWS	21.0	8.0	30	5.2
	C	113	5	0	5	0	CWS	21.0	7.9	30	5.2
	D	114	5	0	5	0	CWS	21.0	7.6	30	4.2
	E	115	5	0	5	0	CWS	21.0	7.9	30	4.8
AN-SS-306	A	116	5	0	5	0	CW	21.0	7.6	30	3.6
	B	117	5	0	5	0		21.0	7.6	29	3.2
	C	118	5	0	5	0		21.0	7.9	29	4.6
	D	119	5	0	5	0		21.0	7.8	30	4.8
	E	120	4	0	4	0		21.0	7.9	29	4.8
							Technician's Initials	CW BJS	CW BJS	CW BJS	CW BJS

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH Y-A-30 Cond./Sal. Y-C-22 DO Y-A-20
Data Verified By: G Lewis
Date Verified: Jan 27, 1999

Forms\Lab\Datasht\Sediment\SURVIVAL.WPD February 21, 1997

① 1 broken worm.

EVS CONSULTANTS - *Neanthes* 20-d SEDIMENT TOXICITY TEST
DAILY WATER QUALITY MONITORING

Client: Various
EVS Project No.: 9852-01.1
EVS Work Order No.: 9800688

Test Species: Neanthes arenaceodentata
Source/Date Received: Donald Reish / Dec. 2, 1998
Test Initiation Date (Day 0): Dec. 8, 1998
Test Termination Date (Day 20): Dec. 28, 1998

Sample ID	Salinity (ppt)								Dissolved Oxygen (mg/L)							
	0	3	6	9	12	15	18	20	0	3	6	9	12	15	18	20
CR-23W	29	29	29	29	29	29	29	30	6.9	4.4①	6.5	6.4	6.5	0.5②	5.7	4.6
CR-22	29	29	29	29	29	29	29	30	7.2	6.6	6.8	6.6	6.7	6.2	6.7	5.0
CR-10	29	29	29	29	29	29	29	30	7.2	6.7	6.6	6.7	6.7	6.0	6.9	5.2
Technician's Initials	JTM	JTM	JGL	JGL	JGL	RGM	PAR	BSJ	JTM	JTM	JGL	JGL	JGL	RGM	POH	BSJ

WQ Instruments Used: Salinity: I-C-22 DO: I-A-20

Comments: ① CR-23W, Rep C - 7.0 mg/L. Increased aeration for WQ jars ② CR 23W Rep A = 6.9 mg/L. Aeration reset for WQ jars

Test Set Up By: JGL, GSY

Data Verified By: G Lauren

Date Verified: Jan 22, 1999

EVS CONSULTANTS - *Neanthes* 20-d SEDIMENT TOXICITY TEST
DAILY WATER QUALITY MONITORING

Client: Boulevard Park / Starr Rock
EVS Project No.: 9852-01.1
EVS Work Order No.: 9809688

Test Species: Neanthes arenaceodentata
Source/Date Received: Donald Reish / Dec. 2, 1998
Test Initiation Date (Day 0): Dec. 8, 1998
Test Termination Date (Day 20): Dec. 28, 1998

Sample ID	Salinity (ppt)								Dissolved Oxygen (mg/L)							
	0	3	6	9	12	15	18	20	0	3	6	9	12	15	18	20
AN-SS-304	29	29	29	29	29	29	29	29	4.9	6.4	6.4	6.5	6.6	6.6	7.0	5.3
AN-SS-301	29	30	29	29	29	29	29	30	6.9	6.1	6.5	6.5	6.6	6.6	6.9	5.8
AN-SS-302	29	29	30	29	29	29	29	29	7.1	0.5 ①	6.4	6.7	6.7	6.6	1.5 ②	1.2
AN-SS-306	29	30	29	29	29	29	29	29	7.1	5.7	6.7	5.2	6.6	6.6	6.9	4.8
AN-SS-303	29	30	30	29	29	29	29	30	6.7	6.0	6.5	6.4	6.7	6.6	6.8	4.9
AN-SS-305	29	29	29	29	29	29	29	29	7.0	5.9	6.6	6.4	6.4	6.6	6.9	4.8
Technician's Initials	JTM	JTM	JGL	JGL	JGL	BGM	JGL	BSJ	JTM	JTM	JGL	JGL	JGL	BGM	JGL	BSJ

WQ Instruments Used: Salinity: I-C-22 DO: I-A-20
Comments: ① AN-SS-302, Rep A - 6.1 mg/L - Restarted aeration on WQ jar. ② Adjusted aeration (Rep A - 6.7)

Test Set Up By: JGL, GSY
Data Verified By: G Lauren
Date Verified: Jan 27, 1999

EVS CONSULTANTS - *Neanthes* 20-d SEDIMENT TOXICITY TEST
DAILY WATER QUALITY MONITORING

Client: Various
EVS Project No.: 9/852-01-1
EVS Work Order No.: 9800688

Test Species: Neanthes arenaceodentata
Source/Date Received: Donald Resh / Dec. 2, 1998
Test Initiation Date (Day 0): Dec-8, 1998
Test Termination Date (Day 20): Dec. 28, 1998

Sample ID	Temperature (°C)																					pH							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	0	3	6	9	12	15	18	20
Control	21.0	20.5	20.5	21.0	20.5	20.5	21.0	21.0	21.0	21.0	21.0	20.5	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	8.0	7.9	7.7	7.6	7.8	7.5	7.8	7.9
Technician's Initials	JGH		JGH	JGH			JGH	JGH	JGH	JGH	JGH	JGH	JGH	JGH	JGH	JGH	JGH	SB	JGH			JGH	JGH	JGH	JGH	JGH			

WQ Instruments Used: Temp. Calibrated Hg thermometer pH YI-A-30
Comments: Recalibrated, bulbs checked

Test Set Up By: JGH, GSy
Data Verified By: C. Laurer
Date Verified: Jan 22, 1999

EVS CONSULTANTS
MARINE POLYCHAETE SEDIMENT TOXICITY TEST DATA SUMMARY

Client Boulevard Park / Starr Rock
EVS Project No. 9/852-01.1
EVS Work Order No. 9800688

EVS Analysts JGK, GSY, LJS, SVS, JKM, BGM, PAH, BS
Test Type/Duration 20-d Survival and Growth
Test Initiation Date (Day 0) Dec. 8, 1998

SAMPLE
Identification Various
Amount Received 7 x 1 L to 10 x 1 L
Date Collected Oct. 26; Oct. 29
Date Received Oct. 28; Oct. 30

TEST SPECIES INFORMATION
Organism Neanthes arenaceodentata
Source/Date Received Donald Reish / Dec. 2, 1998
Day 0 Dry Weight (mg/worm) 0.50
Reference Toxicant Cadmium
Current Reference Toxicant Result
(96-h LC50 and 95% CL) 4.2 mg/L Cd
95% CL: 3.2 to 5.6 mg/L Cd
Reference Toxicant Warning Limits (mean ± 2SD)
9.6 ± 4.7 mg/L Cd

TEST CONDITIONS (for all samples)
Temperature Range (°C) 20.5 - 21.0
pH Range 7.2 - 8.2
Dissolved Oxygen Range (mg/L) 0.5 - 7.2
Salinity Range (ppt) 29 - 30
Photoperiod (L:D h) Constant ambient light
Ammonia Type and Ranges (mg/L N)
☐ Inter: Day 0 0.17 - 24.4 Day 10 2.58 - 11.3 (1.37 - 9.68) Day 20 1.37 - 9.68
☐ Over: Day 0 n/a Day 10 n/a Day 20 n/a
Sulphide Type and Ranges (mg/L S)
☐ Inter: Day 0 n/a Day 10 n/a Day 20 n/a
☐ Over: Day 0 <0.02 - 0.03 Day 10 n/a Day 20 <0.02 - 0.6

DILUTION AND CONTROL MEDIUM (for all sample)
Water Type UV Sterilized, Filtered Sea Water
Temperature (°C) 20.0 - 21.0
pH 7.7 - 8.1
Dissolved Oxygen (mg/L) 7.2 - 7.5
Salinity (ppt) 27 - 30
Other ✓

Sample ID	Mean ± SD			
	Survival (%)	Individual Dry Weight (mg/worm)	Individual Growth Rate (mg/worm/day)	Total Dry Weight (mg)
AN-SS-306	96.0 ± 8.9	12.4 ± 2.1	0.60 ± 0.11	59.0 ± 8.0

Data Verified By G. Laurer
Date Verified Jan 27, 1999

Dissolved oxygen R+D experiment.

EVS CONSULTANTS
10-d MARINE AMPHIPOD SEDIMENT TOXICITY TEST - DAILY WATER QUALITY MONITORING

Client Anchor Environmental (Boulevard Park / Starr Rock)
EVS Project No. 91852-01.1
EVS Work Order No. 9800687

Test Initiation Date (Day 0) 30-Oct-98
Test Termination Date (Day 10) 16 Nov-98
Test Species E. estuarius
Source/Collection Date NRS | 30 Oct. - 01 Nov '98

Sample ID	Temperature (°C)											pH										
	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
CR-10	15	15	15	15	15	15	15	15	15	15	15	7.4	7.7	7.6	7.7	7.6	7.6	7.9	7.9	7.6	7.8	7.8
CR-22	15	15	15	15	15	15	15	15	15	15	15	7.3	7.6	7.6	7.6	7.6	7.6	7.8	7.9	7.6	7.7	7.7
Control	15	15	15	15	15	15	15	15	15	15	15	7.4	7.7	7.6	7.8	7.8	7.7	7.8	8.0	7.7	7.7	7.8
AN-SS-305	15	15	15	15	15	15	15	15	15	15	15	7.3	7.6	7.7	7.6	7.5	7.6	7.8	7.9 ~~7.6~~	7.6	7.6	7.7
Technician's Initials	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH	PAH

WQ Instruments Used: Temp. Hg Thermometer pH F-A-26
Comments Tanks set up strictly to monitor WQ measurements - not seeded; No aeration

Test Set Up By BGM Data Verified By G Lauren Date Verified Jan 8, 1999

RESULTS OF ANALYSIS - Water

File No. K1460

	Sulphide S
AN-SS- 303 1998 Nov 16	<0.02
AN-SS- 304 1998 Nov 16	<0.02
AN-SS- 305 1998 Nov 16	<0.02
AN-SS- 306 1998 Nov 16	<0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Day 10, E.estuarius, overlying water.

RESULTS OF ANALYSIS - Water

File No. K1459

	Ammonia Nitrogen N
AN-SS- 304 1998 Nov 16	1.50
AN-SS- 305 1998 Nov 16	0.62
AN-SS- 306 1998 Nov 16	1.99
AN-SC-84 1998 Nov 16	0.09

Results are expressed as milligrams per litre except where noted.
These samples are identified as Day 10, E.estuarius, interstitial water.

RESULTS OF ANALYSIS - Water

File No. K1380

	Ammonia Nitrogen N
AN-SS- 303 1998 Nov 11	5.39
AN-SS- 304 1998 Nov 11	2.62
AN-SS- 305 1998 Nov 11	2.28
AN-SS- 306 1998 Nov 11	4.73

Results are expressed as milligrams per litre except where noted.
These samples are identified as Day 5, E.estuarius, interstitial water.

RESULTS OF ANALYSIS - Water

File No. K1268

	Ammonia[1] Nitrogen N	Sulphide[2] S
AN-SS- 303 1998 Nov 6	4.99	0.03
AN-SS- 304 1998 Nov 6	3.19	<0.02
AN-SS- 305 1998 Nov 6	3.62	<0.02
AN-SS- 306 1998 Nov 6	4.09	0.03
AN-SC- 72 1998 Nov 6	6.82	<0.02

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
[1]These results are identified as E.estuarius, interstitial Ammonia.
[2]These results are identified as E.estuarius, overlying Sulphide except where noted.

Day 0

RESULTS OF ANALYSIS - Water

File No. K1046

	Ammonia Nitrogen N	Sulphide S
AN-SS- 301 1998 Oct 29	1.88	0.4
AN-SS- 302 1998 Oct 29	2.71	0.3
AN-SS- 303 1998 Oct 29	2.25	0.3
AN-SS- 304 1998 Oct 29	2.89	1.0
AN-SS- 305 1998 Oct 29	2.47	0.3
AN-SS- 306 1998 Oct 29	1.98	0.5

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Bulk, interstitial water.

Test: PW-Polychaete Worm Growth and Survival Test Test ID: EVS8453
Species: NA-Neanthes arenaceodentata Protocol: PSEP 95
Sample ID: VARIOUS Sample Type: SEDIMENT1-Marine
Start Date: 08/12/98 End Date: 28/12/98 Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Survival Start	Survival Day 20	# of Worms Weighed	Initial Worm Wt (mg/worm)	Pan Weight (mg)	Pan + Worms (mg)
	1	1	D-Control	5	0	0	0.5	1271.2	1271.2
	2	2	D-Control	5	5	5	0.5	1273.4	1323.4
	3	3	D-Control	5	5	5	0.5	1282.6	1344.5
	4	4	D-Control	5	1	1	0.5	1265.2	1268.0
	5	5	D-Control	5	4	4	0.5	1286.0	1330.7
	6	1	CR-10	5	5	5	0.5	1264.5	1310.6
	7	2	CR-10	5	5	5	0.5	1309.9	1356.6
	8	3	CR-10	5	4	4	0.5	1269.5	1311.1
	9	4	CR-10	5	4	4	0.5	1270.3	1285.9
	10	5	CR-10	5	5	5	0.5	1303.2	1367.3
	11	1	CR-22	5	5	5	0.5	1258.9	1314.9
	12	2	CR-22	5	3	3	0.5	1260.1	1297.4
	13	3	CR-22	5	4	4	0.5	1281.2	1334.5
	14	4	CR-22	5	5	5	0.5	1281.6	1339.7
	15	5	CR-22	5	5	5	0.5	1268.8	1322.5
	16	1	CR-23-W	5	5	5	0.5	1290.2	1324.3
	17	2	CR-23-W	5	4	4	0.5	1277.7	1332.3
	18	3	CR-23-W	5	3	3	0.5	1272.9	1306.1
	19	4	CR-23-W	5	4	4	0.5	1302.8	1376.1
	20	5	CR-23-W	5	4	4	0.5	1279.8	1324.8
	21	1	AN-SS-301	5	3	3	0.5	1291.9	1345.3
	22	2	AN-SS-301	5	4	4	0.5	1297.2	1338.1
	23	3	AN-SS-301	5	4	4	0.5	1286.2	1328.7
	24	4	AN-SS-301	5	2	2	0.5	1291.4	1332.8
	25	5	AN-SS-301	5	4	4	0.5	1289.7	1330.1
	26	1	AN-SS-302	5	5	5	0.5	1284.7	1326.2
	27	2	AN-SS-302	5	5	5	0.5	1282.1	1359.4
	28	3	AN-SS-302	5	2	2	0.5	1289.1	1303.1
	29	4	AN-SS-302	5	4	4	0.5	1285.8	1306.4
	30	5	AN-SS-302	5	5	5	0.5	1312.7	1388.3
	31	1	AN-SS-303	5	4	4	0.5	1307.5	1368.9
	32	2	AN-SS-303	5	4	4	0.5	1284.7	1333.7
	33	3	AN-SS-303	5	3	3	0.5	1312.4	1342.3
	34	4	AN-SS-303	5	5	5	0.5	1307.8	1357.1
	35	5	AN-SS-303	5	4	4	0.5	1291.4	1317.8
	36	1	AN-SS-304	5	5	5	0.5	1291.1	1336.6
	37	2	AN-SS-304	5	2	2	0.5	1291.8	1315.8
	38	3	AN-SS-304	5	5	5	0.5	1274.6	1359.1
	39	4	AN-SS-304	5	3	3	0.5	1275.9	1308.0
	40	5	AN-SS-304	5	5	5	0.5	1281.4	1315.1
	41	1	AN-SS-305	5	5	5	0.5	1294.8	1347.5
	42	2	AN-SS-305	5	4	4	0.5	1280.4	1331.3
	43	3	AN-SS-305	5	5	5	0.5	1277.4	1353.6
	44	4	AN-SS-305	5	5	5	0.5	1291.2	1350.8
	45	5	AN-SS-305	5	5	5	0.5	1291.6	1350.1
	46	1	AN-SS-306	5	5	5	0.5	1290.1	1359.6
	47	2	AN-SS-306	5	5	5	0.5	1300.5	1362.3
	48	3	AN-SS-306	5	5	5	0.5	1293.0	1340.4
	49	4	AN-SS-306	5	5	5	0.5	1291.6	1348.5
	50	5	AN-SS-306	5	4	4	0.5	1282.8	1342.3

Comments: Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9852-01.1

Reviewed by: G

Polychaete Worm Growth and Survival Test-20 d Survival

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
D-Control	0.0000	1.0000	1.0000	0.2000	0.8000
CR-10	1.0000	1.0000	0.8000	0.8000	1.0000
CR-22	1.0000	0.6000	0.8000	1.0000	1.0000
CR-23-W	1.0000	0.8000	0.6000	0.8000	0.8000
AN-SS-301	0.6000	0.8000	0.8000	0.4000	0.8000
AN-SS-302	1.0000	1.0000	0.4000	0.8000	1.0000
AN-SS-303	0.8000	0.8000	0.6000	1.0000	0.8000
AN-SS-304	1.0000	0.4000	1.0000	0.6000	1.0000
AN-SS-305	1.0000	0.8000	1.0000	1.0000	1.0000
AN-SS-306	1.0000	1.0000	1.0000	1.0000	0.8000

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.6000	0.4690	0.6000	0.0000	1.0000	78.174	5			
CR-10	0.9200	0.1095	0.9200	0.8000	1.0000	11.907	5	-1.486	1.860	0.0863
CR-22	0.8800	0.1789	0.8800	0.6000	1.0000	20.328	5	-1.247	1.860	0.0937
CR-23-W	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	-0.913	1.860	0.0893
AN-SS-301	0.6800	0.1789	0.6800	0.4000	0.8000	26.307	5	-0.356	1.860	0.0937
AN-SS-302	0.8400	0.2608	0.8400	0.4000	1.0000	31.044	5	-1.000	1.860	0.1071
AN-SS-303	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	-0.913	1.860	0.0893
AN-SS-304	0.8000	0.2828	0.8000	0.4000	1.0000	35.355	5	-0.816	1.860	0.1116
AN-SS-305	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-1.686	1.860	0.0848
AN-SS-306	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-1.686	1.860	0.0848

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93898	0.93	-0.7969	0.9796
Bartlett's Test indicates equal variances (p = 0.02)	20.3664	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Stat. comparisons made to D-Control

Polychaete Worm Growth and Survival Test-Avg Individual Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
D-Control	10.000	12.380	2.800	11.175	
CR-10	9.220	9.340	10.400	3.900	12.820
CR-22	11.200	12.433	13.325	11.620	10.740
CR-23-W	6.820	13.650	11.067	18.325	11.250
AN-SS-301	17.800	10.225	10.625	20.700	10.100
AN-SS-302	8.300	15.460	7.000	5.150	15.120
AN-SS-303	15.350	12.250	9.967	9.860	6.600
AN-SS-304	9.100	12.000	16.900	10.700	6.740
AN-SS-305	10.540	12.725	15.240	11.920	11.700
AN-SS-306	13.900	12.360	9.480	11.380	14.875

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	9.089	4.304	9.089	2.800	12.380	47.351	4			
CR-10	9.136	3.265	9.136	3.900	12.820	35.735	5	-0.019	1.895	11.960
CR-22	11.864	1.027	11.864	10.740	13.325	8.660	5	-1.415	1.895	7.282
CR-23-W	12.222	4.206	12.222	6.820	18.325	34.409	5	-1.100	1.895	15.384
AN-SS-301	13.890	5.003	13.890	10.100	20.700	36.019	5	-1.518	1.895	18.961
AN-SS-302	10.206	4.776	10.206	5.150	15.460	46.792	5	-0.364	1.895	17.878
AN-SS-303	10.805	3.241	10.805	6.600	15.350	29.997	5	-0.685	1.895	11.885
AN-SS-304	11.088	3.795	11.088	6.740	16.900	34.229	5	-0.741	1.895	13.785
AN-SS-305	12.425	1.757	12.425	10.540	15.240	14.141	5	-1.597	1.895	8.271
AN-SS-306	12.399	2.118	12.399	9.480	14.875	17.082	5	-1.523	1.895	8.953

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Stat. comparisons made to D-Control

Polychaete Worm Growth and Survival Test-Growth Rate

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
D-Control	0.4750	0.5940	0.1150	0.5338	
CR-10	0.4360	0.4420	0.4950	0.1700	0.6160
CR-22	0.5350	0.5967	0.6412	0.5560	0.5120
CR-23-W	0.3160	0.6575	0.5283	0.8912	0.5375
AN-SS-301	0.8650	0.4862	0.5063	1.0100	0.4800
AN-SS-302	0.3900	0.7480	0.3250	0.2325	0.7310
AN-SS-303	0.7425	0.5875	0.4733	0.4680	0.3050
AN-SS-304	0.4300	0.5750	0.8200	0.5100	0.3120
AN-SS-305	0.5020	0.6112	0.7370	0.5710	0.5600
AN-SS-306	0.6700	0.5930	0.4490	0.5440	0.7188

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.4294	0.2152	0.4294	0.1150	0.5940	50.108	4			
CR-10	0.4318	0.1632	0.4318	0.1700	0.6160	37.804	5	-0.019	1.895	0.0299
CR-22	0.5682	0.0514	0.5682	0.5120	0.6412	9.041	5	-1.415	1.895	0.0182
CR-23-W	0.5861	0.2103	0.5861	0.3160	0.8912	35.876	5	-1.100	1.895	0.0385
AN-SS-301	0.6695	0.2502	0.6695	0.4800	1.0100	37.364	5	-1.518	1.895	0.0474
AN-SS-302	0.4853	0.2388	0.4853	0.2325	0.7480	49.203	5	-0.364	1.895	0.0447
AN-SS-303	0.5153	0.1621	0.5153	0.3050	0.7425	31.452	5	-0.685	1.895	0.0297
AN-SS-304	0.5294	0.1898	0.5294	0.3120	0.8200	35.846	5	-0.741	1.895	0.0345
AN-SS-305	0.5962	0.0878	0.5962	0.5020	0.7370	14.734	5	-1.597	1.895	0.0207
AN-SS-306	0.5950	0.1059	0.5950	0.4490	0.7188	17.800	5	-1.523	1.895	0.0224

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Stat. comparisons made to D-Control

Polychaete Worm Growth and Survival Test-Total Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata

Comments: Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1

Conc-%	1	2	3	4	5
D-Control	0.000	50.000	61.900	2.800	44.700
CR-10	46.100	46.700	41.600	15.600	64.100
CR-22	56.000	37.300	53.300	58.100	53.700
CR-23-W	34.100	54.600	33.200	73.300	45.000
AN-SS-301	53.400	40.900	42.500	41.400	40.400
AN-SS-302	41.500	77.300	14.000	20.600	75.600
AN-SS-303	61.400	49.000	29.900	49.300	26.400
AN-SS-304	45.500	24.000	84.500	32.100	33.700
AN-SS-305	52.700	50.900	76.200	59.600	58.500
AN-SS-306	69.500	61.800	47.400	56.900	59.500

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	31.880	28.530	31.880	0.000	61.900	89.492	5			
CR-10	42.820	17.472	42.820	15.600	64.100	40.803	5	-0.731	1.860	416.254
CR-22	51.680	8.267	51.680	37.300	58.100	15.996	5	-1.491	1.860	328.139
CR-23-W	48.040	16.620	48.040	33.200	73.300	34.596	5	-1.094	1.860	405.452
AN-SS-301	43.720	5.467	43.720	40.400	53.400	12.504	5	-0.911	1.860	313.837
AN-SS-302	45.800	29.770	45.800	14.000	77.300	65.000	5	-0.755	1.860	632.333
AN-SS-303	43.200	14.673	43.200	26.400	61.400	33.966	5	-0.789	1.860	382.796
AN-SS-304	43.960	23.928	43.960	24.000	84.500	54.431	5	-0.725	1.860	515.658
AN-SS-305	59.580	10.001	59.580	50.900	76.200	16.786	5	-2.049	1.860	339.919
AN-SS-306	59.020	8.020	59.020	47.400	69.500	13.589	5	-2.048	1.860	326.646

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97215	0.93	0.20974	0.05778
Bartlett's Test indicates equal variances (p = 0.03)	18.845	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Stat. comparisons made to D-control

Polychaete Worm Growth and Survival Test-20 d Survival

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-10	1.0000	1.0000	0.8000	0.8000	1.0000
CR-22	1.0000	0.6000	0.8000	1.0000	1.0000
CR-23-W	1.0000	0.8000	0.6000	0.8000	0.8000
D-Control	0.0000	1.0000	1.0000	0.2000	0.8000
AN-SS-301	0.6000	0.8000	0.8000	0.4000	0.8000
AN-SS-302	1.0000	1.0000	0.4000	0.8000	1.0000
AN-SS-303	0.8000	0.8000	0.6000	1.0000	0.8000
AN-SS-304	1.0000	0.4000	1.0000	0.6000	1.0000
AN-SS-305	1.0000	0.8000	1.0000	1.0000	1.0000
AN-SS-306	1.0000	1.0000	1.0000	1.0000	0.8000

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	0.9200	0.1095	0.9200	0.8000	1.0000	11.907	5			
CR-22	0.8800	0.1789	0.8800	0.6000	1.0000	20.328	5	0.426	1.860	0.0164
CR-23-W	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	1.500	1.860	0.0119
D-Control	0.6000	0.4690	0.6000	0.0000	1.0000	78.174	5	1.486	1.860	0.0863
*AN-SS-301	0.6800	0.1789	0.6800	0.4000	0.8000	26.307	5	2.558	1.860	0.0164
AN-SS-302	0.8400	0.2608	0.8400	0.4000	1.0000	31.044	5	0.632	1.860	0.0298
AN-SS-303	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	1.500	1.860	0.0119
AN-SS-304	0.8000	0.2828	0.8000	0.4000	1.0000	35.355	5	0.885	1.860	0.0342
AN-SS-305	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-0.632	1.860	0.0074
AN-SS-306	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-0.632	1.860	0.0074

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93898	0.93	-0.7969	0.9796
Bartlett's Test indicates equal variances (p = 0.02)	20.3664	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

Stat. comparisons made to reference sediment CR-10

Polychaete Worm Growth and Survival Test-Avg Individual Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-10	9.220	9.340	10.400	3.900	12.820
CR-22	11.200	12.433	13.325	11.620	10.740
CR-23-W	6.820	13.650	11.067	18.325	11.250
D-Control	10.000	12.380	2.800	11.175	
AN-SS-301	17.800	10.225	10.625	20.700	10.100
AN-SS-302	8.300	15.460	7.000	5.150	15.120
AN-SS-303	15.350	12.250	9.967	9.860	6.600
AN-SS-304	9.100	12.000	16.900	10.700	6.740
AN-SS-305	10.540	12.725	15.240	11.920	11.700
AN-SS-306	13.900	12.360	9.480	11.380	14.875

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	9.136	3.265	9.136	3.900	12.820	35.735	5			
CR-22	11.864	1.027	11.864	10.740	13.325	8.660	5	-1.782	1.860	4.357
CR-23-W	12.222	4.206	12.222	6.820	18.325	34.409	5	-1.296	1.860	10.542
D-Control	9.089	4.304	9.089	2.800	12.380	47.351	4	0.019	1.895	11.960
AN-SS-301	13.890	5.003	13.890	10.100	20.700	36.019	5	-1.779	1.860	13.273
AN-SS-302	10.206	4.776	10.206	5.150	15.460	46.792	5	-0.414	1.860	12.446
AN-SS-303	10.805	3.241	10.805	6.600	15.350	29.997	5	-0.811	1.860	7.871
AN-SS-304	11.088	3.795	11.088	6.740	16.900	34.229	5	-0.872	1.860	9.321
AN-SS-305	12.425	1.757	12.425	10.540	15.240	14.141	5	-1.984	1.860	5.112
AN-SS-306	12.399	2.118	12.399	9.480	14.875	17.082	5	-1.875	1.860	5.632

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Stat. comparisons made to reference sediment CR-10.

Reviewed by: GSL

Polychaete Worm Growth and Survival Test-Growth Rate

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-10	0.4360	0.4420	0.4950	0.1700	0.6160
CR-22	0.5350	0.5967	0.6412	0.5560	0.5120
CR-23-W	0.3160	0.6575	0.5283	0.8912	0.5375
D-Control	0.4750	0.5940	0.1150	0.5338	
AN-SS-301	0.8650	0.4862	0.5063	1.0100	0.4800
AN-SS-302	0.3900	0.7480	0.3250	0.2325	0.7310
AN-SS-303	0.7425	0.5875	0.4733	0.4680	0.3050
AN-SS-304	0.4300	0.5750	0.8200	0.5100	0.3120
AN-SS-305	0.5020	0.6112	0.7370	0.5710	0.5600
AN-SS-306	0.6700	0.5930	0.4490	0.5440	0.7188

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	0.4318	0.1632	0.4318	0.1700	0.6160	37.804	5			
CR-22	0.5682	0.0514	0.5682	0.5120	0.6412	9.041	5	-1.782	1.860	0.0109
CR-23-W	0.5861	0.2103	0.5861	0.3160	0.8912	35.876	5	-1.296	1.860	0.0264
D-Control	0.4294	0.2152	0.4294	0.1150	0.5940	50.108	4	0.019	1.895	0.0299
AN-SS-301	0.6695	0.2502	0.6695	0.4800	1.0100	37.364	5	-1.779	1.860	0.0332
AN-SS-302	0.4853	0.2388	0.4853	0.2325	0.7480	49.203	5	-0.414	1.860	0.0311
AN-SS-303	0.5153	0.1621	0.5153	0.3050	0.7425	31.452	5	-0.811	1.860	0.0197
AN-SS-304	0.5294	0.1898	0.5294	0.3120	0.8200	35.846	5	-0.872	1.860	0.0233
AN-SS-305	0.5962	0.0878	0.5962	0.5020	0.7370	14.734	5	-1.984	1.860	0.0128
AN-SS-306	0.5950	0.1059	0.5950	0.4490	0.7188	17.800	5	-1.875	1.860	0.0141

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-10

RESULTS OF ANALYSIS - Water

File No. K2101

	Ammonia Nitrogen N	Sulphide S
CR-10 1998 Dec 8	8.34	0.02
CR-22 1998 Dec 8	25.6	<0.02
CR-23W 1998 Dec 8	24.4	<0.02
Control 1998 Dec 8	0.17	<0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Day 0, Neanthes, interstitial ammonia and overlying sulphide.

Polychaete Acute Test-96 Hr Survival

Start Date:	08/12/98	Test ID:	RTNACD9811-	Sample ID:	REF-Ref Toxicant
End Date:	12/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CD-Cadmium
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC), 9/852-01.1 (9800688)				

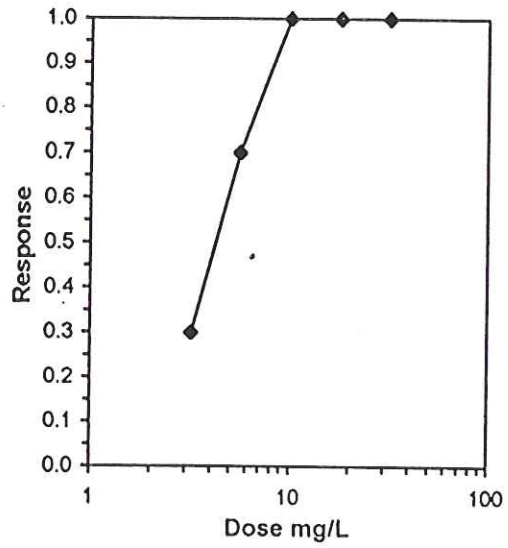
Conc-mg/L	1
D-Control	1.0000
3.2	0.7000
5.6	0.3000
10	0.0000
18	0.0000
32	0.0000

Conc-mg/L	Mean	SD	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Number Resp	Total Number
D-Control	1.0000	0.0000	0	10	10	1			0	10
3.2	0.7000	0.0000	3	7	10	1	0.1053	0.0500	3	10
*5.6	0.3000	0.0000	7	3	10	1	0.0015	0.0500	7	10
10	0.0000	0.0000	10	0	10	1			10	10
18	0.0000	0.0000	10	0	10	1			10	10
32	0.0000	0.0000	10	0	10	1			10	10

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	3.2	5.6	4.2332	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%				
10.0%				
20.0%				
Auto-30.0%	4.2332	3.1780	5.6388	mg/L Cd



Reviewed by: GSL

Test: PA-Polychaete Acute Test			Test ID: RTNACD9811
Species: NA-Neanthes arenaceodentata			Protocol: PSEP 95
Sample ID: REF-Ref Toxicant			Sample Type: CD-Cadmium
Start Date: 08/12/98	End Date: 12/12/98		Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	10				10	
	2	1	3.2	10				7	
	3	1	5.6	10				3	
	4	1	10.0	10				0	
	5	1	18.0	10				0	
	6	1	32.0	10				0	

Comments: Anchor Environmental (LLC), 9/852-01.1 (9800688)

EVS CONSULTANTS
MARINE SPECIES REFERENCE TOXICANT TEST DATA

Client: Various
EVS Project No.: 9852-01-1
EVS Work Order No.: 9800688
Test Initiation Date: Dec. 8, 1998

Reference Toxicant: Cadmium
EVS Stock ID/Preparation Date: 98-C-005 / Nov 98
Test Species: Neanthes arenaceodentata
Source/Collection Date: Donald Reish / Dec. 1, 1998
No. Organisms/Test Volume: 10 / 900 mL

Concentration mg/L Cd	Number of Survivors (24 to 96 hours)				Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Salinity (ppt)	
	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
32.0	0	—	—	—	7.5	7.5	7.3	7.2	7.1	19.5	20.5	21.0	21.0	21.0	7.9	7.7	7.8	7.9	7.9	30	30
18.0	0	—	—	—	7.4	7.5	7.2	7.2	7.1	19.5	20.5	21.0	21.0	21.0	7.9	7.7	7.8	7.9	7.8	30	30
10.0	8	8	0	—	7.3	7.2	7.3	7.2	7.2	19.5	20.5	21.0	21.0	21.0	7.9	7.7	7.9	7.9	7.8	30	30
5.6	10	10	3	3	7.3	7.3	7.3	7.1	7.2	19.5	20.5	21.0	21.0	21.0	7.9	7.7	7.9	8.0	8.0	30	30
3.2	10	10	7	7	7.3	7.3	7.2	7.2	7.2	19.5	20.5	21.0	21.0	21.0	7.9	7.7	7.9	8.0	7.9	30	30
Ctrl	10	10	10	10	7.3	7.3	7.0	7.2	7.2	19.5	20.5	21.0	21.0	21.0	7.9	7.6	7.8	7.9	7.9	30	30
Technician	JGK	JGK	JGK	JGK	BJ	JGK	JGK	JGK	JGK	BJ	JGK	JGK	JGK	JGK	BJ	JGK	JGK	JGK	JGK	BJ	JGK

WQ Instruments Used: Temperature Calibrated Hg Thermometer pH II-A-30 DO II-A-20 Salinity II-C-22
Comments

Test Set Up By: JGK, GSY
Data Verified By: C Lawrence
Date Verified: Jan 27, 1999

EVS CONSULTANTS
MARINE POLYCHAETE SEDIMENT TOXICITY TEST DATA SUMMARY

Client Various
EVS Project No. 9/852-01.1
EVS Work Order No. 9800688

EVS Analysts JGK, GSY, JKM, BWY
Test Type/Duration Acut - 96-h
Test Initiation Date (Day 0) Dec. 8, 1998

SAMPLE

Identification Cd Ref. Tox. stock soln lot #98-C-005
Amount ~~Received~~ Prepared 1L
Date ~~Collected~~ Prepared Oct. 2, 1998
Date Received /

TEST SPECIES INFORMATION

Organism Neanthes arenaceodentata
Source/Date Received Donald Reish / Dec. 2, 1998
Day 0 Dry Weight (mg/worm) 0.50
Reference Toxicant Cadmium
Current Reference Toxicant Result
(96-h LC50 and 95% CL) 4.2 mg/L Cd
95% CL: 3.2 to 5.6 mg/L Cd
Reference Toxicant Warning Limits (mean ± 2SD)
9.6 ± 4.7 mg/L Cd

TEST CONDITIONS

Temperature Range (°C) 19.5 - 21.0
pH Range 7.6 - 8.0
Dissolved Oxygen Range (mg/L) 7.1 - 7.5
Salinity Range (ppt) 30
Photoperiod (L:D h) Constant ambient light
Ammonia Type and Ranges (mg/L N) n/a
☐ Inter: Day 0 _____ Day 10 _____ Day 20 _____
☐ Over: Day 0 _____ Day 10 _____ Day 20 _____
Sulfide Type and Ranges (mg/L S) n/a
☐ Inter: Day 0 _____ Day 10 _____ Day 20 _____
☐ Over: Day 0 _____ Day 10 _____ Day 20 _____

DILUTION AND CONTROL MEDIUM

Water Type UV Sterilized, Filtered Sea Water
Temperature (°C) 20.0
pH 7.9
Dissolved Oxygen (mg/L) 7.7
Salinity (ppt) 30
Other n/a

Sample ID mg/L Cd	Mean ± SD			
	Survival (%)	Individual Dry Weight (mg/worm)	Individual Growth Rate (mg/worm/day)	Total Dry Weight (mg)
Negative Control	100.0			
3.2	70.0			
5.6	30.0			
10.0	0			
18.0	0			
32.0	0			

Data Verified By G. Lawrence Date Verified Jan 27, 1999

Polychaete Worm Growth and Survival Test-Total Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-23-W	34.100	54.600	33.200	73.300	45.000
CR-10	46.100	46.700	41.600	15.600	64.100
CR-22	56.000	37.300	53.300	58.100	53.700
D-Control	0.000	50.000	61.900	2.800	44.700
AN-SS-301	53.400	40.900	42.500	41.400	40.400
AN-SS-302	41.500	77.300	14.000	20.600	75.600
AN-SS-303	61.400	49.000	29.900	49.300	26.400
AN-SS-304	45.500	24.000	84.500	32.100	33.700
AN-SS-305	52.700	50.900	76.200	59.600	58.500
AN-SS-306	69.500	61.800	47.400	56.900	59.500

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23-W	48.040	16.620	48.040	33.200	73.300	34.596	5			
CR-10	42.820	17.472	42.820	15.600	64.100	40.803	5	0.484	1.860	216.262
CR-22	51.680	8.267	51.680	37.300	58.100	15.996	5	-0.438	1.860	128.147
D-Control	31.880	28.530	31.880	0.000	61.900	89.492	5	1.094	1.860	405.452
AN-SS-301	43.720	5.467	43.720	40.400	53.400	12.504	5	0.552	1.860	113.845
AN-SS-302	45.800	29.770	45.800	14.000	77.300	65.000	5	0.147	1.860	432.341
AN-SS-303	43.200	14.673	43.200	26.400	61.400	33.966	5	0.488	1.860	182.804
AN-SS-304	43.960	23.928	43.960	24.000	84.500	54.431	5	0.313	1.860	315.666
AN-SS-305	59.580	10.001	59.580	50.900	76.200	16.786	5	-1.330	1.860	139.927
AN-SS-306	59.020	8.020	59.020	47.400	69.500	13.589	5	-1.330	1.860	126.654

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97215	0.93	0.20974	0.05778
Bartlett's Test indicates equal variances (p = 0.03)	18.845	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-23-W

Polychaete Worm Growth and Survival Test-Growth Rate

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata

Comments: Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1

Conc-%	1	2	3	4	5
CR-23-W	0.3160	0.6575	0.5283	0.8912	0.5375
CR-10	0.4360	0.4420	0.4950	0.1700	0.6160
CR-22	0.5350	0.5967	0.6412	0.5560	0.5120
D-Control	0.4750	0.5940	0.1150	0.5338	
AN-SS-301	0.8650	0.4862	0.5063	1.0100	0.4800
AN-SS-302	0.3900	0.7480	0.3250	0.2325	0.7310
AN-SS-303	0.7425	0.5875	0.4733	0.4680	0.3050
AN-SS-304	0.4300	0.5750	0.8200	0.5100	0.3120
AN-SS-305	0.5020	0.6112	0.7370	0.5710	0.5600
AN-SS-306	0.6700	0.5930	0.4490	0.5440	0.7188

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23-W	0.5861	0.2103	0.5861	0.3160	0.8912	35.876	5			
CR-10	0.4318	0.1632	0.4318	0.1700	0.6160	37.804	5	1.296	1.860	0.0264
CR-22	0.5682	0.0514	0.5682	0.5120	0.6412	9.041	5	0.185	1.860	0.0174
D-Control	0.4294	0.2152	0.4294	0.1150	0.5940	50.108	4	1.100	1.895	0.0385
AN-SS-301	0.6695	0.2502	0.6695	0.4800	1.0100	37.364	5	-0.571	1.860	0.0397
AN-SS-302	0.4853	0.2388	0.4853	0.2325	0.7480	49.203	5	0.709	1.860	0.0376
AN-SS-303	0.5153	0.1621	0.5153	0.3050	0.7425	31.452	5	0.597	1.860	0.0262
AN-SS-304	0.5294	0.1898	0.5294	0.3120	0.8200	35.846	5	0.448	1.860	0.0298
AN-SS-305	0.5962	0.0878	0.5962	0.5020	0.7370	14.734	5	-0.099	1.860	0.0193
AN-SS-306	0.5950	0.1059	0.5950	0.4490	0.7188	17.800	5	-0.084	1.860	0.0206

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-23-W

Reviewed by: GSL

Polychaete Worm Growth and Survival Test-Avg Individual Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-23-W	6.820	13.650	11.067	18.325	11.250
CR-10	9.220	9.340	10.400	3.900	12.820
CR-22	11.200	12.433	13.325	11.620	10.740
D-Control	10.000	12.380	2.800	11.175	
AN-SS-301	17.800	10.225	10.625	20.700	10.100
AN-SS-302	8.300	15.460	7.000	5.150	15.120
AN-SS-303	15.350	12.250	9.967	9.860	6.600
AN-SS-304	9.100	12.000	16.900	10.700	6.740
AN-SS-305	10.540	12.725	15.240	11.920	11.700
AN-SS-306	13.900	12.360	9.480	11.380	14.875

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23-W	12.222	4.206	12.222	6.820	18.325	34.409	5			
CR-10	9.136	3.265	9.136	3.900	12.820	35.735	5	1.296	1.860	10.542
CR-22	11.864	1.027	11.864	10.740	13.325	8.660	5	0.185	1.860	6.970
D-Control	9.089	4.304	9.089	2.800	12.380	47.351	4	1.100	1.895	15.384
AN-SS-301	13.890	5.003	13.890	10.100	20.700	36.019	5	-0.571	1.860	15.887
AN-SS-302	10.206	4.776	10.206	5.150	15.460	46.792	5	0.709	1.860	15.060
AN-SS-303	10.805	3.241	10.805	6.600	15.350	29.997	5	0.597	1.860	10.485
AN-SS-304	11.088	3.795	11.088	6.740	16.900	34.229	5	0.448	1.860	11.935
AN-SS-305	12.425	1.757	12.425	10.540	15.240	14.141	5	-0.099	1.860	7.726
AN-SS-306	12.399	2.118	12.399	9.480	14.875	17.082	5	-0.084	1.860	8.246

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-23-W

Polychaete Worm Growth and Survival Test-20 d Survival

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata

mments: Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1

Conc-%	1	2	3	4	5
CR-23-W	1.0000	0.8000	0.6000	0.8000	0.8000
CR-10	1.0000	1.0000	0.8000	0.8000	1.0000
CR-22	1.0000	0.6000	0.8000	1.0000	1.0000
D-Control	0.0000	1.0000	1.0000	0.2000	0.8000
AN-SS-301	0.6000	0.8000	0.8000	0.4000	0.8000
AN-SS-302	1.0000	1.0000	0.4000	0.8000	1.0000
AN-SS-303	0.8000	0.8000	0.6000	1.0000	0.8000
AN-SS-304	1.0000	0.4000	1.0000	0.6000	1.0000
AN-SS-305	1.0000	0.8000	1.0000	1.0000	1.0000
AN-SS-306	1.0000	1.0000	1.0000	1.0000	0.8000

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23-W	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5			
CR-10	0.9200	0.1095	0.9200	0.8000	1.0000	11.907	5	-1.500	1.860	0.0119
CR-22	0.8800	0.1789	0.8800	0.6000	1.0000	20.328	5	-0.784	1.860	0.0193
D-Control	0.6000	0.4690	0.6000	0.0000	1.0000	78.174	5	0.913	1.860	0.0893
AN-SS-301	0.6800	0.1789	0.6800	0.4000	0.8000	26.307	5	1.177	1.860	0.0193
AN-SS-302	0.8400	0.2608	0.8400	0.4000	1.0000	31.044	5	-0.302	1.860	0.0327
AN-SS-303	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	0.000	1.860	0.0149
AN-SS-304	0.8000	0.2828	0.8000	0.4000	1.0000	35.355	5	0.000	1.860	0.0372
AN-SS-305	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-2.138	1.860	0.0104
AN-SS-306	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-2.138	1.860	0.0104

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93898	0.93	-0.7969	0.97962
rtlett's Test indicates equal variances (p = 0.02)	20.3664	21.666		

othesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-23-W

Polychaete Worm Growth and Survival Test-Total Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-22	56.000	37.300	53.300	58.100	53.700
CR-23-W	34.100	54.600	33.200	73.300	45.000
CR-10	46.100	46.700	41.600	15.600	64.100
D-Control	0.000	50.000	61.900	2.800	44.700
AN-SS-301	53.400	40.900	42.500	41.400	40.400
AN-SS-302	41.500	77.300	14.000	20.600	75.600
AN-SS-303	61.400	49.000	29.900	49.300	26.400
AN-SS-304	45.500	24.000	84.500	32.100	33.700
AN-SS-305	52.700	50.900	76.200	59.600	58.500
AN-SS-306	69.500	61.800	47.400	56.900	59.500

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	51.680	8.267	51.680	37.300	58.100	15.996	5			
CR-23-W	48.040	16.620	48.040	33.200	73.300	34.596	5	0.438	1.860	128.147
CR-10	42.820	17.472	42.820	15.600	64.100	40.803	5	1.025	1.860	138.949
D-Control	31.880	28.530	31.880	0.000	61.900	89.492	5	1.491	1.860	328.139
AN-SS-301	43.720	5.467	43.720	40.400	53.400	12.504	5	1.796	1.860	36.532
AN-SS-302	45.800	29.770	45.800	14.000	77.300	65.000	5	0.426	1.860	355.028
AN-SS-303	43.200	14.673	43.200	26.400	61.400	33.966	5	1.126	1.860	105.491
AN-SS-304	43.960	23.928	43.960	24.000	84.500	54.431	5	0.682	1.860	238.353
AN-SS-305	59.580	10.001	59.580	50.900	76.200	16.786	5	-1.361	1.860	62.614
AN-SS-306	59.020	8.020	59.020	47.400	69.500	13.589	5	-1.425	1.860	49.341

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97215	0.93	0.20974	0.05778
Bartlett's Test indicates equal variances (p = 0.03)	18.845	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediments CR-22

Polychaete Worm Growth and Survival Test-Growth Rate

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-22	0.5350	0.5967	0.6412	0.5560	0.5120
CR-23-W	0.3160	0.6575	0.5283	0.8912	0.5375
CR-10	0.4360	0.4420	0.4950	0.1700	0.6160
D-Control	0.4750	0.5940	0.1150	0.5338	
AN-SS-301	0.8650	0.4862	0.5063	1.0100	0.4800
AN-SS-302	0.3900	0.7480	0.3250	0.2325	0.7310
AN-SS-303	0.7425	0.5875	0.4733	0.4680	0.3050
AN-SS-304	0.4300	0.5750	0.8200	0.5100	0.3120
AN-SS-305	0.5020	0.6112	0.7370	0.5710	0.5600
AN-SS-306	0.6700	0.5930	0.4490	0.5440	0.7188

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	0.5682	0.0514	0.5682	0.5120	0.6412	9.041	5			
CR-23-W	0.5861	0.2103	0.5861	0.3160	0.8912	35.876	5	-0.185	1.860	0.0174
CR-10	0.4318	0.1632	0.4318	0.1700	0.6160	37.804	5	1.782	1.860	0.0109
D-Control	0.4294	0.2152	0.4294	0.1150	0.5940	50.108	4	1.415	1.895	0.0182
AN-SS-301	0.6695	0.2502	0.6695	0.4800	1.0100	37.364	5	-0.887	1.860	0.0243
AN-SS-302	0.4853	0.2388	0.4853	0.2325	0.7480	49.203	5	0.759	1.860	0.0222
AN-SS-303	0.5153	0.1621	0.5153	0.3050	0.7425	31.452	5	0.696	1.860	0.0107
AN-SS-304	0.5294	0.1898	0.5294	0.3120	0.8200	35.846	5	0.441	1.860	0.0144
AN-SS-305	0.5962	0.0878	0.5962	0.5020	0.7370	14.734	5	-0.617	1.860	0.0039
AN-SS-306	0.5950	0.1059	0.5950	0.4490	0.7188	17.800	5	-0.508	1.860	0.0052

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-22.

Reviewed by: GSL

Polychaete Worm Growth and Survival Test-Avg Individual Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-22	11.200	12.433	13.325	11.620	10.740
CR-23-W	6.820	13.650	11.067	18.325	11.250
CR-10	9.220	9.340	10.400	3.900	12.820
D-Control	10.000	12.380	2.800	11.175	
AN-SS-301	17.800	10.225	10.625	20.700	10.100
AN-SS-302	8.300	15.460	7.000	5.150	15.120
AN-SS-303	15.350	12.250	9.967	9.860	6.600
AN-SS-304	9.100	12.000	16.900	10.700	6.740
AN-SS-305	10.540	12.725	15.240	11.920	11.700
AN-SS-306	13.900	12.360	9.480	11.380	14.875

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	11.864	1.027	11.864	10.740	13.325	8.660	5			
CR-23-W	12.222	4.206	12.222	6.820	18.325	34.409	5	-0.185	1.860	6.970
CR-10	9.136	3.265	9.136	3.900	12.820	35.735	5	1.782	1.860	4.357
D-Control	9.089	4.304	9.089	2.800	12.380	47.351	4	1.415	1.895	7.282
AN-SS-301	13.890	5.003	13.890	10.100	20.700	36.019	5	-0.887	1.860	9.702
AN-SS-302	10.206	4.776	10.206	5.150	15.460	46.792	5	0.759	1.860	8.875
AN-SS-303	10.805	3.241	10.805	6.600	15.350	29.997	5	0.696	1.860	4.300
AN-SS-304	11.088	3.795	11.088	6.740	16.900	34.229	5	0.441	1.860	5.750
AN-SS-305	12.425	1.757	12.425	10.540	15.240	14.141	5	-0.617	1.860	1.541
AN-SS-306	12.399	2.118	12.399	9.480	14.875	17.082	5	-0.508	1.860	2.061

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97331	0.929	0.16055	-0.4503
Bartlett's Test indicates equal variances (p = 0.21)	12.0087	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Stat. comparisons made to reference sediment CR-22

Polychaete Worm Growth and Survival Test-20 d Survival

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-22	1.0000	0.6000	0.8000	1.0000	1.0000
CR-23-W	1.0000	0.8000	0.6000	0.8000	0.8000
CR-10	1.0000	1.0000	0.8000	0.8000	1.0000
D-Control	0.0000	1.0000	1.0000	0.2000	0.8000
AN-SS-301	0.6000	0.8000	0.8000	0.4000	0.8000
AN-SS-302	1.0000	1.0000	0.4000	0.8000	1.0000
AN-SS-303	0.8000	0.8000	0.6000	1.0000	0.8000
AN-SS-304	1.0000	0.4000	1.0000	0.6000	1.0000
AN-SS-305	1.0000	0.8000	1.0000	1.0000	1.0000
AN-SS-306	1.0000	1.0000	1.0000	1.0000	0.8000

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	0.8800	0.1789	0.8800	0.6000	1.0000	20.328	5			
CR-23-W	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	0.784	1.860	0.0193
CR-10	0.9200	0.1095	0.9200	0.8000	1.0000	11.907	5	-0.426	1.860	0.0164
D-Control	0.6000	0.4690	0.6000	0.0000	1.0000	78.174	5	1.247	1.860	0.0937
AN-SS-301	0.6800	0.1789	0.6800	0.4000	0.8000	26.307	5	1.768	1.860	0.0238
AN-SS-302	0.8400	0.2608	0.8400	0.4000	1.0000	31.044	5	0.283	1.860	0.0372
AN-SS-303	0.8000	0.1414	0.8000	0.6000	1.0000	17.678	5	0.784	1.860	0.0193
AN-SS-304	0.8000	0.2828	0.8000	0.4000	1.0000	35.355	5	0.535	1.860	0.0417
AN-SS-305	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-0.894	1.860	0.0149
AN-SS-306	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	-0.894	1.860	0.0149

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93898	0.93	-0.7969	0.97962
ett's Test indicates equal variances (p = 0.02)	20.3664	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-22.

Polychaete Worm Growth and Survival Test-Total Dry Weight

Start Date:	08/12/98	Test ID:	EVS8453	Sample ID:	VARIOUS
End Date:	28/12/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	NA-Neanthes arenaceodentata
Comments:	Anchor Environmental (LLC)-Boulevard Park/Starr Rock 9/852-01.1				

Conc-%	1	2	3	4	5
CR-10	46.100	46.700	41.600	15.600	64.100
CR-22	56.000	37.300	53.300	58.100	53.700
CR-23-W	34.100	54.600	33.200	73.300	45.000
D-Control	0.000	50.000	61.900	2.800	44.700
AN-SS-301	53.400	40.900	42.500	41.400	40.400
AN-SS-302	41.500	77.300	14.000	20.600	75.600
AN-SS-303	61.400	49.000	29.900	49.300	26.400
AN-SS-304	45.500	24.000	84.500	32.100	33.700
AN-SS-305	52.700	50.900	76.200	59.600	58.500
AN-SS-306	69.500	61.800	47.400	56.900	59.500

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	42.820	17.472	42.820	15.600	64.100	40.803	5			
CR-22	51.680	8.267	51.680	37.300	58.100	15.996	5	-1.025	1.860	138.949
CR-23-W	48.040	16.620	48.040	33.200	73.300	34.596	5	-0.484	1.860	216.262
D-Control	31.880	28.530	31.880	0.000	61.900	89.492	5	0.731	1.860	416.254
AN-SS-301	43.720	5.467	43.720	40.400	53.400	12.504	5	-0.110	1.860	124.647
AN-SS-302	45.800	29.770	45.800	14.000	77.300	65.000	5	-0.193	1.860	443.142
AN-SS-303	43.200	14.673	43.200	26.400	61.400	33.966	5	-0.037	1.860	193.606
AN-SS-304	43.960	23.928	43.960	24.000	84.500	54.431	5	-0.086	1.860	326.468
AN-SS-305	59.580	10.001	59.580	50.900	76.200	16.786	5	-1.862	1.860	150.729
AN-SS-306	59.020	8.020	59.020	47.400	69.500	13.589	5	-1.884	1.860	137.456

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97215	0.93	0.20974	0.05778
Bartlett's Test indicates equal variances (p = 0.03)	18.845	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Statistical comparisons made to reference sediment CR-10

EVS CONSULTANTS
SEDIMENT TOXICITY TESTS - SURVIVAL AND FINAL WATER QUALITY DATA

Client: Various
EVS Project No.: 9/852-01.1
EVS Work Order No.: 9800688

Test Type: 20-d survival and growth
Test Species: Hyalella azteca & Chironomus tentans
Test Initiation Date (Day 0): Dec. 8, 1998
Test Termination Date: Dec. 28, 1998

Sample ID	Rep.	Pan No.	No. Alive	No. Dead	Total Recovered	No. Missing	Tech. Init.	Temp. (°C)	pH	Cond. (µmhos/cm) ☐ Salinity (ppt) ☑	DO (mg/L)
Control/Sed.	A	1	0	5	0	0	BST	21.0	7.8	29	5.4 ~~7.8~~
	B	2	5	0	5	0		21.0	7.7	29	~~7.7~~ 5.7 ~~5.7~~
	C ①	3	0	5	0	~~5~~ 0		21.0	7.6	29	~~7.6~~ 5.7 ~~5.8~~
	D *	4	~~5~~ ~~4~~ 1	0	~~5~~ ~~4~~ 1	~~0~~ 4		21.0	7.3	29	~~7.3~~ 3.8
	E	5	~~5~~ ~~4~~	0	~~5~~ 4	1		21.0	7.8	30	~~7.8~~ 5.8
CR-10	A	6	5	0	5	0		21.0	7.2	30	0.9
	B	7	5	0	5	0		21.0	7.9	30	4.8
	C	8	4	0	4	1		21.0	7.9	30	5.2
	D	9	4	0	4	1		21.0	7.4	30	0.8
	E	10	5	0	5	0		21.0	7.8	30	3.8
CR-22	A	11	5	0	5	0		21.0	7.9	30	5.6 ~~7.9~~
	B	12	3	0	3	2		21.0	7.8	30	5.6 ~~7.8~~
	C	13	4	0	4	1		21.0	7.9	30	5.5 ~~7.9~~
	D	14	5	0	5	0		21.0	7.8	30	5.5 ~~7.8~~
	E	15	5	0	5	0		21.0	7.8	30	5.2 ~~7.8~~
							Technician's Initials	BST	BST	BST	BST

~~* exchanged with W.Q. jar in tear down.~~
① Pan # 3 used to tear down W.Q. jar + W.Q. Jar has 5 worm alive

WQ Instruments Used: Temp. Calibrated Thermometer pH 4-A-30 Cond./Sal. 11-C-22 DO 11-A-20
Data Verified By
Date Verified: Jan 27, 1999

Forms\Lab\Datasheets\Sediment\SURVIVAL.WPD February 21, 1997

Statis : use 5 "alive" for rep. C. GSL

EVS CONSULTANTS
SEDIMENT TOXICITY TESTS - SURVIVAL AND FINAL WATER QUALITY DATA

Client: Various
EVS Project No.: 91852-01-1
EVS Work Order No.: 9800688

Test Type: 20-d survival and growth
Test Species: Hyalella azteca & Chironomus dilutus
Test Initiation Date (Day 0): Dec-8, 1998
Test Termination Date: Dec-28, 1998

Sample ID	Rep.	Pan No.	No. Alive	No. Dead	Total Recovered	No. Missing	Tech. Init.	Temp. (°C)	pH	Cond. (µmhos/cm) ☐ Salinity (ppt) ☑	DO (mg/L)
CR-23-W	A	16	5	0	5	0		21.0	7.9	29	5.4
	B	17	4	0	4	1		21.0	7.7	29	4.6
	C	18	3	0	3	2		21.0	7.8	29	5.2
	D	19	4	0	4	1		21.0	7.7	29	5.2
	E	20	4	0	4	1		21.0	7.7	29	5.1
							Technician's Initials				

WQ Instruments Used: Temp. Calibrated Hg thermometer pH T-14-30 Cond./Sal. T-C-22 DO T-A-20
Data Verified By: [signature]
Date Verified: Jan 22, 1999

EVS ENVIRONMENT CONSULTANTS

MARINE POLYCHAETE DRY WEIGHT DATA SHEET

CLIENT: Anchor Environmental
PROJECT #: 9/852-01.1
WORK ORDER #: 9800688

TEST SPECIES: Nenthes arenaceodentata
TEST INITIATION DATE: Dec.08,1998.
FILE NAME: a:\polydrywa:\polydryw\inw688.wk1
BALANCE TYPE: Mettler Toledo AG104

Pan #	Rep	Sample ID:	Survival At Start	Survival At Day 20	# Worms Weighed	Pan Weight (mg)	Pan + Worm Weight (mg)
	1	IN.W.	5		5	1267.8	1270.0 OK
	2	IN.W.	5		5	1265.8	1267.9 OK
	3	IN.W.	5		5	1281.0	1283.0 OK
	4	IN.W.	5		5	1283.7	1286.6 OK

Note:
By visual observation about 50% of worms were normal in size (average weight 0.42 mg/worm), and about 50% were big in size (pan # 4 represent this group: 0.58 mg/worm).

Technician Initials: JGK

Technician Initials: JGK

H:\user\lab1\s* *olydrywt.wk1 and Balance Room C:\polydrywt.wk1

EVS ENVIRONMENT CONSULTANTS

MARINE POLYCHAETE DRY WEIGHT DATA SHEET

CLIENT: Anchor Environmental (LLC)
PROJECT #: 9/852-01.1
WORK ORDER #: 9800688

TEST SPECIES: Neanthes arenaceodentata
TEST INITIATION DATE: Dec.8,1998
FILE NAME: a:\polydryw\test688.wk1
BALANCE TYPE: Mettler Toledo AG104

Pan #	Rep	Sample ID:	Survival At Start	Survival At Day 20	# Worms Weighed	Pan Weight (mg)	Pan + Worm Weight (mg)
1	A	Control Sediment	5	0	0	1271.2	1271.2 CHECK FOR ERROR
2	B	Control Sediment	5	5	5	1273.4	1323.4 OK
3	C	Control Sediment	5	5	5	1282.6	1344.5 OK
4	D	Control Sediment	5	1	1	1265.2	1268.0 OK
5	E	Control Sediment	5	4	4	1286.0	1330.7 OK
6	A	CR-10	5	5	5	1264.5	1310.6 OK
7	B	CR-10	5	5	5	1309.9	1356.6 OK
8	C	CR-10	5	4	4	1269.5	1311.1 OK
9	D	CR-10	5	4	4	1270.3	1285.9 OK
10	E	CR-10	5	5	5	1303.2	1367.3 OK
11	A	CR-22	5	5	5	1258.9	1314.9 OK
12	B	CR-22	5	3	3	1260.1	1297.4 OK
13	C	CR-22	5	4	4	1281.2	1334.5 OK
14	D	CR-22	5	5	5	1281.6	1339.7 OK
15	E	CR-22	5	5	5	1268.8	1322.5 OK
16	A	CR-23-W	5	5	5	1290.2	1324.3 OK
17	B	CR-23-W	5	4	4	1277.7	1332.3 OK
18	C	CR-23-W	5	3	3	1272.9	1306.1 OK
19	D	CR-23-W	5	4	4	1302.8	1376.1 OK
20	E	CR-23-W	5	4	4	1279.8	1324.8 OK
21	A	AN-SS-36	5	5	5	1289.8	1335 OK
22	B	AN-SS-36	5	5	5	1260.3	1305.2 OK

H:\user\lab1\stats\polydrywt.wk1 and Balance Room C:\polydrywt.wk1

G. Lauren
Jan 27, 1999

91	A	AN–SS–301	5	3	3	1291.9	1345.3 OK
92	B	AN–SS–301	5	4	4	1297.2	1338.1 OK

93	C	AN-SS-301	5	4	4	1286.2	1328.7 OK
94	D	AN-SS-301	5	2	2	1291.4	1332.8 OK
95	E	AN-SS-301	5	4	4	1289.7	1330.1 OK
96	A	AN-SS-302	5	5	5	1284.7	1326.2 OK
97	B	AN-SS-302	5	5	5	1282.1	1359.4 OK
98	C	AN-SS-302	5	2	2	1289.1	1303.1 OK
99	D	AN-SS-302	5	4	4	1285.8	1306.4 OK
100	E	AN-SS-302	5	5	5	1312.7	1388.3 OK
101	A	AN-SS-303	5	4	4	1307.5	1368.9 OK
102	B	AN-SS-303	5	4	4	1284.7	1333.7 OK
103	C	AN-SS-303	5	3	3	1312.4	1342.3 OK
104	D	AN-SS-303	5	5	5	1307.8	1357.1 OK
105	E	AN-SS-303	5	4	4	1291.4	1317.8 OK
106	A	AN-SS-304	5	5	5	1291.1	1336.6 OK
107	B	AN-SS-304	5	2	2	1291.8	1315.8 OK
108	C	AN-SS-304	5	5	5	1274.6	1359.1 OK
109	D	AN-SS-304	5	3	3	1275.9	1308 OK
110	E	AN-SS-304	5	5	5	1281.4	1315.1 OK
111	A	AN-SS-305	5	5	5	1294.8	1347.5 OK
112	B	AN-SS-305	5	4	4	1280.4	1331.3 OK
113	C	AN-SS-305	5	5	5	1277.4	1353.6 OK
114	D	AN-SS-305	5	5	5	1291.2	1350.8 OK
115	E	AN-SS-305	5	5	5	1291.6	1350.1 OK
116	A	AN-SS-306	5	5	5	1290.1	1359.6 OK
117	B	AN-SS-306	5	5	5	1300.5	1362.3 OK
118	C	AN-SS-306	5	5	5	1293	1340.4 OK
119	D	AN-SS-306	5	5	5	1291.6	1348.5 OK
120	E	AN-SS-306	5	4	4	1282.8	1342.3 OK

Technician Initials: JGK Technician Initials: JGK

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

End of Report

RESULTS OF ANALYSIS - Water

File No. K2528

	Ammonia Nitrogen N	Sulphide S
Control 1998 Dec 28	8.63	0.06
ANSS 306 1998 Dec 28	1.74	<0.02
ANSS 305 1998 Dec 28	2.35	<0.05
ANSS 302 1998 Dec 28	7.45	0.02
CR 22 1998 Dec 28	4.40	<0.02
ANSS 303 1998 Dec 28	1.37	0.03
CR 10 1998 Dec 28	2.75	0.6

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Day 20, Neanthes, interstitial Ammonia and overlying Sulphide.

RESULTS OF ANALYSIS - Water

File No. K2528

	Ammonia Nitrogen N	Sulphide S
CR 23W 1998 Dec 28	9.68	0.02
ANSS 301 1998 Dec 28	3.70	0.02
ANSS 304 1998 Dec 28	6.38	0.31

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Day 20, Neanthes, interstitial Ammonia and overlying Sulphide.

REMARKS

File No. K2528

The detection limit for Sulphide has been increased for some of the samples reported in the following data tables due to turbidity in the samples.

Appendix 1 - QUALITY CONTROL - Replicates

File No. K2404

Water		CR-22	CR-22
		98 12 18	QC # - 143325
Nutrients			
Ammonia Nitrogen	N	10.0	10.1

Results are expressed as milligrams per litre.
Results are for Day 10, Neanthes, interstitial water.
< = Less than the detection limit indicated.

Appendix 1 - QUALITY CONTROL - Replicates

File No. K2404

Water		AN-SS-301 98 12 18	AN-SC-301 QC # - 143324
Nutrients			
Ammonia Nitrogen	N	4.87	4.84

Results are expressed as milligrams per litre.
Results are for Day 10, Neanthes, interstitial water.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Water

File No. K2404

		CR-22	CR-23W
		98 12 18	98 12 18
Nutrients			
Ammonia Nitrogen	N	10.0	11.7

Results are expressed as milligrams per litre.
Results are for Day 10, Neanthes, interstitial water.
: = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Water File No. K2404

		AN-SS-301	AN-SS-302
		98 12 18	98 12 18
Nutrients			
Ammonia Nitrogen	N	4.87	5.57

Results are expressed as milligrams per litre.
Results are for Day 10, Neanthes, interstitial water.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Water

File No. K2404

		AN-SS-303	AN-SS-304	AN-SS-305	AN-SS-306	CR-10
		98 12 18	98 12 18	98 12 18	98 12 18	98 12 18
Nutrients						
Ammonia Nitrogen	N	6.90	4.35	4.73	7.14	5.80

Results are expressed as milligrams per litre.
Results are for Day 10, Neanthes, interstitial water.
< = Less than the detection limit indicated.

RESULTS OF ANALYSIS - Water File No. K2404

		Control
		98 12 18
Nutrients		
Ammonia Nitrogen	N	2.58

Results are expressed as milligrams per litre.
Results are for Day 10, Neanthes, interstitial water.
< = Less than the detection limit indicated.

Appendix 1 - QUALITY CONTROL - Replicates

File No. K2101

Water	AN-SS-304 98 12 08	AN-SS-304 QC # - 142358
Inorganic Parameters		
Sulphide S	<0.02	<0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Day 0, Neanthes, interstitial ammonia and overlying sulphide.

RESULTS OF ANALYSIS - Water

File No. K2101

	Ammonia Nitrogen N	Sulphide S
AN-SS- 301 1998 Dec 8	5.82	<0.02
AN-SS- 302 1998 Dec 8	11.0	<0.02
AN-SS- 303 1998 Dec 8	10.4	0.03
AN-SS- 304 1998 Dec 8	5.96	<0.02
AN-SC- 305 1998 Dec 8	6.18	<0.02
AN-SS- 306 1998 Dec 8	11.6	0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as Day 0, Neanthes, interstitial ammonia and overlying sulphide.

APPENDIX D

Raw Data for the 48-h *Mytilus galloprovincialis* Larvae Development Toxicity Tests

EVS CONSULTANTS
48-h LARVAL DEVELOPMENT TOXICITY TEST - DAILY WATER QUALITY DATA

Client Boulevard Park / Starr Rock
EVS Project No. 9852-01.1
EVS Work Order No. 9800689
Logbook #10 Pages 145-147

Test Initiation Date/Time Nov. 25/98 (1640h)
Test Termination Date Nov. 27/98
Test Species M. galloprovincialis

Sample ID	Temperature (°C)			pH			Salinity (ppt)			Dissolved Oxygen (mg/L)		
	0	24	48	0	24	48	0	24	48	0	24	48
AN-SS-301	15.0	15.5	15.5	7.9	7.9	7.8	29	29	30	6.5	5.9	6.1
AN-SS-302	15.0	15.5	15.5	7.9	7.9	7.8	29	29	31	6.4	5.9	6.2
AN-SS-303	15.0	15.5	15.5	8.0	7.9	7.8	29	29	30	6.4	5.9	6.1
AN-SS-304	15.0	15.5	16.0	8.0	7.9	7.8	29	29	30	6.5	6.0	6.0
AN-SS-305	15.0	15.5	16.0	8.0	7.9	7.8	29	29	31	6.5	6.0	6.1
AN-SS-306	15.0	15.5	16.0	8.0	7.9	~~7.8~~ 7.9	29	30	31	6.5	5.6	6.0
Technician Initials	BGM	JGK	AMB	BGM	JGK	AMB	AMB BGM	JGK	JGK	BGM	JGK	AMB

WQ Instruments Used: Temp. calibrated Hg thermo. pH II-A-30 Salinity II-C-22 DO I-A-20
Comments

Test Set Up By JGK, PAH Data Verified By C. McPherson Date Verified Dec 22/98

EVS CONSULTANTS
LARVAL DEVELOPMENT SEDIMENT TOXICITY TEST DATA SUMMARY

Client: BOULEVARD PARK / BLACK ROCK
EVS Project No.: 9/852-01.1
EVS Work Order No.: 9800689

EVS Analysts: SK JLK BLH CNR GSY JEH PAH
Test Type/Duration: 48h Bivalve Larvae
Test Initiation Date (Day 0): November 25, 1998

SAMPLE

Identification: LARIUS
Amount Received: 7x1L, 10x1L, 9x1L
Date Collected: October 26-29, 1998
Date Received: October 28-30, 1998

TEST SPECIES INFORMATION

Organism: Mytilus galloprovincialis
Source: Carlsbad Aquafarm, Inc
Date Received: November 25, 1998
Reference Toxicant: SDS
Current Reference Toxicant Result: NORMAL ; ALIVE/NORMAL
(EC50 and 95% CL): 3.3 (3.2 + 3.4) mg/L SDS ; 3.2 (3.1 + 3.3) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD)
3.7 ± 1.6 mg/L SDS ; 3.4 ± 1.3 mg/L SDS

TEST CONDITIONS

Temperature Range (°C): 15.0-17.0
pH Range: 7.7-8.0
Dissolved Oxygen Range (mg/L): 4.4-8.0
Salinity Range (ppt): 29-31
Photoperiod (L:D h): 14:10
Ammonia Type and Ranges (mg/L N): OVERLYING
Start (0 h): <0.02 - 0.37 End: 0.04-0.33
Sulphide Type and Ranges (mg/L S): OVERLYING
Start (0 h): <0.02 - 0.10 End: <0.02
Other: → INITIAL EMBRYO DENSITY: 285 embryos/mL

DILUTION AND CONTROL MEDIUM

Water Type: FILTERED, UV-STERILIZED SEAWATER
Temperature (°C): 15.0
pH: 8.0
Dissolved Oxygen (mg/L): 8.0
Salinity (ppt): 29
Other: AMMONIA (mg/L N): <0.02
SULFIDES (mg/L S): <0.02

Sample ID	Mean ± SD		
	% Normal Larvae	% Surviving Larvae	% Normal/Surviving Larvae
NEGATIVE CONTROL	94.1±1.1	96.8±3.6	91.8±5.0
CR-10	92.9±4.0	75.5±8.9*	70.0±7.5*
CR-22	97.4±2.0	70.4±6.1*	68.6±5.7*
CR-23W	95.9±0.8	71.6±3.6*	68.7±3.6*
AN-SS-301	95.3±0.7 +	76.8±3.4*	73.2±3.4*
AN-SS-302	95.7±1.3	71.9±3.7*	68.8±3.9*
AN-SS-303	96.9±1.1	73.1±3.9*	70.8±3.4*
AN-SS-304	84.6±3.0 *Δ+0	69.0±2.6*	58.5±3.4 *Δ+0
AN-SS-305	94.1±1.1 +0	72.0±3.5*	68.4±2.9*
AN-SS-306	89.5±3.1 *+0	71.6±2.4*	64.1±3.4 *0

* - INDICATES SIGNIFICANT DIFFERENCE BETWEEN SAMPLE AND NEGATIVE CONTROL

Data Verified By: C McPherson Date Verified: Dec 23/98

Δ - INDICATES SIGNIFICANT DIFFERENCE BETWEEN SAMPLE AND REFERENCE SEDIMENT CR-10.
+ - INDICATES SIGNIFICANT DIFFERENCE BETWEEN SAMPLE AND REFERENCE SEDIMENT CR-22.

0 - INDICATES SIGNIFICANT DIFFERENCE BETWEEN SAMPLE AND REFERENCE SEDIMENT CR-23W.

EVS CONSULTANTS
48-h LARVAL DEVELOPMENT TOXICITY TEST - DAILY WATER QUALITY DATA

Client ——

EVS Project No. 9852-01.1

EVS Work Order No. 9800689

Logbook #10 Pages 145-147

Test Initiation Date/Time Nov. 25/98 (1640h)

Test Termination Date Nov. 27/98

Test Species M. galloprovincialis

Sample ID	Temperature (°C)			pH			Salinity (ppt)			Dissolved Oxygen (mg/L)		
	0	24	48	0	24	48	0	24	48	0	24	48
Negative Control	15.0	15.5	16.0	8.0	8.0	8.0	29	29	30	8.0	7.3	7.5
CR-10	15.0	15.5	16.0	8.0	7.9	7.9	29	29	31	7.7	6.9	6.9
CR-22	15.0	15.5	16.0	8.0	7.9	7.9	29	29	30	7.3	6.8	7.0
CR-23W	15.0	15.5	16.0	8.0	7.9	7.9	29	29	31	7.2	6.3	6.3
Technician Initials	BGM	JGL	CMB	BGM	JGL	CMB	[illegible]	JGL	JGL	BGM	JGL	[illegible] CMB

WQ Instruments Used: Temp. Calibrated Hg thermo pH II-A-30 Salinity II-C-22 DO II-A-20

Comments

Test Set Up By JGL, PAH Data Verified By [signature] Date Verified Dec 22/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - FINAL WATER QUALITY

Client BOULEVARD PACK / STARR ROCK
EVS Project No. 9/552-01.1
EVS Work Order No. 9/852-01.1 7800689
Logbook #10 Pages 145-147

Test Species M. galloprovincialis
Test Initiation Date/Time NOVEMBER 25 1998 / 1640h
Test Termination Date NOVEMBER 27, 1998
Test Duration 48h

Sample ID	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
AN-SS-301	A	15.5	7.8	30	5.7
	B	16.0	7.7	30	5.6
	C	16.0	7.7	30	5.4
	D	16.0	7.7	30	5.8
	E	16.0	7.7	30	5.3
AN-SS-302	A	16.0	7.7	30	5.8
	B	16.0	7.7	30	5.0
	C	16.0	7.8	30	5.5
	D	16.0	7.8	30	5.6
	E	16.0	7.8	30	5.7
AN-SS-303	A	16.0	7.9	30	6.0
	B	16.0	7.8	30	5.6
	C	16.0	7.9	30	5.2
	D	16.0	7.9	30	5.4
	E	16.0	7.8	30	5.3
		#Cells			
Tech. Init.		CMB	JKH CMB	JKH	CMB JKH

WQ Instruments Used: Temp. calibrated thermometer pH II-A-30 Salinity II-C-22 DO II-A-20

Comments

Test Set Up By JKK, FAH Data Verified By C. McPherson Date Verified Dec 27 98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - FINAL WATER QUALITY

Client BOULEVARD PARK / SNAKE ROCK
EVS Project No. 9852-01.1
EVS Work Order No. 9852-01-T9800689
Logbook #10 Pages 145-147

Test Species M. galloprovincialis
Test Initiation Date/Time November 25, 1998 / 1:40h
Test Termination Date November 27, 1998
Test Duration 48h

Sample ID	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
AN-SS-304	A	16.0	7.9	30	CWB 5.8 6.0
	B	16.0	7.8	30	CWB 5.5 5.8
	C	17.0	7.8	30	CWB 5.6 4.4
	D	16.0	7.9	30	CWB 6.2 6.3
	E	16.0	7.8	30	CWB 5.0 5.4
AN-SS-305	A	16.0	7.8	30	5.8
	B	16.0	7.8	30	5.5
	C	16.0	7.8	30	5.6
	D	16.0	7.9	30	6.2
	E	16.0	7.7	30	5.0
AN-SS-306	A	16.0	7.9	30	5.8
	B	16.0	7.9	30	6.3
	C	16.0	7.9	30	6.4
	D	16.0	7.9	30	6.6
	E	16.0	7.9	30	6.6
Tech. Init.		CWB	JAM CWB	JAM / CWB	JAM / CWB

WQ Instruments Used: Temp. Calibrated thermometer pH II-A-30 Salinity II-C-22 DO II-A-20

Comments

Test Set Up By JGK, PAH Data Verified By [signature] Date Verified 12/2/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - FINAL WATER QUALITY

Client _____
EVS Project No. 9852-01.1
EVS Work Order No. 9800689
Logbook #10 Pages 145-147

Test Species M. galloprovincialis
Test Initiation Date/Time November 25, 1998 / 1640h
Test Termination Date November 27, 1998
Test Duration 48h

Sample ID	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
CR-10	A	16.0	7.9	30	6.4
	B	16.0	7.9	30	6.5
	C	16.0	8.0	30	6.6
	D	16.0	8.0	30	6.7
	E	16.0	7.9	30	5.7
CR-22	A	16.0	7.8	30	6.0
	B	16.0	7.9	30	6.4
	C	16.0	7.9	30	6.4
	D	17.0	7.9	30	6.5
	E	16.0	7.9	30	6.6
CR-23 W	A	16.0	7.8	30	6.0
	B	16.0	7.8	30	5.9
	C	16.0	7.8	30	5.8
	D	16.0	7.9	30	6.2
	E	16.0	7.9	30	5.8
Tech. Init.		CAB	JFM / CAB	JFM	JFM / CAB

WQ Instruments Used: Temp. calibrated thermometer pH II-A-30 Salinity II-C-22 DO II-A-20

Comments _____

Test Set Up By JGK, JFM Data Verified By C. A. Blaylock Date Verified Dec 22/98

Bivalve Larval Survival and Development Test-Proportion Normal

Start Date:	25/11/98	Test ID:	evs8478	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-22	0.9948	0.9653	0.9952	0.9661	0.9507
AN-SS-301	0.9481	0.9474	0.9548	0.9515	0.9648
AN-SS-302	0.9765	0.9471	0.9442	0.9552	0.9612
AN-SS-303	0.9849	0.9535	0.9691	0.9682	0.9673
AN-SS-304	0.8854	0.8042	0.8402	0.8599	0.8416
AN-SC-305	0.9356	0.9263	0.9463	0.9536	0.9447
AN-SC-306	0.8400	0.9073	0.9014	0.9179	0.9087

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	0.9744	0.0198	1.4232	1.3468	1.5016	5.047	5			
*AN-SS-301	0.9533	0.0071	1.3535	1.3393	1.3819	1.279	5	2.111	1.860	0.0020
AN-SS-302	0.9568	0.0129	1.3636	1.3323	1.4170	2.477	5	1.680	1.860	0.0023
AN-SS-303	0.9686	0.0111	1.3951	1.3534	1.4477	2.419	5	0.792	1.860	0.0023
*AN-SS-304	0.8463	0.0298	1.1692	1.1125	1.2255	3.542	5	6.850	1.860	0.0026
*AN-SC-305	0.9413	0.0106	1.3269	1.2958	1.3537	1.681	5	2.865	1.860	0.0021
*AN-SC-306	0.8951	0.0313	1.2432	1.1593	1.2803	3.866	5	4.657	1.860	0.0028

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.9779	0.91	0.00403	0.14147
Bartlett's Test indicates equal variances (p = 0.16)	9.30489	16.8119		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-22.

Reviewed by: CdH 12/1/98

Bivalve Larval Survival and Development Test-Proportion Alive/Normal

Start Date:	25/11/98	Test ID:	evs8477	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-10	0.6667	0.6947	0.6351	0.8281	0.6772
AN-SS-301	0.7053	0.7579	0.7404	0.6877	0.7684
AN-SS-302	0.7298	0.6281	0.7123	0.6737	0.6947
AN-SS-303	0.6877	0.7193	0.6596	0.7474	0.7263
AN-SS-304	0.5965	0.5333	0.5719	0.6246	0.5965
AN-SC-305	0.6632	0.7053	0.6807	0.6491	0.7193
AN-SC-306	0.5895	0.6526	0.6737	0.6281	0.6632

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	0.7004	0.0746	0.9945	0.9222	1.1432	8.672	5			
AN-SS-301	0.7319	0.0344	1.0272	0.9778	1.0687	3.774	5	-0.772	1.860	0.0033
AN-SS-302	0.6877	0.0393	0.9784	0.9149	1.0242	4.309	5	0.376	1.860	0.0034
AN-SS-303	0.7081	0.0345	1.0005	0.9479	1.0442	3.780	5	-0.142	1.860	0.0033
*AN-SS-304	0.5846	0.0342	0.8705	0.8188	0.9113	3.978	5	2.984	1.860	0.0032
AN-SC-305	0.6835	0.0290	0.9736	0.9368	1.0124	3.206	5	0.510	1.860	0.0031
AN-SC-306	0.6414	0.0336	0.9290	0.8754	0.9628	3.752	5	1.575	1.860	0.0032

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.92798	0.91	0.95825	2.88479
Bartlett's Test indicates equal variances (p = 0.33)	6.88132	16.8119		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates significant differences				

* STAT. COMPARISON MADE WITH REFERENCE SED. CR-10.

Reviewed by: CdM 12/27/98

Bivalve Larval Survival and Development Test-Proportion Alive

Start Date:	25/11/98	Test ID:	evs8477	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-10	0.7298	0.7228	0.7193	0.9123	0.6912
AN-SS-301	0.7439	0.8000	0.7754	0.7228	0.7965
AN-SS-302	0.7474	0.6632	0.7544	0.7053	0.7228
AN-SS-303	0.6982	0.7544	0.6807	0.7719	0.7509
AN-SS-304	0.6737	0.6632	0.6807	0.7263	0.7088
AN-SC-305	0.7088	0.7614	0.7193	0.6807	0.7614
AN-SC-306	0.7018	0.7193	0.7474	0.6842	0.7298

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	0.7551	0.0891	1.0609	0.9816	1.2701	11.126	5			
AN-SS-301	0.7677	0.0336	1.0687	1.0163	1.1071	3.704	5	-0.139	1.860	0.0058
AN-SS-302	0.7186	0.0367	1.0123	0.9516	1.0523	3.998	5	0.872	1.860	0.0058
AN-SS-303	0.7312	0.0394	1.0266	0.9703	1.0729	4.312	5	0.609	1.860	0.0059
AN-SS-304	0.6905	0.0262	0.9811	0.9516	1.0203	2.902	5	1.469	1.860	0.0055
AN-SC-305	0.7263	0.0350	1.0209	0.9703	1.0605	3.847	5	0.720	1.860	0.0058
AN-SC-306	0.7165	0.0245	1.0096	0.9741	1.0442	2.691	5	0.948	1.860	0.0055

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.84587	0.91	1.89705	7.16687
Bartlett's Test indicates equal variances (p = 0.03)	14.2676	16.8119		

Hypothesis Test (1-tail, 0.05)

Heteroscedastic t Test indicates no significant differences

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-10.

Reviewed by: 12/4/98

Bivalve Larval Survival and Development Test-Proportion Normal

Start Date:	25/11/98	Test ID:	evs8477	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-10	0.9135	0.9612	0.8829	0.9077	0.9797
AN-SS-301	0.9481	0.9474	0.9548	0.9515	0.9648
AN-SS-302	0.9765	0.9471	0.9442	0.9552	0.9612
AN-SS-303	0.9849	0.9535	0.9691	0.9682	0.9673
AN-SS-304	0.8854	0.8042	0.8402	0.8599	0.8416
AN-SC-305	0.9356	0.9263	0.9463	0.9536	0.9447
AN-SC-306	0.8400	0.9073	0.9014	0.9179	0.9087

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-10	0.9290	0.0401	1.3112	1.2216	1.4278	6.529	5			
AN-SS-301	0.9533	0.0071	1.3535	1.3393	1.3819	1.279	5	-1.082	1.860	0.0028
AN-SS-302	0.9568	0.0129	1.3636	1.3323	1.4170	2.477	5	-1.272	1.860	0.0031
AN-SS-303	0.9686	0.0111	1.3951	1.3534	1.4477	2.419	5	-2.038	1.860	0.0031
*AN-SS-304	0.8463	0.0298	1.1692	1.1125	1.2255	3.542	5	3.339	1.860	0.0034
AN-SC-305	0.9413	0.0106	1.3269	1.2958	1.3537	1.681	5	-0.395	1.860	0.0029
AN-SC-306	0.8951	0.0313	1.2432	1.1593	1.2803	3.866	5	1.549	1.860	0.0036

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97589	0.91	0.25683	1.17526
Bartlett's Test indicates equal variances (p = 0.06)	12.1865	16.8119		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates significant differences				

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-10.

Reviewed by [illegible] Dec 22/98

Bivalve Larval Survival and Development Test-Proportion Alive/Normal

Start Date:	25/11/98	Test ID:	evs8476	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
D-Control	0.9368	0.9860	0.9298	0.8596	0.8772
CR-10	0.6667	0.6947	0.6351	0.8281	0.6772
CR-22	0.6702	0.6842	0.7298	0.6000	0.7439
CR-23W	0.6737	0.7368	0.6526	0.7123	0.6596
AN-SS-301	0.7053	0.7579	0.7404	0.6877	0.7684
AN-SS-302	0.7298	0.6281	0.7123	0.6737	0.6947
AN-SS-303	0.6877	0.7193	0.6596	0.7474	0.7263
AN-SS-304	0.5965	0.5333	0.5719	0.6246	0.5965
AN-SC-305	0.6632	0.7053	0.6807	0.6491	0.7193
AN-SC-306	0.5895	0.6526	0.6737	0.6281	0.6632

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9179	0.0505	1.2942	1.1868	1.4520	8.073	5			
*CR-10	0.7004	0.0746	0.9945	0.9222	1.1432	8.672	5	4.946	1.860	0.0068
*CR-22	0.6856	0.0568	0.9767	0.8861	1.0401	6.230	5	5.872	1.860	0.0054
*CR-23W	0.6870	0.0362	0.9776	0.9405	1.0321	4.022	5	6.342	1.860	0.0046
*AN-SS-301	0.7319	0.0344	1.0272	0.9778	1.0687	3.774	5	5.358	1.860	0.0046
*AN-SS-302	0.6877	0.0393	0.9784	0.9149	1.0242	4.309	5	6.268	1.860	0.0047
*AN-SS-303	0.7081	0.0345	1.0005	0.9479	1.0442	3.780	5	5.910	1.860	0.0046
*AN-SS-304	0.5846	0.0342	0.8705	0.8188	0.9113	3.978	5	8.607	1.860	0.0045
*AN-SC-305	0.6835	0.0290	0.9736	0.9368	1.0124	3.206	5	6.574	1.860	0.0044
*AN-SC-306	0.6414	0.0336	0.9290	0.8754	0.9628	3.752	5	7.414	1.860	0.0045

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95046	0.93	0.691	1.92647
Bartlett's Test indicates equal variances (p = 0.14)	13.5794	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* STAT. COMPARISONS MADE WITH D-CONTROL (NEGATIVE CONTROL)

Reviewed by [illegible] 12/28/98

Bivalve Larval Survival and Development Test-Proportion Alive

Start Date:	25/11/98	Test ID:	evs8476	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
D-Control	0.9895	1.0000	0.9930	0.9298	0.9263
CR-10	0.7298	0.7228	0.7193	0.9123	0.6912
CR-22	0.6737	0.7088	0.7333	0.6211	0.7825
CR-23W	0.6947	0.7684	0.6842	0.7404	0.6947
AN-SS-301	0.7439	0.8000	0.7754	0.7228	0.7965
AN-SS-302	0.7474	0.6632	0.7544	0.7053	0.7228
AN-SS-303	0.6982	0.7544	0.6807	0.7719	0.7509
AN-SS-304	0.6737	0.6632	0.6807	0.7263	0.7088
AN-SC-305	0.7088	0.7614	0.7193	0.6807	0.7614
AN-SC-306	0.7018	0.7193	0.7474	0.6842	0.7298

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9677	0.0364	1.4189	1.2959	1.5412	7.928	5			
*CR-10	0.7551	0.0891	1.0609	0.9816	1.2701	11.126	5	4.909	1.860	0.0099
*CR-22	0.7039	0.0609	0.9970	0.9077	1.0856	6.725	5	7.204	1.860	0.0064
*CR-23W	0.7165	0.0362	1.0100	0.9741	1.0687	4.032	5	7.644	1.860	0.0053
*AN-SS-301	0.7677	0.0336	1.0687	1.0163	1.1071	3.704	5	6.567	1.860	0.0053
*AN-SS-302	0.7186	0.0367	1.0123	0.9516	1.0523	3.998	5	7.606	1.860	0.0053
*AN-SS-303	0.7312	0.0394	1.0266	0.9703	1.0729	4.312	5	7.257	1.860	0.0054
*AN-SS-304	0.6905	0.0262	0.9811	0.9516	1.0203	2.902	5	8.436	1.860	0.0050
*AN-SC-305	0.7263	0.0350	1.0209	0.9703	1.0605	3.847	5	7.470	1.860	0.0053
*AN-SC-306	0.7165	0.0245	1.0096	0.9741	1.0442	2.691	5	7.909	1.860	0.0050

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95519	0.93	0.77453	2.64355
Bartlett's Test indicates equal variances (p = 0.02)	19.7618	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* STAT. COMPARISONS MADE W/ D-CONTROL (NEGATIVE CONTROL)

Reviewed by: 12/7/98

Bivalve Larval Survival and Development Test-Proportion Normal

Start Date:	25/11/98	Test ID:	evs8476	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
D-Control	0.9468	0.9525	0.9364	0.9245	0.9470
CR-10	0.9135	0.9612	0.8829	0.9077	0.9797
CR-22	0.9948	0.9653	0.9952	0.9661	0.9507
CR-23W	0.9697	0.9589	0.9538	0.9621	0.9495
AN-SS-301	0.9481	0.9474	0.9548	0.9515	0.9648
AN-SS-302	0.9765	0.9471	0.9442	0.9552	0.9612
AN-SS-303	0.9849	0.9535	0.9691	0.9682	0.9673
AN-SS-304	0.8854	0.8042	0.8402	0.8599	0.8416
AN-SC-305	0.9356	0.9263	0.9463	0.9536	0.9447
AN-SC-306	0.8400	0.9073	0.9014	0.9179	0.9087

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9414	0.0111	1.3272	1.2925	1.3512	1.748	5			
CR-10	0.9290	0.0401	1.3112	1.2216	1.4278	6.529	5	0.403	1.860	0.0029
CR-22	0.9744	0.0198	1.4232	1.3468	1.5016	5.047	5	-2.845	1.860	0.0021
CR-23W	0.9588	0.0078	1.3671	1.3441	1.3958	1.453	5	-2.924	1.860	0.0003
AN-SS-301	0.9533	0.0071	1.3535	1.3393	1.3819	1.279	5	-2.029	1.860	0.0003
AN-SS-302	0.9568	0.0129	1.3636	1.3323	1.4170	2.477	5	-1.986	1.860	0.0006
AN-SS-303	0.9686	0.0111	1.3951	1.3534	1.4477	2.419	5	-3.707	1.860	0.0006
*AN-SS-304	0.8463	0.0298	1.1692	1.1125	1.2255	3.542	5	7.442	1.860	0.0008
AN-SC-305	0.9413	0.0106	1.3269	1.2958	1.3537	1.681	5	0.024	1.860	0.0004
*AN-SC-306	0.8951	0.0313	1.2432	1.1593	1.2803	3.866	5	3.518	1.860	0.0011

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98046	0.93	0.28079	0.73158
Bartlett's Test indicates equal variances (p = 0.02)	19.681	21.666		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates significant differences

* STAT. COMPARISONS MADE WITH D-CONTROL (NEGATIVE CONTROL)

Reviewed by: Dec 7/18

Test: BV-Bivalve Larval Survival and Development Test — Test ID: evs8476
Species: MG-Mytilus galloprovincialis — Protocol: PSEP 95
Sample ID: Various — Sample Type: SEDIMENT1-Marine
Start Date: 25/11/98 — End Date: 27/11/98 — Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Initial Density	Number Normal	Number Abnormal	Notes
	1	1	D-Control	285	267	15	
	2	2	D-Control	285	281	14	
	3	3	D-Control	285	265	18	
	4	4	D-Control	285	245	20	
	5	5	D-Control	285	250	14	
	6	1	CR-10	285	190	18	
	7	2	CR-10	285	198	8	
	8	3	CR-10	285	181	24	
	9	4	CR-10	285	236	24	
	10	5	CR-10	285	193	4	
	11	1	CR-22	285	191	1	
	12	2	CR-22	285	195	7	
	13	3	CR-22	285	208	1	
	14	4	CR-22	285	171	6	
	15	5	CR-22	285	212	11	
	16	1	CR-23W	285	192	6	
	17	2	CR-23W	285	210	9	
	18	3	CR-23W	285	186	9	
	19	4	CR-23W	285	203	8	
	20	5	CR-23W	285	188	10	
	21	1	AN-SS-301	285	201	11	
	22	2	AN-SS-301	285	216	12	
	23	3	AN-SS-301	285	211	10	
	24	4	AN-SS-301	285	196	10	
	25	5	AN-SS-301	285	219	8	
	26	1	AN-SS-302	285	208	5	
	27	2	AN-SS-302	285	179	10	
	28	3	AN-SS-302	285	203	12	
	29	4	AN-SS-302	285	192	9	
	30	5	AN-SS-302	285	198	8	
	31	1	AN-SS-303	285	196	3	
	32	2	AN-SS-303	285	205	10	
	33	3	AN-SS-303	285	188	6	
	34	4	AN-SS-303	285	213	7	
	35	5	AN-SS-303	285	207	7	
	36	1	AN-SS-304	285	170	22	
	37	2	AN-SS-304	285	152	37	
	38	3	AN-SS-304	285	163	31	
	39	4	AN-SS-304	285	178	29	
	40	5	AN-SS-304	285	170	32	
	41	1	AN-SC-305	285	189	13	
	42	2	AN-SC-305	285	201	16	
	43	3	AN-SC-305	285	194	11	
	44	4	AN-SC-305	285	185	9	
	45	5	AN-SC-305	285	205	12	
	46	1	AN-SC-306	285	168	32	
	47	2	AN-SC-306	285	186	19	
	48	3	AN-SC-306	285	192	21	
	49	4	AN-SC-306	285	179	16	
	50	5	AN-SC-306	285	189	19	

Comments: Boulevard Park/Starr Rock; 9/852-01.1; 9800689

Reviewed by: 22/1/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - SEDIMENT (SAMPLES)

Cli _____
EVS Project No. 9557-011
EVS Work Order No. 9506689
Logbook #10 Pages 145-147
Initial Embryo Density 285 embryos/10mL

Test Species M. galloprovincialis
Source/Date Received Cordstad Laboratories, Inc / Nov. 25, 1998
Test Initiation Date/Time November 25, 1998 / 1640h
Test Termination Date November 27, 1998
Test Volume (mL) 900 mL
Aliquot Size (mL) 10 mL

Sample ID	Rep.	Primary Count		Backup Count		Comments	Tech. Init.
		Normal Larvae	Abnormal Larvae	Normal Larvae	Abnormal Larvae		
NEGATIVE CONTROL	A	267	15				SVS
	B	281	14				SVS
	C	265	18				SVS
	D	245	20				SVS
	E	250	14				SVS
CR-10	A	190	18				SVS
	B	198	8				SVS
	C	181	24				SVS
	D	236	24				SVS
	E	193	4				SVS
CR-22	A	191	1				SVS
	B	195	7				SVS
	C	208	1				SVS
	D	171	6				SVS
	E	212	11				SVS
CR-23W	A	192	6				SVS
	B	210	9				SVS
	C	186	9				SVS
	D	203	8				SVS
	E	188	10				SVS

Data Verified By [illegible] Date Verified 12/18

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - SEDIMENT (SAMPLES)

Client Bolsa Chica / Shaw USA
EVS Project No. 7252-01.1
EVS Work Order No. 7820687
Logbook 1116 Pages 145-147
Initial Embryo Density 285 embryos/mL

Test Species M. galloprovincialis
Source/Date Received Carlsbad Aquafarms / Nov. 25, 1997
Test Initiation Date/Time Nov. 25, 1997 / 1640h
Test Termination Date Nov. 27, 1997
Test Volume (mL) 900mL
Aliquot Size (mL) 10mL

Sample ID	Rep.	Primary Count		Backup Count		Comments	Tech. Init.
		Normal Larvae	Abnormal Larvae	Normal Larvae	Abnormal Larvae		
	A	189	13				SA
	B	201	16				SA
NA-SC-305	C	194	11				SA
	D	185	9				SA
	E	205	12				SA
	A	168	32				SA
	B	186	19				SA
NA-SC-306	C	192	21				SA
	D	179	16				SA
	E	189	19				SA
	A						
	B						
	C						
	D						
	E						
	A						
	B						
	C						
	D						
	E						

Data Verified By [signature] Date Verified 12/22/97

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - SEDIMENT (SAMPLES)

Client: Boundary Bay / White Rock
EVS Project No. 9155 Vol. 1
EVS Work Order No. 9700680
Logbook #10 Pages 145-147
Initial Embryo Density ~285 embryos/10mL

Test Species: M. galloprovincialis
Source/Date Received: Cultured Aquaculture Inc. / Nov 25, 1998
Test Initiation Date/Time: November 25, 1998 / 1040h
Test Termination Date: November 27, 1998
Test Volume (mL): 900mL
Aliquot Size (mL): 10mL

Sample ID	Rep.	Primary Count Normal Larvae	Primary Count Abnormal Larvae	Backup Count Normal Larvae	Backup Count Abnormal Larvae	Comments	Tech. Init.
AA-SC-301	A	201	11				SM
	B	216	12				SM
	C	211	10				SM
	D	196	10				SM
	E	219	8				SM
AA-SC-302	A	203	5				SM
	B	179	10				SM
	C	203	12				SM
	D	192	9				SM
	E	198	8				SM
AA-SC-303	A	196	3				SM
	B	205	10				SM
	C	185	12				SM
	D	213	7				SM
	E	207	7				SM
AA-SC-304	A	170	22				SM
	B	152	37				SM
	C	163	31				SM
	D	178	29				SM
	E	170	32				SM

Data Verified By: C. McPherson
Date Verified: Dec 22/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - FINAL WATER QUALITY

Client —
EVS Project No. 9/852-01.1
EVS Work Order No. 9806689
Logbook #10 Pages 145-147

Test Species M. galloprovincialis
Test Initiation Date/Time November 25, 1998 / 1640h
Test Termination Date November 27, 1998
Test Duration 48h

Sample ID	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
Neg. Control	A	16.0	8.0	30	7.5
	B	16.0	8.0	30	7.6
	C	16.0	8.0	30	7.7
	D	16.0	8.0	30	7.7
	E	16.0	8.0	30	7.7
Tech. Init.		CAB	JKM / CAB	JKM / CAB	JKM / CAB

WQ Instruments Used: Temp. Calibrated thermometer pH IV-A-30 Salinity IV-C-22 DO IV-A-20

Comments

Test Set Up By JKK, CAH Data Verified By C. McPherson Date Verified Dec 22 98

Bivalve Larval Survival and Development Test-Proportion Alive/Normal

Start Date:	25/11/98	Test ID:	evs8478	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
ments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-22	0.6702	0.6842	0.7298	0.6000	0.7439
AN-SS-301	0.7053	0.7579	0.7404	0.6877	0.7684
AN-SS-302	0.7298	0.6281	0.7123	0.6737	0.6947
AN-SS-303	0.6877	0.7193	0.6596	0.7474	0.7263
AN-SS-304	0.5965	0.5333	0.5719	0.6246	0.5965
AN-SC-305	0.6632	0.7053	0.6807	0.6491	0.7193
AN-SC-306	0.5895	0.6526	0.6737	0.6281	0.6632

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	0.6856	0.0568	0.9767	0.8861	1.0401	6.230	5			
AN-SS-301	0.7319	0.0344	1.0272	0.9778	1.0687	3.774	5	-1.565	1.860	0.0019
AN-SS-302	0.6877	0.0393	0.9784	0.9149	1.0242	4.309	5	-0.051	1.860	0.0020
AN-SS-303	0.7081	0.0345	1.0005	0.9479	1.0442	3.780	5	-0.743	1.860	0.0019
*AN-SS-304	0.5846	0.0342	0.8705	0.8188	0.9113	3.978	5	3.391	1.860	0.0018
AN-SC-305	0.6835	0.0290	0.9736	0.9368	1.0124	3.206	5	0.101	1.860	0.0017
AN-SC-306	0.6414	0.0336	0.9290	0.8754	0.9628	3.752	5	1.520	1.860	0.0018

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96128	0.91	-0.4903	-0.4298
Bartlett's Test indicates equal variances (p = 0.88)	2.39817	16.8119		
Hypothesis Test (1-tail, 0.05)				
oscedastic t Test indicates significant differences				

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-22.

Reviewed by: GdM Dec 22/98

Bivalve Larval Survival and Development Test-Proportion Alive

Start Date:	25/11/98	Test ID:	evs8478	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-22	0.6737	0.7088	0.7333	0.6211	0.7825
AN-SS-301	0.7439	0.8000	0.7754	0.7228	0.7965
AN-SS-302	0.7474	0.6632	0.7544	0.7053	0.7228
AN-SS-303	0.6982	0.7544	0.6807	0.7719	0.7509
AN-SS-304	0.6737	0.6632	0.6807	0.7263	0.7088
AN-SC-305	0.7088	0.7614	0.7193	0.6807	0.7614
AN-SC-306	0.7018	0.7193	0.7474	0.6842	0.7298

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-22	0.7039	0.0609	0.9970	0.9077	1.0856	6.725	5			
AN-SS-301	0.7677	0.0336	1.0687	1.0163	1.1071	3.704	5	-2.060	1.860	0.0023
AN-SS-302	0.7186	0.0367	1.0123	0.9516	1.0523	3.998	5	-0.436	1.860	0.0023
AN-SS-303	0.7312	0.0394	1.0266	0.9703	1.0729	4.312	5	-0.824	1.860	0.0024
AN-SS-304	0.6905	0.0262	0.9811	0.9516	1.0203	2.902	5	0.487	1.860	0.0020
AN-SC-305	0.7263	0.0350	1.0209	0.9703	1.0605	3.847	5	-0.688	1.860	0.0022
AN-SC-306	0.7165	0.0245	1.0096	0.9741	1.0442	2.691	5	-0.389	1.860	0.0019

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97107	0.91	-0.1698	-0.2922
Bartlett's Test indicates equal variances (p = 0.64)	4.23495	16.8119		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates no significant differences				

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-22.

Reviewed by CAM Dec 22/98

Bivalve Larval Survival and Development Test-Proportion Normal

Start Date:	25/11/98	Test ID:	evs8479	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-23W	0.9697	0.9589	0.9538	0.9621	0.9495
AN-SS-301	0.9481	0.9474	0.9548	0.9515	0.9648
AN-SS-302	0.9765	0.9471	0.9442	0.9552	0.9612
AN-SS-303	0.9849	0.9535	0.9691	0.9682	0.9673
AN-SS-304	0.8854	0.8042	0.8402	0.8599	0.8416
AN-SC-305	0.9356	0.9263	0.9463	0.9536	0.9447
AN-SC-306	0.8400	0.9073	0.9014	0.9179	0.9087

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23W	0.9588	0.0078	1.3671	1.3441	1.3958	1.453	5			
AN-SS-301	0.9533	0.0071	1.3535	1.3393	1.3819	1.279	5	1.161	1.860	0.0003
AN-SS-302	0.9568	0.0129	1.3636	1.3323	1.4170	2.477	5	0.202	1.860	0.0006
AN-SS-303	0.9686	0.0111	1.3951	1.3534	1.4477	2.419	5	-1.597	1.860	0.0006
*AN-SS-304	0.8463	0.0298	1.1692	1.1125	1.2255	3.542	5	9.635	1.860	0.0008
*AN-SC-305	0.9413	0.0106	1.3269	1.2958	1.3537	1.681	5	3.017	1.860	0.0003
*AN-SC-306	0.8951	0.0313	1.2432	1.1593	1.2803	3.866	5	5.328	1.860	0.0010

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97033	0.91	-0.3931	1.03339
Bartlett's Test indicates equal variances (p = 0.41)	6.11746	16.8119		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates significant differences				

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-23W.

Reviewed by: 12/22/98

Bivalve Larval Survival and Development Test-Proportion Alive

Start Date:	25/11/98	Test ID:	evs8479	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-23W	0.6947	0.7684	0.6842	0.7404	0.6947
AN-SS-301	0.7439	0.8000	0.7754	0.7228	0.7965
AN-SS-302	0.7474	0.6632	0.7544	0.7053	0.7228
AN-SS-303	0.6982	0.7544	0.6807	0.7719	0.7509
AN-SS-304	0.6737	0.6632	0.6807	0.7263	0.7088
AN-SC-305	0.7088	0.7614	0.7193	0.6807	0.7614
AN-SC-306	0.7018	0.7193	0.7474	0.6842	0.7298

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23W	0.7165	0.0362	1.0100	0.9741	1.0687	4.032	5			
AN-SS-301	0.7677	0.0336	1.0687	1.0163	1.1071	3.704	5	-2.313	1.860	0.0012
AN-SS-302	0.7186	0.0367	1.0123	0.9516	1.0523	3.998	5	-0.090	1.860	0.0012
AN-SS-303	0.7312	0.0394	1.0266	0.9703	1.0729	4.312	5	-0.618	1.860	0.0013
AN-SS-304	0.6905	0.0262	0.9811	0.9516	1.0203	2.902	5	1.297	1.860	0.0009
AN-SC-305	0.7263	0.0350	1.0209	0.9703	1.0605	3.847	5	-0.432	1.860	0.0012
AN-SC-306	0.7165	0.0245	1.0096	0.9741	1.0442	2.691	5	0.017	1.860	0.0009

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93704	0.91	-0.1125	-1.2429
Bartlett's Test indicates equal variances (p = 0.96)	1.4438	16.8119		

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

* STAT. COMPARISONS MADE WITH REFERENCE SED. CR-RBM.

Reviewed by GM 12/2/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST DATA SUMMARY

Client _____
EVS Project No. 9/852-01.1
EVS Work Order No. 9800689

EVS Analysts SVS JGK BAH GSY JEM
Test Type 48h Bivalve Larval Reftox
Test Initiation Date November 25, 1998

SAMPLE

Identification SDS REFTOX (EVS LOT# 98-S-053)
Amount Received (PREPARED) 1L of 1000 mg/L SDS sol'n
Date Collected (PREPARED) November 9, 1998
Date Received —
Temperature (°C) —
pH —
Dissolved Oxygen (mg/L) —
Salinity (ppt) —
Other —

TEST SPECIES INFORMATION

Organism Mytilus galloprovincialis
Source Carlsbad Aquafarm Inc.
Date Received November 25, 1998
Reference Toxicant SDS
Current Reference Toxicant Result NORMAL; WNRS/NORMAL
(EC50 and 95% CL) 3.3(3.2-3.4) mg/L SDS; 3.2(3.1-3.3) mg/L SDS
Reference Toxicant Warning Limits
(mean ± 2SD) 3.7 ± 1.6 mg/L SDS; 3.4 ± 1.3 mg/L SDS

DILUTION AND CONTROL MEDIUM

Salt Water (Burrard Inlet) FILTERED, UV-STERILIZED
Temperature (°C) 15.0
pH 8.0
Dissolved Oxygen (mg/L) ~~29~~ 8.0
Salinity (ppt) 29
Other —

TEST CONDITIONS

Temperature Range (°C) 15.0 - 16.0
pH Range 8.1 - 7.5
Dissolved Oxygen Range (mg/L) ~~8.1~~ 2.0 - 8.1
Salinity Range (ppt) 28 - ~~30~~ 31
Photoperiod (L:Dh) 14:10
Initial Embryo Density 285 embryos/1 mL
Test Volume (mL) 900 mL
Other —

Toxicity Test Results REPORTED ABOVE.

Data Verified By C. McPherson
Date Verified Dec 23/98

Bivalve Larval Survival and Development Test-Proportion Alive/Normal

Start Date:	25/11/98	Test ID:	evs8479	Sample ID:	Various
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SEDIMENT1-Marine
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	Boulevard Park/Starr Rock; 9/852-01.1; 9800689				

Conc-%	1	2	3	4	5
CR-23W	0.6737	0.7368	0.6526	0.7123	0.6596
AN-SS-301	0.7053	0.7579	0.7404	0.6877	0.7684
AN-SS-302	0.7298	0.6281	0.7123	0.6737	0.6947
AN-SS-303	0.6877	0.7193	0.6596	0.7474	0.7263
AN-SS-304	0.5965	0.5333	0.5719	0.6246	0.5965
AN-SC-305	0.6632	0.7053	0.6807	0.6491	0.7193
AN-SC-306	0.5895	0.6526	0.6737	0.6281	0.6632

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
CR-23W	0.6870	0.0362	0.9776	0.9405	1.0321	4.022	5			
AN-SS-301	0.7319	0.0344	1.0272	0.9778	1.0687	3.774	5	-2.009	1.860	0.0011
AN-SS-302	0.6877	0.0393	0.9784	0.9149	1.0242	4.309	5	-0.031	1.860	0.0012
AN-SS-303	0.7081	0.0345	1.0005	0.9479	1.0442	3.780	5	-0.940	1.860	0.0011
*AN-SS-304	0.5846	0.0342	0.8705	0.8188	0.9113	3.978	5	4.570	1.860	0.0010
AN-SC-305	0.6835	0.0290	0.9736	0.9368	1.0124	3.206	5	0.177	1.860	0.0009
*AN-SC-306	0.6414	0.0336	0.9290	0.8754	0.9628	3.752	5	2.066	1.860	0.0010

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94305	0.91	-0.2646	-1.1018
Bartlett's Test indicates equal variances (p = 1.00)	0.42829	16.8119		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates significant differences				

* STAT. COMPARISONS MADE WITH REFERENCE SED., CR-23W.

Reviewed by: 12/28/98

EVS CONSULTANTS

48-h LARVAL DEVELOPMENT TOXICITY TEST - DAILY WATER QUALITY DATA

Client ____

EVS Project No. 9852-01.9

EVS Work Order No. 9800689

Logbook #10 Pages 145-147

Test Initiation Date/Time Nov. 25/98 (1640h)

Test Termination Date Nov. 27/98.

Test Species M. galloprovincialis

Sample ID (mg/L SDS)	Temperature (°C)			pH			Salinity (ppt)			Dissolved Oxygen (mg/L)		
	0	24	48	0	24	48	0	24	48	0	24	48
10.0	15.0	15.5	16.0	8.1	8.0	7.6	29	30	31	8.1	7.3	2.4
5.6	15.0	15.5	16.0	8.1	8.1	7.8	29	30	31	8.1	7.3	4.2
3.2	15.0	15.5	15.5	8.1	8.1	7.8	29	30	30	8.1	7.8	5.9
1.8	15.0	15.5	15.5	8.1	8.1	7.9	29	30	30	8.1	7.8	6.9
1.0	15.0	15.5	15.5	8.1	8.1	8.0	29	30	30	8.1	7.8	7.2
Negative Control	15.0	15.5	15.5	8.0	8.0	8.0	29	29 1Gh	30	8.0	7.8	7.5
Technician Initials	BGM	JGh	Jom JGK	BGM CSY	JGh	JGh	BGM	JGh	Jom JGK	BGM CSY	JGh	Jom

WQ Instruments Used: Temp. Hg thermo (calibrated) pH II-A-30 Salinity II-C-22 DO II-A-20

Comments ____

Test Set Up By JGh, PAH Data Verified By C. McPherson Date Verified Dec 22/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - FINAL WATER QUALITY

Client —
EVS Project No. 9852-01.1
EVS Work Order No. 9852-01-1st 9800689
Logbook #10 Pages 145-147

Test Species M. galloprovincialis
Test Initiation Date/Time November 25, 1998 / 1641h
Test Termination Date November 27, 1998
Test Duration 48h

Sample ID (mg/L SDS)	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
10.0	A	16.0	7.5	28	2.2
	B	16.0	7.5	29	2.0
	C	16.0	7.5	28	2.2
	D				
	E				
5.6	A	16.0	7.8	29	4.8
	B	16.0	7.8	29	4.8
	C	16.0	7.8	28	4.8
	D				
	E				
3.2	A	16.0	7.9	29	6.3
	B	16.0	7.9	29	6.2
	C	16.0	7.9	29	6.2
	D				
	E				
Tech. Init.		CMB	JGK / CMB	CMB	CMB

WQ Instruments Used: Temp. Calibrated thermometer pH II-A-30 Salinity II-C-22 DO II-A-20

Comments

Test Set Up By JGK, PAH Data Verified By [signature] Date Verified Dec 22/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - FINAL WATER QUALITY

Client —

EVS Project No. 9852-01.1

EVS Work Order No. 9852-01-19800689

Logbook #10 Pages 145-149

Test Species N. gallaprovincialis

Test Initiation Date/Time November 25, 1998 / 1640h

Test Termination Date November 27, 1998

Test Duration 48h

Sample ID (mg/L SDS)	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
1.8	A	16.0	8.0	29	6.8
	B	16.0	8.0	29	6.8
	C	16.0	8.0	29	6.8
	D				
	E				
1.0	A	16.0	8.0	29	7.0
	B	16.0	8.0	29	7.0
	C	16.0	8.0	29	7.0
	D				
	E				
Neg Control	A	16.0	8.0	30	7.5
	B	16.0	8.0	30	7.6
	C	16.0	8.0	30	7.7
	D	16.0	8.0	30	7.7
	E	16.0	8.0	30	7.7
Tech. Init.		CAB	JGK / CAB	CAB	CAB

WQ Instruments Used: Temp. Calibrated Thermometer pH II-A-30 Salinity II-C-22 DO II-A-20

Comments

Test Set Up By JGK, PAH Data Verified By C. McPherson Date Verified Dec 22/98

EVS CONSULTANTS
LARVAL DEVELOPMENT TOXICITY TEST - SEDIMENT (CONTROLS)

Client _____
EVS Project No. 7/852-01.1
EVS Work Order No. 9800659
Logbook #10 Pages 145-147
Initial Embryo Density 285 embryos/10mL

Test Species M. galloprovincialis
Source/Date Received Carlsbad Aquafarms Inc/Nov. 25, 1998
Test Initiation Date/Time November 25, 1998 12:40h
Test Termination Date November 27, 1998
Test Volume (mL) 900mL
Aliquot Size (mL) 10mL

Concentration	Rep.	Primary Count		Backup Count		Comments	Tech. Init.
		Normal Larvae	Abnormal Larvae	Normal Larvae	Abnormal Larvae		
Reference Toxicant							
10.0	A	0	78				SD
	B	0	77				SD
	C	0	62				SD
5.6	A	0	161				SD
	B	0	141				SD
	C	0	139				SD
3.2	A	146	130				DS
	B	129	115				SD
	C	138	122				SD
1.8	A	239	17				SD
	B	279	21				SD
	C	269	24				SD
1.0	A	266	19				SD
	B	252	15				SD
	C	268	20				SD
Control Seawater							
	A	267	15				SDS
	B	281	14				SDS
	C	265	18				SDS
	D	245	20				SDS
	E	250	14				SDS

Data Verified By C. McPherson Date Verified Dec 22/98

Test: BV-Bivalve Larval Survival and Development Test Test ID: rtmgsds29p
Species: MG-Mytilus galloprovincialis Protocol: PSEP 95
Sample ID: REF-Ref Toxicant Sample Type: SDS-Sodium dodecyl sulfate
Start Date: 25/11/98 End Date: 27/11/98 Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Initial Density	Number Normal	Number Abnormal	Notes
	1	1	D-Control	285	267	15	
	2	2	D-Control	285	281	14	
	3	3	D-Control	285	265	18	
	4	4	D-Control	285	245	20	
	5	5	D-Control	285	250	14	
	6	1	1.0	285	266	19	
	7	2	1.0	285	252	15	
	8	3	1.0	285	268	20	
	9	1	1.8	285	239	17	
	10	2	1.8	285	279	21	
	11	3	1.8	285	269	24	
	12	1	3.2	285	146	130	
	13	2	3.2	285	129	115	
	14	3	3.2	285	138	122	
	15	1	5.6	285	0	161	
	16	2	5.6	285	0	141	
	17	3	5.6	285	0	139	
	18	1	10.0	285	0	78	
	19	2	10.0	285	0	77	
	20	3	10.0	285	0	62	

Comments: 9/852-01.1; 9800689

Reviewed by:

Bivalve Larval Survival and Development Test-Proportion Normal

Start Date:	25/11/98	Test ID:	rtmgsds29p	Sample ID:	REF-Ref Toxicant
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	PSEP 95	Test Species:	MG-Mytilus galloprovincialis
Comments:	9/852-01.1; 9800689				

Conc-mg/L	1	2	3	4	5
D-Control	0.9468	0.9525	0.9364	0.9245	0.9470
1	0.9333	0.9438	0.9306		
1.8	0.9336	0.9300	0.9181		
3.2	0.5290	0.5287	0.5308		
5.6	0.0000	0.0000	0.0000		
10	0.0000	0.0000	0.0000		

			Transform: Arcsin Square Root					t-Stat	1-Tailed Critical	MSD	Number Resp	Total Number
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N					
D-Control	0.9414	0.0111	1.3272	1.2925	1.3512	1.748	5				6	81
1	0.9359	0.0070	1.3151	1.3041	1.3315	1.101	3	0.950	2.466	0.0315	3	54
1.8	0.9272	0.0081	1.2979	1.2805	1.3102	1.191	3	2.296	2.466	0.0315	4	62
*3.2	0.5295	0.0011	0.8149	0.8141	0.8162	0.138	3	40.150	2.466	0.0315	172	367
5.6	0.0000	0.0000	0.0413	0.0394	0.0424	4.007	3				441	441
10	0.0000	0.0000	0.0591	0.0566	0.0635	6.571	3				217	217

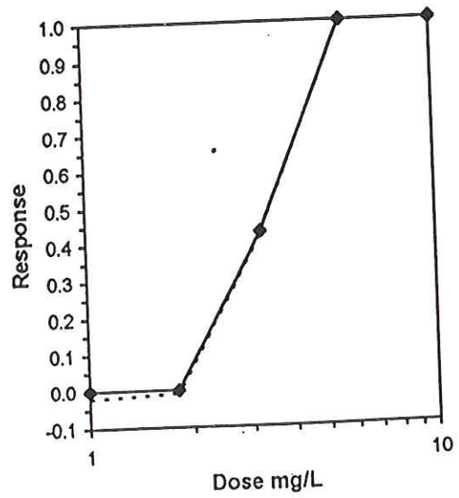
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96692	0.825	-0.6763	0.6657
Bartlett's Test indicates equal variances (p = 0.04)	8.39622	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	1.8	3.2	2.4		0.0156	0.01656	0.19776	0.00031	9.5E-12	3, 10

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%	3.3130	3.2172	3.4117
5.0%	3.3271	3.2201	3.4377
10.0%	3.3412	3.2195	3.4676
20.0%	3.3692	3.2009	3.5463
Auto-0.0%	3.3130	3.2172	3.4117

mg/L SDS



Reviewed by: 27/11/98

Bivalve Larval Survival and Development Test-Proportion Alive/Normal

Start Date:	25/11/98	Test ID:	rtmgsds29p
End Date:	27/11/98	Lab ID:	BCEVS-EVS Environment C
Sample Date:		Protocol:	PSEP 95
Comments:	9/852-01.1; 9800689		
Sample ID:	REF-Ref Toxicant		
Sample Type:	SDS-Sodium dodecyl sulfate		
Test Species:	MG-Mytilus galloprovincialis		

Conc-mg/L	1	2	3	4	5
D-Control	0.9368	0.9860	0.9298	0.8596	0.8772
1	0.9333	0.8842	0.9404		
1.8	0.8386	0.9789	0.9439		
3.2	0.5123	0.4526	0.4842		
5.6	0.0000	0.0000	0.0000		
10	0.0000	0.0000	0.0000		

			Transform: Arcsin Square Root									
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	1-Tailed Critical	MSD	Number Resp	Total Number
D-Control	0.9179	0.0505	1.2942	1.1868	1.4520	8.073	5				7	81
1	0.9193	0.0306	1.2858	1.2236	1.3241	4.226	3	0.123	2.466	0.1692	4	54
1.8	0.9205	0.0730	1.3047	1.1574	1.4252	10.417	3	-0.153	2.466	0.1692	4	62
*3.2	0.4830	0.0298	0.7684	0.7380	0.7977	3.888	3	7.662	2.466	0.1692	189	367
5.6	0.0000	0.0000	0.0413	0.0394	0.0424	4.007	3				441	441
10	0.0000	0.0000	0.0591	0.0566	0.0635	6.571	3				217	217

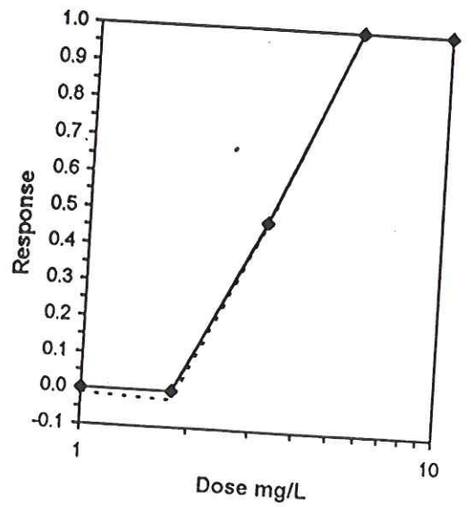
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95833	0.825	0.08975	0.13674
Bartlett's Test indicates equal variances (p = 0.29)	3.7606	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	1.8	3.2	2.4		0.11136	0.12033	0.21786	0.00883	6.1E-05	3, 10

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%	3.2318	3.1375	3.3288
5.0%	3.2375	3.1327	3.3458
10.0%	3.2432	3.1250	3.3660
20.0%	3.2548	3.0954	3.4223
Auto-0.0%	3.2318	3.1375	3.3288

MG/L SDS



ToxCalc v5.0

Reviewed 27/11/98

File No. K1764

REMARKS

The detection limit for Sulphide has been increased for some of the samples reported in the following data tables due to the Turbidity of these samples.

RESULTS OF ANALYSIS - Water

File No. K1764

	Ammonia Nitrogen N	Sulphide S
AN-SS- 301 1998 Nov 24	0.19	<0.05
AN-SS- 302 1998 Nov 24	0.23	<0.05
AN-SS- 303 1998 Nov 24	0.37	<0.05
AN-SS- 304 1998 Nov 24	0.12	0.10
AN-SS- 305 1998 Nov 24	0.21	<0.05
AN-SS- 306	0.17	<0.05

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
hese samples are identified as 0 hour, Bivalve, overlying water.

File No. K1764

RESULTS OF ANALYSIS - Water

	Ammonia Nitrogen N	Sulphide S
Negative Control 1998 Nov 24	<0.02	<0.02
CR-10 1998 Nov 24	0.09	<0.05
CR-22 1998 Nov 24	0.25	<0.05
CR-23W 1998 Nov 24	0.32	<0.05

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as 0 hour, Bivalve, overlying water.

Appendix 1 - QUALITY CONTROL - Replicates

File No. K1764

Water	AN-SS-302 98 11 24	AN-SS-302 QC # 141208
Nutrients		
Ammonia Nitrogen N	0.23	0.23
Inorganic Parameters		
Sulphide S	<0.05	<0.05

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as 0 hour, Bivalve, overlying water.

RESULTS OF ANALYSIS - Water

File No. K1826

	Ammonia Nitrogen N	Sulphide S
AN-SS- 301 1998 Nov 27	0.15	<0.02
AN-SS- 302 1998 Nov 27	0.18	<0.02
AN-SS- 303 1998 Nov 27	0.33	<0.02
AN-SS- 304 1998 Nov 27	0.11	<0.02
AN-SS- 305 1998 Nov 27	0.14	<0.02
AN-SS- 306 1998 Nov 27	0.24	<0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as 48 hour, Bivalve, overlying water.

RESULTS OF ANALYSIS - Water

File No. K1826

	Ammonia Nitrogen N	Sulphide S
Negative Control 1998 Nov 27	0.04	<0.02
CR-10 1998 Nov 27	0.14	<0.02
CR-22 1998 Nov 27	0.17	<0.02
CR-23W 1998 Nov 27	0.22	<0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
hese samples are identified as 48 hour, Bivalve, overlying water.

Appendix 1 - QUALITY CONTROL - Replicates

File No. K1826

Water	AN-SS-306 98 11 27	AN-SS-306 QC # 141487
Nutrients		
Ammonia Nitrogen N	0.24	0.23
Inorganic Parameters		
Sulphide S	<0.02	<0.02

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
These samples are identified as 48 hour, Bivalve, overlying water.

Appendix 2 - METHODOLOGY

File No. K1826

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

End of Report

APPENDIX K
NATURAL RECOVERY MODELING

APPENDIX K
NATURAL RECOVERY MODELING
WHATCOM WATERWAY AREA

CONTENTS

K.1 Natural Recovery Modeling K-1
K.2 Natural Recovery Modeling Results K-7

TABLES

K-1 Sensitivity Analysis Summary

Appendix K

K.1 Natural Recovery Modeling

The Officer and Lynch (1989) model is a one-dimensional analytical equation that simulates sediment natural recovery. The model simulates natural recovery by incorporating a number of concurrent processes, including:

- Burial of contaminated sediments;
- Mixing of cleaner sediments to the surface by benthic organisms; and
- Exchanges between the bottom sediments and water column.

The model also allows for non-advective concentrate exchange due to periodic and episodic resuspension of bottom sediments and exchanges across the bottom boundary layer. In the Officer and Lynch model, the bioturbation effects are represented by a constant diffusion coefficient applied over the mixed layer interval (below which is a non-diffusive medium).

The Sediment Cleanup Standards User Manual provides a description of how natural recovery modeling is generally applied under the SMS. The Officer and Lynch model was previously verified in Bellingham Bay, based on simulations of the observed initial recovery of sediment mercury concentrations in the bay immediately following G-P's completion of source controls in the early 1970s. (Officer and Lynch 1989).

The Officer and Lynch model is based on the flux and concentrate continuity equations for a system that includes advective and diffusive processes (Officer and Lynch, 1982). The model applies a radiation-type boundary condition for the sediment-water interface and the bottom of the mixed layer. Using a mass-based coordinate system, the model solution for an instantaneous source of unit strength at z=0 and t=0 is the following:

$$c_1(z,t) = \exp\left(\frac{vz}{2D} - \frac{v^2 t}{4D} - kt\right)\sum_{n=1}^{\infty} Z_n(z)\exp\left(-D\alpha_n^2 t\right) \qquad [1]$$

where:

z = depth coordinate;

D = diffusion parameter (g^2/cm^4-yr);

V = interface concentrate exchange coefficient (g/cm^2-yr); and

α_n are given by solution of the transcendental equation

$$\tan \alpha_n d = \frac{4D\alpha_n(v+V)}{4D^2\alpha_n^2 - v(v+2V)} \quad [2]$$

and

$$Z_n = \frac{2D^2\alpha_n^2(D^2\alpha_n^2 + \frac{v^2}{4})(\cos \alpha_n z + \frac{v+2V}{2D\alpha_n} \sin \alpha_n z)}{d(D^2\alpha_n^2 + \frac{v^2}{4})\left[D^2\alpha_n^2 + \frac{(v+2V)^2}{4}\right] + D(v+V)\left[D^2\alpha_n^2 + \frac{v(v+2V)}{4}\right]} \quad [3]$$

where:

d = accumulation in the mixed layer (g/cm^2); and

v = sediment accumulation rate (g/cm^2-yr)

For a distributed source, f(t), at the sediment-water interface, the sediment concentration becomes (Officer and Lynch, 1989):

$$C_1(z,t) = \int_{-\infty} f(t')c_1(z,t-t')dt' \quad [4]$$

where:

t = time a given core was taken and analyzed (yr)

This model was successfully applied and verified for atmospheric inputs of ^{137}Cs in Blelham tarn, Lake Michigan, and Long Island Sound (Officer and Lynch, 1982); and for mercury concentrations in Bellingham Bay sediments (Officer and Lynch, 1989). The Officer and Lynch model was also previously used to predict natural recovery within the Sitcum Waterway Problem Area of the Commencement Bay Nearshore/Tideflats Superfund Site (Port of Tacoma, 1992).

For a given set of values of v, d, V, and D, a unique set of roots exists for Equation 2. As noted in Officer and Lynch (1982), these roots have the following characteristics:

- α=0 is a root; this root makes no contribution to the solution;
- there is exactly one root within each interval, $(n-1)\pi/d \leq \alpha_n \leq n\pi/d$, for n=1, 2, 3, . . . ; and
- for large values of n, α_{n+1} approaches $n\pi/d$.

Officer and Lynch (1982) used the Newton-Raphson method to find the α_n roots of Equation 2. For this modeling, the modified Newton-Raphson method was used. The Newton-Raphson technique is well known and widely applied to finding the roots of various functions; the modified form is particularly good at solving equations with multiple roots. Other methods were also evaluated (e.g. using the Brent method) and found to yield consistent results.

In using Equation 1, only a finite number of α_n terms can be summed. As n increases, the series approaches the asymptote; the individual component contributions decrease in absolute value every m terms and alternately change sign. To evaluate the minimum number of

terms to reduce the truncation error to ε/d, the following relationship was used (Officer and Lynch 1982):

$$n^* \geq \frac{d}{\pi}\sqrt{\frac{\ln(2m/\varepsilon)}{Dt}} \qquad [5]$$

where:

n^* = number of terms

$\varepsilon = 10^{-5}$

$m = d/z$

Equation 5 was evaluated for each z at each time step to insure that the minimum number of α terms was used in the solution.

To utilize the Officer and Lynch model, the solution for a distributed input depends on the solution of an instantaneous source. Once c_1 has been evaluated, Equation 4 is solved using the Riemann summation, whereby the integrand is assumed to be effectively constant over very small intervals, $\Delta t'$. Officer and Lynch empirically determined a value for $\Delta t'$ by systematically decreasing an initial value until convergence was observed. They used a value of $\Delta t' = 0.05$ year and found acceptable accuracy in the cases investigated (Officer and Lynch 1982). For the purposes of this modeling, a more conservative value of $\Delta t' = 0.02$ year was used after verification of convergence of the solution.

In Equation 4, f(t) is the time-dependent input flux which is given as $f(t) = vc_o(t)$. In this modeling, the initial concentration, c_o, given at each station was assumed to be a constant profile over the mixed layer depth, d. To represent this condition with the Officer and Lynch model, a constant input flux equal to vc_o was applied and the model was run for a sufficient amount of time until the mixed layer had a resulting average concentration profile of c_o.

Once an average concentration of c_o was obtained across the mixed layer, the incoming concentration, c_i, was applied with the mass accumulation rate, v, for each particular station. At each station, the predicted concentration was the average of the concentrations over the mixed layer that resulted from the solution of Equation 4 integrated from $t' = 0$ to 9 years.

The Officer and Lynch model, compiled as described above, was compared with the results for Bellingham Bay in Officer and Lynch (1989). The characteristic parameters, d, v, D, and V are station dependent and are given in Officer and Lynch (1989). The mercury input rate history for Bellingham Bay is given in Bothner et al (1980). Station 6 in Bellingham Bay was used for model comparison. The model results duplicated the concentrations originally reported by Officer and Lynch.

The Officer and Lynch model, coded by Anchor as outlined above, was applied to each individual sampling station located within prospective sediment cleanup areas delineated in Figure 11-1 (Volume II). Input parameters used in the RI/FS application of the model are summarized below. Site-specific inputs to the Officer and Lynch sediment natural recovery model were derived from three sources:

- Model parameters presented in Officer and Lynch (1989);
- Parameter values presented in Section 9.0 (Volume I); and
- Additional estimates of net sedimentation rates within the Whatcom Waterway navigation channel, determined by calculating net changes in the mudline elevation of the Whatcom Waterway between 1975 and 1996 (using Corps channel condition survey data; no dredging of the Whatcom Waterway occurred during this period).

Parameter values used in the natural recovery modeling are described below.

Net Sedimentation Rates. One of the more important sediment natural recovery modeling parameters is the net sedimentation rate, which is a measure of the long-term burial rate of contaminated sediments beneath cleaner, more recent sediment materials. Net sedimentation rate estimates in inner Bellingham Bay (i.e., outside of the protected Whatcom Waterway channel) were based on ^{210}Pb, ^{137}Cs, and total mercury core profiles within and adjacent to the prospective Whatcom Waterway sediment cleanup area (see Section 9.0 of the RI Report and Bothner et al., 1980). Net sedimentation rates measured in three inner bay coring locations were very similar, ranging from 1.5 to 1.8 cm/yr. Using channel condition survey data, similar (within statistical limits) sedimentation rates were also estimated in the outer Whatcom Waterway navigation channel, offshore of Station 27+00 (Figure 14-2; Volume II). An average sedimentation rate of 1.6 cm/yr was therefore assumed to be representative of all prospective sediment cleanup areas outside of the protected channel areas.

Sedimentation rate estimates were calculated for sites within the protected Whatcom Waterway navigation channel area based on the net change in the mudline elevation of the WW Area observed between the 1975 and 1996 U.S. Corps of Engineers channel condition surveys. Overall, these data revealed that net sedimentation rates increased proceeding into the more protected areas of the Whatcom Waterway navigation channel and Log Pond (Figure 12-2; Volume II). However, considerable variability in sedimentation rates was evident within the channel area. For the purpose of this RI/FS analysis, sedimentation rate estimates for each sediment sampling station were calculated within a 50-foot grid area that surrounded the sampling station. Station-specific net

sedimentation rates are summarized on Table 14-1 (Volume II). In some cases, there was not discernable sedimentation rate.

Gross Sedimentation and Resuspension Exchange Rates. As discussed in Section 9.0 (Volume I), the net sedimentation rates outlined above represent only a fraction of the total quantity of material that settles through the water column (i.e., relative to the gross sedimentation rate, as determined by sediment trap measurements). Up to 90 percent of the settleable material collected in sediment traps appears to be resuspended back into the water column by ambient currents and waves. For the purpose of the natural recovery calculations, the average gross sedimentation rate measured in sediment traps (16 cm/yr, or 7.5 gm/cm^2-yr; consistent with values reported by Officer and Lynch, 1989) was assumed to apply throughout the prospective WW sediment cleanup area. Resuspension rates were then calculated as the difference between the gross and net sedimentation measurements, ranging from approximately 50 to 90 percent of gross sedimentation.

Non-Advective Concentrate Exchange. The non-advective concentrate exchange represents processes that contribute to the exchange of contaminants without contributing to the sedimentation rate. Examples include the periodic and/or episodic resuspension and subsequent settling of sediments due to tidal cycles, storm events, and propeller wash. For the purposes of natural recovery modeling, this parameter was calculated as the product of the resuspension rate and the fraction of resuspended sediments that, due to tidal advection and dispersion processes, are not provided sufficient time to resettle in the region. Representative settling velocities for different sized sediment material (i.e., sand, silt, and clay fractions) were calculated using Stoke's relationship.

Dispersion caused by bottom layer (landward) transport by the oscillatory motions of the tides contributes to water movement and sediment transport. Based on the available current velocity data (Collyer, 1998), and WASP model runs for the Whatcom Waterway and Bellingham Bay area (Section 8.0; Volume I), bottom velocities typically average 3 cm/s.

Using the data outlined above, the average residence time for a representative particle of sand, silt, and clay was calculated. The residence time estimates conservatively assumed a resuspension mixing depth of half the water column (i.e., complete vertical mixing) and using a transport distance (to "clean" sediment areas in the inner bay) of 3,000 feet. Using this information, the fractional component for each sediment type was combined to yield a representative fraction based on the measured sediment component breakdown for each station. Finally, the interface concentrate exchange parameter was estimated as the fraction of sediments suspended and transported out of the entire mouth segment, multiplied by the resuspension rate.

Because sediment transfer will likely occur over a smaller spatial scale following active sediment remediation, the relatively large mixing cell approximation (3,000 foot distance) used in this analysis was conservative, likely underestimating the true rate of natural recovery that would occur following active remediation. Values of the interface concentrate exchange coefficient derived in this manner ranged from 0 to 3.5 g-cm^2/yr, values that are consistent with approximately 35 percent of the resuspension rate, and also consistent with values reported for Bellingham Bay by Officer and Lynch (1989) (Table 14-1; Volume II).

Bioturbation. The bioturbation zone within surface sediments was observed to extend over the surface 11 to 24 cm, based on interpretations of ^{210}Pb core profiles at the site (see Section 9.0; Volume I). This is consistent with the bioturbation depth of about 14 cm assumed by Officer and Lynch; a average value of 16 cm (slightly more conservative than the Officer and Lynch value) was used in the model. Within this zone, a bioturbation diffusion coefficient of 34 cm^2/yr was applied in the model, based on values presented in Officer and Lynch (1989) (Table 14-1; Volume II).

Source Concentrations in Settling Particulate Matter. Sediment concentrations in recently deposited material, including locally resuspended sediments, were estimated using sediment trap data collected in inner Bellingham Bay (see Section 9.0; Volume I). The average mercury concentration measured in the traps was 0.34 mg/kg. The concentration of settling particulate matter (SPM) in the traps is only 33 percent of the concentration in underlying sediments—which are approximately 1 ppm Hg—further evidence the mercury in the bay is declining in response to source controls. In areas where sediment trap data were not available, including interior parts of the waterway, the concentration of SPM was assigned a value equal to 33 percent of the underlying sediment concentrations (Table 14-1; Volume II).

Surface Sediment Concentrations. Surface sediment concentrations were primarily based on 0 to 10-cm grab samples collected in August and September 1996, and in October 1998 (see Section 2.0; Volume I). The average value of all available RI samples within areas of the WW Area was used as the initial concentration for that particular model segment (Table 14-1; Volume II).

Recovery Time Frame. For the purposes of this FS, natural recovery was evaluated through the year 2005. Typically, the natural recovery period would begin when adequate source controls are attained, and would continue for an additional period of roughly 10 years (see Sediment Cleanup Standards User Manual). However, since source controls may already be adequate for the purpose of the WW Area cleanup (see above), and in order to achieve Ecology's goal to complete cleanup projects as quickly as practicable, an expedited natural recovery time frame was considered. The year 2005 generally

represents the minimum estimated time frame for recovery of biological resources following active cleanup (e.g., dredging), including preliminary estimates of the time required for remedy selection (0.5 year), remedial design, permitting, and legal agreements (1.5 years), remedial action implementation/construction (2 years), and biological recovery following construction (2 years).

K.2 Natural Recovery Modeling Results

As discussed above, the Officer and Lynch model was applied to all sediment stations within prospective sediment cleanup areas of the WW Area. The results of the modeling were presented for two cases:

1. Assuming zero non-advective concentrate exchange (i.e., no consideration of periodic and/or episodic resuspension and subsequent settling of sediments due to tidal cycles, storm events, and propeller wash). This was accomplished in the modeling by setting parameter V in Equation 1 equal to zero; and
2. Using a more realistic (though still conservative) value for non-advective concentrate exchange, as outlined above.

A representative output of the Officer and Lynch model is presented in Figure 14-3 (Volume II), which compares the sediment mercury profile measured in 1996 at Station HC-NR-101 within SSU 5B (offshore of the ASB) with the profile predicted for 2005. The model output clearly reveals the significant decline in mercury concentrations expected prior to 2005. The previously observed declines in mercury concentrations were corroborated with detailed mathematical modeling of natural recovery processes performed for this RI/FS. Most of this predicted decline was associated with sediment burial, and secondarily is attributable to non-advective exchange processes.

Based on the natural recovery model output outline above, the extent of the WW Area that is predicted to recover to below SQS criteria was depicted graphically on Figure 14-4 (Volume II). Most areas of the WW Area that currently exceed SQS criteria (based on chemical or confirmatory biological testing results collected in 1996 and 1998) are expected to recover to below the prospective SQS criterion by the year 2005 (Figure 14-4). However, based on conservative modeling assumptions, three sediment site units may not recover within the next 10 years to below SQS criteria. These areas are:

1) G-P Log Pond;
2) Nearshore areas located adjacent to the Whatcom Waterway immediately offshore of the G-P ASB; and
3) The former Starr Rock sediment disposal site.

All three of these areas contained the highest mercury (and also woody debris) concentrations reported within inner Bellingham Bay,

and encompass most of the areas that currently (1996 to 1998 sampling) exceed Ecology's CSL based on biological effects.

Model Sensitivity Analysis. The variability of the Officer and Lynch model to the possible input parameter range was evaluated using a quantitative sensitivity analysis. The analysis was based on the measured average, minimum and maximum values for each of the 6 key model input parameters (holding all other parameters fixed at baseline values) applied to a representative station (HC-NR-101). The results of the sensitivity analysis are summarized in Table K-1, and reveal that model results were most sensitive to the assumed depth of the mixed layer, resulting in an average coefficient of variation of model output of nearly 30 percent. However, the mixed layer depth assumed for the baseline analysis (16 cm) is greater than values reported for inner Bellingham Bay by Bothner et al. (1980) and Officer and Lynch (1989), and is also greater than the default mixing depth of 10 cm presented in the SMS Users Manual (Ecology 1991). Thus, the 16 cm mixed depth value used to develop natural recovery estimates in this RI/FS (Figure 14-4; Volume II) is likely conservative. All other parameters, including the interface concentration exchange coefficient, contributed less than 15 percent to the variation in model results.

Table K- 1. Sensitivity Analysis Summary

Parameter	Units	Parameter Range			Mercury (mg/kg)			Average Coefficient of Variation	Basis of Range
		Minimum	Average	Maximum	Minimum	Average	Maximum		
Depth of Mixed Layer	cm	11	16	24	0.48	0.67	0.87	29%	Project, UW Sample Results
Bioturbation Rate	cm^2/yr	8.7	34.0	198	0.55	0.67	0.73	14%	Officer and Lynch (1989)
Interface Concentrate Exchange Coefficient	g/cm^2-yr	0	2	4	0.80	0.67	0.64	12%	Officer and Lynch (1989), Calculations
Initial Mercury Surface Concentration	mg/kg	1.3	1.6	1.7	0.56	0.67	0.71	11%	Sample Results
Net Sedimentation Rate	cm/yr	1.5	1.6	1.8	0.71	0.67	0.60	8%	Bothner, UW, Project Sediment Trap Studies
Input Mercury Concentration	mg/kg	0.23	0.34	0.45	0.64	0.67	0.70	4%	Sample Results

APPENDIX L
SCREENING-LEVEL PUGET SOUND DREDGED DISPOSAL ANALYSIS
SEDIMENT QUALITY EVALUATION
WHATCOM WATERWAY AREA

APPENDIX L
SCREENING-LEVEL PUGET SOUND DREDGED DISPOSAL ANALYSIS
SEDIMENT QUALITY EVALUATION
WHATCOM WATERWAY AREA
BELLINGHAM, WASHINGTON

CONTENTS

L.1 Introduction ***L-1***
L.2 Previous Sampling Results ***L-1***
L.3 Screening-Level PSDDA Characterization Results – July, 1997 Sampling ***L-2***

TABLES

L-1 Sediment Compositing Scheme
L-2 Summary of Sediment Composite Sampling Data for the Screening Level PSDDA Evaluation of Whatcom and I &J Street Waterways, Bellingham, WA
L-3 Detected PSDDA SL and PSDDA ML Exceedences
L-4 Summary of Bioassay Results for Controls and Reference Stations and Comparison to Performance Criteria
L-5 Summary of the Results of the *Eohaustorius estuarius* Bioassays and Comparison to PSDDA Criteria
L-6 Summary of the Results of the *Dendraster excentricus* Bioassays and Comparison to PSDDA Criteria
L-7 Summary of the Results of the *Neanthes arenaceodentata* Bioassays and Comparison to PSDDA Criteria
L-8 Comparison of Bioassay Results and Sediment Biological Effects Interpretive Criteria
L-9 Whatcom Waterway Bioaccumulation Mercury Concentrations
L-10 Whatcom Waterway Mean Mercury Concentrations
L-11 PSSDA Analysis Summary

FIGURES

L-1 Sediment Sampling Location Plan: Whatcom Waterway Area
L-2 Mercury Bioaccumulation in N. Virens and M. Nasuta

APPENDIX L
SCREENING-LEVEL PUGET SOUND DREDGED DISPOSAL ANALYSIS SEDIMENT QUALITY EVALUATION WHATCOM WATERWAY AREA BELLINGHAM, WASHINGTON

L.1 Introduction

A screening-level Puget Sound Dredged Disposal Analysis (PSDDA) sediment quality evaluation was conducted in order to evaluate possible open-water or habitat enhancement/mitigation (subgrade) disposal options for relatively clean sediments previously identified at the head of the Whatcom Waterway and throughout the I&J Street Waterway. This screening-level analysis was not intended to constitute a full characterization for PSDDA dredge material management decisions, but rather to make a qualitative judgement about the likely suitability of material for open-water disposal and/or beneficial reuse.

Various project alternatives for sediment dredging, disposal, and/or beneficial reuse were developed by Georgia-Pacific and the Bellingham Bay Demonstration Pilot Project. These alternatives are more fully described in Section 14. The screening-level analysis presented herein was performed to more accurately address possible open-water and beneficial reuse options for relatively clean sediments present in the I&J Street Waterway and at the head of the Whatcom Waterway.

Specific sampling methods, procedures, and quality control criteria used in this screening-level evaluation are summarized in the Addendum 2 sampling and analysis plan (SAP) (Hart Crowser, 1997).

L.2 Previous Sampling Results

Chemistry and bioassay results from the remedial investigation (RI) sampling activities are described in the Whatcom Waterway RI Report. Key findings of the RI are summarized below:

- Surface sediment chemical analysis and confirmatory bioassay results suggest that the extent of surface sediments exceeding the Washington State Sediment Management Standards (SMS; Chapter 173-204 WAC) minimum cleanup level (MCUL) are restricted to the middle and seaward reaches of the Whatcom Waterway, and to areas immediately adjacent to the mouth of the Whatcom Waterway (see Figure 11-1);

- Compared with the middle and seaward reaches of the Whatcom Waterway, surface sediments at the head of the Whatcom Waterway and

throughout the I&J Street Waterway contained significantly lower mercury concentrations. Mercury and other chemical concentrations within these surface sediments were below MCUL criteria; much of these areas are also below Sediment Quality Standards (SQS) as defined in the SMS;

- Depth profiles of sediment mercury concentrations throughout the Whatcom Waterway site exhibit a distinct subsurface maximum ranging from roughly 2 to 6 feet below the sediment/water interface, depending on location; and

- The only chemicals detected in either surface or subsurface marine sediments in the Whatcom Waterway area exceeding the SQS chemical criteria in one or more samples were as follows (in order of decreasing frequency and magnitude of exeedance relative to the SQS):

  - Mercury;
  - Phenols/Cresols (especially 4-methylphenol and 2,4-methylphenol);
  - Polycyclic Aromatic Hydrocarbons (PAHs);
  - Phthalate Esters (especially bis[2-ethylhexyl]phthalate);
  - Hexachlorobenzene;
  - Dibenzofuran;
  - Benzoic acid;
  - Zinc; and
  - Cadmium.

L.3 Screening-Level PSDDA Characterization Results – July, 1997 Sampling

In July 1997, sediment core samples were collected from two areas within the I&J Street Waterway and from two areas within the Whatcom Waterway (Figure L-1). Four cores were collected from each area (HC-VC-94A through HC-VC-94D; HC-VC-95A through HC-VC-95D; HC-VC-96A through HC-VC-96D; and HC-VC-97A through HC-VC-97D) and were composited into two representative samples. The sediment cores were composited as indicated in Table L-1. Samples designated as "C1" represent the shallower 0- to 4-foot-depth interval composite. Samples designated as "C2" represent the deeper 4 feet to the –25 MLLW elevation composite (also representing an approximate 4-foot interval). As per PSDDA guidelines, native sediments were not composited with overlying contaminated sediments. Sampling and

analysis procedures were completed in accordance with PSDDA guidelines (PSDDA, 1998) and the SAP.

During sediment coring, the sampling vessel was anchored into position at each station using a differential Global Positioning system (DGPS). Coordinates for the sampling positions were recorded to an accuracy of within 6 feet at the time of sample collection. Samplers monitored core tube penetration and recovery. Core penetration depths ranged from 9 to 14 feet below mudline. Some compaction of sediments was expected during core tube advancement as a result of the vibracoring technique. Compaction ranged from 0 to 47 percent. Compactions greater than 25 percent were generally not accepted unless difficult coring conditions (e.g., wood, concrete, riprap shoreline, debris) precluded better recovery. The decision criteria for core acceptance was (in order of priority):

- Core to desired penetration depth;
- Sample within 10-foot radius of proposed location; and
- Recover sediment with less than 25 percent compaction.

If field crews encountered difficult coring conditions at a proposed location, subsequent core attempts were advanced in 10-foot radius increments away from the proposed location for improved penetration depth. If compaction was greater than 25 percent, additional core attempts were advanced at the designated location to improve sample recovery. At sampling locations HC-VC-94A, HC-VC-94B, HC-VC-96A, HC-VC-97C, and HC-VC-97D sediment compactions were greater than 25 percent. Several attempts were made to improve sample recovery at these locations, but difficult coring conditions precluded better recovery. The core with the best percent recovery was retained.

After the cores were retrieved and accepted, core tubes were capped, sealed, labeled, and placed upright in a chilled ice-box on the vessel deck. Core logging and sampling took place at the Hart Crowser laboratory facility. Cores were handled in accordance with the SAP. Core extrusion/description logs are at Anchor and are available upon request.

Sample composites were submitted to Multichem Analytical Services, Inc. (MAS) of Renton, Washington for chemical, conventional, and grain size analyses. Analysis results are summarized in Table L-2. Sample composites were submitted to EVS Environment Consultants laboratory of North Vancouver, British Columbia, Canada for bioassay and bioaccumulation testing. Complete laboratory and data validation reports are available from Anchor upon request.

Table L-3 is a summary of the PSDDA SL and ML exceedences for detected data. Method reporting limits for undetected data exceeded the PSDDA SL for 1,2-dichlorobenzene (one sample with an exceedence ratio [ER] of 1.03),

1,2,4-trichlorobenzene (five samples with an average ER of 1.20), and n-nitrosodiphenylamine (seven samples with an average ER of 1.64).

Toxicity tests were conducted on all sediment composite samples. The following sediment toxicity tests were conducted:

- 10-day amphipod mortality bioassay using *Eohaustorius estuarius*;
- 20-day juvenile polychaete growth bioassay using *Neanthes arenaceodentata*; and
- 48-hour sediment larval development test using *Dendraster excentricus*.

Toxicity test results for the sediment composite samples are summarized in Tables L-4 through L-8. Sample composites HC-VC-96-C1, HC-VC-96-C2, and HC-VC-97-C2 exceeded the PSDDA bioassay interpretive criteria ("one-hit" and "two-hit" rules).

Sediment samples that passed the PSDDA bioassay criteria ("one-hit" and "two-hit" rules) and contained chemical concentrations that exceeded the PSDDA bioaccumulation trigger values were subjected to bioaccumulation testing. Twenty-eight day bioaccumulation tests were conducted on sample composites HC-VC-94-C2 and HC-VC-97-C1 using *Macoma nasuta* and *Nereis virens*. Due to insufficient sample volume, animals were exposed to four replicates of each sediment treatment, reference sediment, and native control sediment, except for sample HC-VC-94-C2. Sample HC-VC-94-C2 was set up for one test replicate for *M. nasuta* only, because of insufficient sample volume. Bioaccumulation test results are summarized in Figure L-2 and Tables L-9 and L-10.

Table L-11 presents a summary of the chemistry, bioassay, and bioaccumulation evaluation with respect to PSDDA and SMS interpretive criteria. Two samples contained one chemical (2-methylphenol in Sample HC-VC-95-C1 and 4-methylphenol in Sample HC-VC-97-C1) that exceeded the PSDDA ML and passed the PSDDA bioassay criteria. Because only one chemical exceeded the PSDDA ML in each of the samples, and the chemical concentrations did not exceed the PSDDA ML by more than 100 percent, these sample composites are considered suitable for unconfined open-water disposal (PSDDA 1998). As summarized in Table L-11, sediments in five of the eight sampling areas, including all of the I&J Street Waterway, are likely suitable for open-water disposal or beneficial reuse.

Table L-1. Sediment Compositing Scheme

Sample ID	Depth Interval	Composite ID
HC-VC-94A	0-4.0 ft	HC-VC-94-C1
HC-VC-94B1	0-3.8 ft	
HC-VC-94B2	0-4.1 ft	
HC-VC-94C	0-2.4 ft	
HC-VC-94D	0-3.5 ft	
HC-VC-94A	4.0-6.9 ft	HC-VC-94-C2
HC-VC-94B1	3.8-4.8 ft	
HC-VC-94B2	4.1-8.6 ft	
HC-VC-95A	0-2.7 ft	HC-VC-95-C1
HC-VC-95B	0-1.9 ft	
HC-VC-95C	0-2.7 ft	
HC-VC-95D	0-2.9 ft	
HC-VC-95A	2.7-4.4 ft	HC-VC-95-C2
HC-VC-95B	1.9-4.3 ft	
HC-VC-95C	2.7-5.9 ft	
HC-VC-96A1	0-4.4 ft	HC-VC-96-C1
HC-VC-96A2	0-6.0	
HC-VC-96B	0-1.9 ft	
HC-VC-96C	0-3.8 ft	
HC-VC-96D	0-2.0 ft	
HC-VC-96A1	4.4-12.9 ft	HC-VC-96-C2
HC-VC-96A2	6.0-12.0 ft	
HC-VC-96B	1.9-4.9 ft	
HC-VC-96C	2.0-10.3 ft	
HC-VC-97A	0-5.0 ft	HC-VC-97-C1
HC-VC-97B	0-3.0 ft	
HC-VC-97C	0-3.7 ft	
HC-VC-97D	0-4.9 ft	
HC-VC-97A	5.0-7.0 ft	HC-VC-97-C2
HC-VC-97B	3.0-6.0 ft	
HC-VC-97C	3.7-10.2 ft	
HC-VC-97D	4.9-8.9 ft	

Table L-2. Summary of Sediment Composite Sampling Data for the Screening Level PSDDA Evaluation of Whatcom and I Waterways, Bellingham, WA

Sample ID	HC-VC-94-C1	HC-VC-94-C2	HC-VC-95-C1	HC-VC-95-C2	HC-VC-96-C1	HC-VC-96-C2	HC-VC-97-C1	HC-VC-97-C2	PSDDA SL	PSDDA ML	PSDDA BT	SQS	MCUL
Metals in mg/kg (dry weight)													
Antimony	0.51 UE	0.54 UE	0.42 UE	0.34 UE	0.62 UE	0.95 E	0.62 UE	0.58 UE	150	200	150	—	—
Arsenic	11	11	5.8	4.2	12	22	8.2	7.5	57	700	507.1	57	93
Cadmium	1.1	1.6	0.85 U	0.67 U	3.4	6.1	1.7	2.7	5.1	14	—	5.1	6.7
Chromium	58	62	41	24	79	120	69	74		—	—	260	270
Copper	44	46	39	18	79	140	73	130	390	1300	—	390	390
Lead	15	15	12	4.9	120	290	140	150	450	1200	—	450	530
Mercury	1.3	1.8	0.68	0.15	2.7	4.3	1.8	2.5	0.41	2.3	1.5	0.41	0.59
Nickel	73	76	51	21	63	60	53	50	140	370	370	—	—
Silver	0.22 E	0.25 E	0.19 E	0.071 E	0.8 E	1.5 E	1 E	1.2 E	6.1	8.4	6.1	6.1	6.1
Zinc	83	89	69	37	280	320	190	220	410	3800	—	410	960
Tributyltin in ug/L (in porewater)													
Tributyltin	0.05 U	0.05 U	0.11	0.07 U	0.20	0.05 U	0.19	0.05 U	0.15	—	0.15	—	—
LPAHs in ug/kg (dry weight)													
Naphthalene	43	29 E	160	220	200	180	280	720	2100	2400	—	—	—
Acenaphthylene	30 U	33 U	13 E	17 E	17 E	46 U	23 E	50	560	1300	—	—	—
Acenaphthene	33 U	36 U	20 E	26	130	78	110	340	500	2000	—	—	—
Fluorene	13 E	9 E	45	58	140	120	140	370	540	3600	—	—	—
Phenanthrene	48	31 E	89	89	470	440	460	1200	1500	21000	—	—	—
Anthracene	15 E	10 E	35	37	110	89	150	300	960	13000	—	—	—
2-Methylnaphthalene	21 E	17 E	160	230	120	210	130	330	670	1900	—	—	—
Total LPAHs	140	96	522	677	1187	1117	1293	3310	5200	29000	—	—	—
LPAHs in mg/kg-oc													
Naphthalene	1.9	1.0 E	3.0	4.6	3.4	1.6	4.9	9.5		—	—	99	170
Acenaphthylene	1.3 U	1.1 U	0.24 E	0.35 E	0.29 E	0.42 U	0.40 E	0.66		—	—	66	66
Acenaphthene	1.4 U	1.2 U	0.38 E	0.54	2.2	0.71	1.9	4.5		—	—	16	57
Fluorene	0.56 E	0.31 E	0.85	1.2	2.4	1.1	2.5	4.9		—	—	23	79
Phenanthrene	2.1	1.1 E	1.7	1.9	8.1	4.0	8.1	16		—	—	100	480
Anthracene	0.65 E	0.34 E	0.66	0.77	1.9	0.81	2.6	3.9		—	—	220	1200
2-Methylnaphthalene	0.91 E	0.59 E	3.0	4.8	2.1	1.9	2.3	4.3		—	—	38	64
Total LPAHs	6.1	3.3	9.8	14	20	10	23	44		—	—	370	780
HPAHs in ug/kg (Dry Weight)													
Fluoranthene	66	43	130	90	490	340	670	1000	1700	30000	4600	—	—
Pyrene	71	46 E	120	73	440	360	550	760	2600	16000	—	—	—
Benz(a)anthracene	25 E	46 U	56	25 E	150	120	260	310	1300	5100	—	—	—
Chrysene	32 E	17 E	56	22 E	190	160	360	380	1400	21000	—	—	—
Total benzofluoranthenes	39 E	23 E	49 U	39 U	196	122 E	390	340	3200	9900	—	—	—
Benzo(a)pyrene	21 E	11 E	30 E	13 E	100	67	210	230	1600	3600	3600	—	—
Indeno(1,2,3-cd)pyrene	16 E	9 E	15 E	39 U	58 E	33 E	110	110	600	4400	—	—	—
Dibenz(a,h)anthracene	60 U	66 U	51 U	41 U	75 U	93 U	72 U	70 U	230	1900	—	—	—
Benzo(ghi)perylene	21 E	13 E	20 E	12 E	71 E	41 E	130	130	670	3200	—	—	—
Total HPAHs	291	162	427	235	1695	1243	2680	3260	12000	69000	—	—	—

Table L-2. Cont.

Sample ID	HC-VC-94-C1	HC-VC-94-C2	HC-VC-95-C1	HC-VC-95-C2	HC-VC-96-C1	HC-VC-96-C2	HC-VC-97-C1	HC-VC-97-C2	PSDDA SL	PSDDA ML	PSDDA BT	SQS	MCUL
HPAHs in mg/kg-oc													
Fluoranthene	2.9	1.5	2.5	1.9	8.4	3.1	12	13		—	—	160	1200
Pyrene	3.1	1.6 E	2.3	1.5	7.6	3.3	9.6	10		—	—	1000	1400
Benz(a)anthracene	1.1 E	1.6 U	1.1	0.52 E	2.6	1.1	4.6	4.1		—	—	110	270
Chrysene	1.4 E	0.59 E	1.1	0.46 E	3.3	1.5	6.3	5.0		—	—	110	460
Total benzofluoranthenes	1.7 E	0.79 E	0.92 U	0.81 U	3.4	1.1 E	6.8	4.5		—	—	230	450
Benzo(a)pyrene	0.91 E	0.38 E	0.57 E	0.27 E	1.7	0.61	3.7	3.0		—	—	99	210
Indeno(1,2,3-cd)pyrene	0.70 E	0.31 E	0.28 E	0.81 U	1.0 E	0.30 E	1.9	1.4		—	—	34	88
Dibenz(a,h)anthracene	2.6 U	2.3 U	0.96 U	0.85 U	1.3 U	0.84 U	1.3 U	0.92 U		—	—	12	33
Benzo(ghi)perylene	0.91 E	0.45 E	0.38 E	0.25 E	1.2 E	0.37 E	2.3	1.7		—	—	31	78
Total HPAHs	13	5.6	8.1	4.9	29	11	47	43		—	—	960	5300
Miscellaneous Semivolatiles in ug/kg (dry weight)													
1,2-Dichlorobenzene	36 U	19 U	30 U	24 U	16 E	33 E	12 E	21 U	35	110	37	—	—
1,3-Dichlorobenzene	49 U	53 U	42 U	33 U	61 U	19 E	58 U	57 U	170	—	1241	—	—
1,4-Dichlorobenzene	32 U	35 U	28 U	22 U	12 E	29 E	17 E	21 E	110	120	120	—	—
1,2,4-Trichlorobenzene	30 U	33 U	26 U	20 U	38 U	47 U	36 U	35 U	31	64	—	—	—
Hexachlorobenzene	4.1	5.3	2.3	1.8 U	23	28	13	4.6	22	230	168	—	—
Dibenzofuran	14 E	10 E	88	120	95	52 U	100	220 E	540	1700	—	—	—
Hexachlorobutadiene	2.6 U	2.8 U	2.2 U	1.8 U	3.3 U	4 U	3.1 U	3 U	29	290	212	—	—
Hexachloroethane	37 U	40 U	31 U	25 U	46 U	57 U	43 U	43 U	1400	14000	10220	—	—
N-Nitroso diphenylamine	40 U	43 U	34 U	27 U	50 U	62 U	47 U	46 U	28	130	130	—	—
Benzyl Alcohol	3.9 E	2.8 E	3.5 E	0.93 E	15 E	28 E	55 E	8 E	57	870	—	57	73
Benzoic Acid	100 EB	95 EB	390 B	230 B	370 B	420 B	390 B	260 EB	650	760	—	650	650
Miscellaneous Semivolatiles in mg/kg-oc													
1,2-Dichlorobenzene	1.6 U	0.65 U	0.57 U	0.50 U	0.28 E	0.30 E	0.21 E	0.28 U		—	—	2.3	2.3
1,4-Dichlorobenzene	1.4 U	1.2 U	0.53 U	0.46 U	0.21 E	0.26 E	0.30 E	0.28 E		—	—	3.1	9
1,2,4-Trichlorobenzene	1.3 U	1.1 U	0.49 U	0.42 U	0.65 U	0.43 U	0.63 U	0.46 U		—	—	0.81	1.8
Hexachlorobenzene	0.18	0.18	0.043	0.038 U	0.40	0.25	0.23	0.061		—	—	0.38	2.3
Dibenzofuran	0.61 E	0.34 E	1.7	2.5	1.6	0.47 U	1.8	2.9 E		—	—	15	58
Hexachlorobutadiene	0.11 U	0.097 U	0.042 U	0.038 U	0.057 U	0.036 U	0.054 U	0.039 U		—	—	3.9	6.2
N-Nitroso diphenylamine	1.7 U	1.5 U	0.64 U	0.56 U	0.86 U	0.56 U	0.82 U	0.60 U		—	—	11	11
Phthalates in ug/kg (dry weight)													
Dimethyl phthalate	67 U	73 U	57 U	45 U	83 U	100 U	16 E	78 U	1400	—	1400	—	—
Diethyl phthalate	79 U	9 E	67 U	53 U	11 E	120 U	93 U	91 U	1200	—	—	—	—
Di-n-butyl phthalate	18 EB	22 EB	39 U	31 U	58 U	72 U	52 EB	54 U	5100	—	10220	—	—
Butyl benzyl phthalate	60 U	65 U	51 U	40 U	75 U	93 U	38 U	70 U	970	—	—	—	—
Bis(2-ethylhexyl)phthalate	38 EB	46 EB	360 B	23 EB	460 B	290 B	560 B	130 EB	8300	—	13870	—	—
Di-n-octyl phthalate	56 U	61 U	48 U	38 U	70 U	87 U	67 U	65 U	6200	—	—	—	—
Phthalates in mg/kg-oc													
Dimethyl phthalate	2.9 U	2.5 U	1.1 U	0.94 U	1.4 U	0.91 U	0.28 E	1.0 U		—	—	53	53
Diethyl phthalate	3.4 U	0.31 E	1.3 U	1.1 U	0.19 E	1.1 U	1.6 U	1.2 U		—	—	61	110
Di-n-butyl phthalate	0.78 EB	0.76 EB	0.74 U	0.65 U	1.0 U	0.65 U	0.91 EB	0.71 U		—	—	220	1700
Butyl benzyl phthalate	2.6 U	2.2 U	0.96 U	0.83 U	1.3 U	0.84 U	0.67 U	0.92 U		—	—	4.9	64
Bis(2-ethylhexyl)phthalate	1.7 EB	1.6 EB	6.8 B	0.48 EB	7.9 B	2.6 B	9.8 B	1.7 EB		—	—	47	78
Di-n-octyl phthalate	2.4 U	2.1 U	0.91 U	0.79 U	1.2 U	0.79 U	1.2 U	0.85 U		—	—	58	4500

Table L-2. Cont.

Sample ID	HC-VC-94-C1	HC-VC-94-C2	HC-VC-95-C1	HC-VC-95-C2	HC-VC-96-C1	HC-VC-96-C2	HC-VC-97-C1	HC-VC-97-C2	PSDDA SL	PSDDA ML	PSDDA BT	SQS	MCUL
Phenols in ug/kg (dry weight)													
Phenol	34 B	23 B	160 B	63 B	210 B	230 B	190 B	290 B	420	1200	876	420	1200
2-Methylphenol	12 E	7.4 E	130	74	13 E	31 E	18 E	28 E	63	77	—	63	63
4-Methylphenol	130	78	460	260	4600	12000	3900	7600	670	3600	—	670	670
2,4-Dimethylphenol	14 E	8.4 E	190	120	8 E	46 E	8.8 E	19 E	29	210	—	29	29
Pentachlorophenol	4 E	4.3 E	11 E	5.7 E	29 E	150	37 E	44 E	400	690	504	360	690
Pesticides and PCBs in ug/kg (dry weight)													
4,4-DDD	4 E	14 UE	4.1 E	1.8 UE	28 E	52 E	25 E	61 E		—	—	—	—
4,4-DDE	5.2 UE	14 UE	4.4 UE	1.8 UE	16 UE	25 E	16 UE	15 UE		—	—	—	—
4,4-DDT	5.2 UE	14 UE	4.4 UE	1.8 UE	16 UE	20 UE	16 UE	15 UE		—	—	—	—
Total DDT	5.2 UE	14 UE	4.4 UE	1.8 UE	28 E	77 E	25 E	61 E	6.9	69	50	—	—
Aldrin	2.6 U	2.8 U	2.2 U	1.8 U	3.3	4.9	5.1	3.5	10	—	37	—	—
Alpha Chlordane	2.6 U	2.8 U	2.2 U	1.8 U	3.3 U	4 U	3.1 U	3 U	10	—	37	—	—
Dieldrin	5.2 U	5.7 U	4.4 U	3.5 U	9.5	10	14	20	10	—	37	—	—
Heptachlor	5.2 UE	2.8 UE	4.4 UE	1.8 UE	16 UE	20 UE	16 UE	15 UE	10	—	37	—	—
PCB-1016	52 U	57 U	44 U	35 U	coellution w/1242	coellution w/1242	coellution w/1242	coellution w/1242		—	—	—	—
PCB-1016 + 1242	NA	NA	NA	NA	280	510	200	190		—	—	—	—
PCB-1221	52 U	57 U	44 U	35 U	65 U	81 U	62 U	61 U		—	—	—	—
PCB-1232	52 U	57 U	44 U	35 U	65 U	81 U	62 U	61 U		—	—	—	—
PCB-1242	52 U	57 U	44 U	35 U	coellution w/1242	coellution w/1242	coellution w/1242	coellution w/1242		—	—	—	—
PCB-1248	52 U	57 U	44 U	35 U	65 U	81 U	62 U	61 U		—	—	—	—
PCB-1254	52 U	57 U	44 U	35 U	65 U	81 U	62 U	61 U		—	—	—	—
PCB-1260	52 U	57 U	44 U	35 U	330	510	160	320		—	—	—	—
Total PCBs	52 U	57 U	44 U	35 U	610	1000	360	510	130	3100	—	—	—
PCBs in mg/kg-oc	2.3 U	2 U	0.83 U	0.73 U	11	9.1	6.3	6.7		—	38	12	65
Conventionals													
Ammonia-Nitrogen (mg/kg dry wt)	12	36	8.1	21	100	610	87	260		—	—	—	—
Total Organic Carbon (%dry)	2.3	2.9	5.3	4.8	5.8	11	5.7	7.6		—	—	—	—
pH	8.2	8.4	8.1	8.2	8.2	8.2	8.1	8.1		—	—	—	—
Moisture (%)	47	53	40	24	59	67	57	56		—	—	—	—
Grain Size Summary													
Percent gravel	0	0	2	9	6	1	0	1		—	—	—	—
Percent sand	18	7	55	73	31	29	37	35		—	—	—	—
Percent silt	47	49	25	11	38	42	41	40		—	—	—	—
Percent clay	35	44	18	7	25	28	22	24		—	—	—	—

Table L-3. Detected PSDDA SL and PSDDA ML Exceedences

Sample ID	Analyte	Result	Unit	PSDDA SL	PSDDA SL E-Ratio (1)	PSDDA ML	PSDDA ML E-Ratio (1)
HC-VC-96-C2	Cadmium	6.1	mg/kg	0.41	1.20	14	
HC-VC-94-C1	Mercury	1.3	mg/kg	0.41	3.17	2.3	
HC-VC-94-C2	Mercury	1.8	mg/kg	0.41	4.39	2.3	
HC-VC-95-C1	Mercury	0.68	mg/kg	0.41	1.66	2.3	
HC-VC-96-C1	Mercury	2.7	mg/kg	0.41		2.3	1.17
HC-VC-96-C2	Mercury	4.3	mg/kg	0.41		2.3	1.87
HC-VC-97-C1	Mercury	1.8	mg/kg	0.41	4.39	2.3	
HC-VC-97-C2	Mercury	2.5	mg/kg	0.41		2.3	1.09
HC-VC-96-C1	Tributyltin	0.20	ug/L	0.15	1.33	NA	
HC-VC-97-C1	Tributyltin	0.19	ug/L	0.15	1.27	NA	
HC-VC-96-C1	Hexachlorobenzene	23	ug/kg	22	1.05	230	
HC-VC-96-C2	Hexachlorobenzene	28	ug/kg	22	1.27	230	
HC-VC-95-C1	2-Methylphenol	130	ug/kg	63		77	1.69
HC-VC-95-C2	2-Methylphenol	74	ug/kg	63	1.17	77	
HC-VC-95-C1	2,4-Dimethylphenol	190	ug/kg	29	6.55	210	
HC-VC-95-C2	2,4-Dimethylphenol	120	ug/kg	29	4.14	210	
HC-VC-96-C2	2,4-Dimethylphenol	46 E	ug/kg	29	1.59	210	
HC-VC-96-C1	4-Methylphenol	4600	ug/kg	670		3600	1.28
HC-VC-96-C2	4-Methylphenol	12000	ug/kg	670		3600	3.33
HC-VC-97-C1	4-Methylphenol	3900	ug/kg	670		3600	1.08
HC-VC-97-C2	4-Methylphenol	7600	ug/kg	670		3600	2.11
HC-VC-97-C1	Dieldrin	14	ug/kg	10	1.40	NA	
HC-VC-97-C2	Dieldrin	20	ug/kg	10	2.00	NA	
HC-VC-96-C1	Total DDT	28 E	ug/kg	6.9	4.06	69	
HC-VC-96-C2	Total DDT	77 E	ug/kg	6.9		69	1.12
HC-VC-97-C1	Total DDT	25 E	ug/kg	6.9	3.62	69	
HC-VC-97-C2	Total DDT	31 E	ug/kg	6.9	4.49	69	
HC-VC-96-C1	Total PCBs	610	ug/kg	130	4.69	3100	
HC-VC-96-C2	Total PCBs	1000	ug/kg	130	7.69	3100	
HC-VC-97-C1	Total PCBs	360	ug/kg	130	2.77	3100	
HC-VC-97-C2	Total PCBs	510	ug/kg	130	3.92	3100	

(1) - E-Ratio, or exceedance ratio, of an analyte/compound with respect to a criteria value is calculated by dividing the concentration of the analyte/compound by the criteria.

Table L-4. Summary of Bioassay Results for Controls and Reference Stations and Comparison to Performance Criteria

SAMPLE ID	*Eohaustorius estuaris* MEAN PERCENT MORTALITY[a]	*Dendraster excentricus* MEAN NORMAL SURVIVAL	*Neanthes arenaceodentata* MEAN INDIVIDUAL GROWTH (MIG) RATE (mg/ind/day dry weight)[a]
Negative Control			M_C < 10%;
Performance Criteria	M_C < 10%	$N_C/I \geq 70\%$	MIG ≥ 0.38 mg/ind/day
Test Performance	1 ± 2%	81%	0%; 0.57 ± 0.09
Reference Sediment			
Performance Criteria	$M_R - M_C \leq 20\%$	$N_R/N_C \geq 0.65$	$MIG_R/MIG_C \geq 0.8$
HC-CR-10 Performance	3 ± 3%	75%	0.69 ± 0.16
HC-CR-24 Performance	3 ± 4%	80%	0.56 ± 0.11

[a] Mean and standard deviation for five replicate samples

Table L-5. Summary of the Results of the *Eohaustorius estuarius* Bioassays and Comparison to PSDDA Criteria

Station ID	Reference Station[a]	Mean Mortality, %[b]	Significant Difference[c]	One-Hit Rule	Two-Hit Rule
HC-VC-94-C1	HC-CR-10	9 ± 3	No	Pass	Pass
HC-VC-94-C2	HC-CR-10	29 ± 10	Yes	Pass	Pass
HC-VC-95-C1	HC-CR-24	2 ± 3	No	Pass	Pass
HC-VC-95-C2	HC-CR-24	5 ± 4	No	Pass	Pass
HC-VC-96-C1	HC-CR-24	5 ± 4	No	Pass	Pass
HC-VC-96-C2	HC-CR-24	26 ± 13	Yes	Pass	Pass
HC-VC-97-C1	HC-CR-24	5 ± 4	No	Pass	Pass
HC-VC-97-C2	HC-CR-24	39 ± 18	Yes	**Fail**	**Fail**

[a] Corresponding reference station with similar grain size.
[b] Mean and standard deviation for five replicate samples.
[c] Statistically significant increases in percent mortality compared to reference as determined by a t-Test (normally distributed data) or Mann-Whitney Test (M-W: nonparametric data) at the $\alpha = 0.05$ level.

Table L-6. Summary of the Results of the *Dendraster excentricus* Bioassays and Comparison to PSDDA Criteria

Station ID	Reference Station[A]	Mean Normal survival, %[B]	Significant Difference[C]	One-Hit Rule	Two-Hit Rule
HC-VC-94-C1	HC-CR-10	113.8 ± 5.3	No	Pass	Pass
HC-VC-94-C2	HC-CR-10	63.4 ± 14.1	Yes	Pass	Pass
HC-VC-95-C1	HC-CR-24	80.4 ± 6.1	Yes	Pass	Pass
HC-VC-95-C2	HC-CR-24	108.4 ± 9.3	No	Pass	Pass
HC-VC-96-C1	HC-CR-24	0.4 ± 0.5	Yes	**Fail**	**Fail**
HC-VC-96-C2	HC-CR-24	0	Yes	**Fail**	**Fail**
HC-VC-97-C1	HC-CR-24	83.0 ± 11.4	No	Pass	Pass
HC-VC-97-C2	HC-CR-24	0	Yes	**Fail**	**Fail**

[a] Corresponding reference station with similar grain size.
[b] Mean and standard deviation for five replicate samples.
[c] Statistically significant decreases in percent normal survival compared to reference as determined by a t-test (normally distributed data) or Mann-Whitney Test (M-W: nonparametric data) at the $\alpha = 0.05$ level.

Table L-7. Summary of the Results of the *Neanthes arenaceodentata* Bioassays and Comparison to PSDDA Criteria

Station ID	Reference Station[a]	Mean Individual Growth Rate, mg/ind/day dry wt[b]	Significant Difference[c]	One-Hit Rule	Two-Hit Rule
HC-VC-94-C1	HC-CR-10	0.61 ± 0.04	Yes	Pass	Pass
HC-VC-94-C2	HC-CR-10	0.71 ± 0.06	No	Pass	Pass
HC-VC-95-C1	HC-CR-24	0.59 ± 0.08	No	Pass	Pass
HC-VC-95-C2	HC-CR-24	0.67 ± 0.11	No	Pass	Pass
HC-VC-96-C1	HC-CR-24	0.00	Yes	**Fail**	**Fail**
HC-VC-96-C2	HC-CR-24	0.00	Yes	**Fail**	**Fail**
HC-VC-97-C1	HC-CR-24	0.45 ± 0.16	No	Pass	Pass
HC-VC-97-C2	HC-CR-24	0.00	Yes	**Fail**	**Fail**

NOTE: SQS - Sediment Quality Standards
MCUL - Minimum Cleanup Level

[a] Corresponding reference station with similar grain size.
[b] Mean and standard deviation for five replicate samples.
[c] Statistically significant decreases in growth relative to reference as determined by a t-test (normally distributed data) or Mann-Whitney Test (M-W: nonparametric data) at the $\alpha = 0.05$ level.

Table L-8. Comparison of Bioassay Results and Sediment Biological Effects Interpretive Criteria

	E. estuaris		*D. excentricus*		*N. arenaceodentata*			
STATION ID	One-Hit	Two-Hit	One-Hit	Two-Hit	One-Hit	Two-Hit	PSDDA "ONE-HIT RULE"	PSDDA "TWO-HIT RULE"
HC-VC-94-C1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
HC-VC-94-C2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
HC-VC-95-C1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
HC-VC-95-C2	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
HC-VC-96-C1	Pass	Pass	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**
HC-VC-96-C2	Pass	Pass	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**
HC-VC-97-C1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
HC-VC-97-C2	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**	**Fail**

Table L-9. Whatcom Waterway Bioaccumulation Mercury Concentrations

Sample ID	Hg (mg/kg wet weight)	
	N. virens	*M. nasuta*
Negative control	0.019	0.019
Negative control	0.014	0.014
Negative control	0.013	0.021
Negative control	0.016	0.045
HC-CR-10	0.017	0.017
HC-CR-10	0.011	0.021
HC-CR-10	0.009	0.016
HC-CR-10	0.011	0.019
HC-CR-24	0.015	0.015
HC-CR-24	0.019	0.023
HC-CR-24	0.018	0.015
HC-CR-24	0.018	0.017
HC-VC-97-C1	0.014	0.05
HC-VC-97-C1	0.01	0.029
HC-VC-97-C1	0.011	0.019
HC-VC-97-C1	0.015	0.022
HC-VC-94-C2	NA	0.03
Background	0.018	0.023
Day 0	0.009	0.024

NOTE: NA - Insufficient sample volume

Table L-10. Whatcom Waterway Mean Mercury Concentrations (mg/kg wet weight)

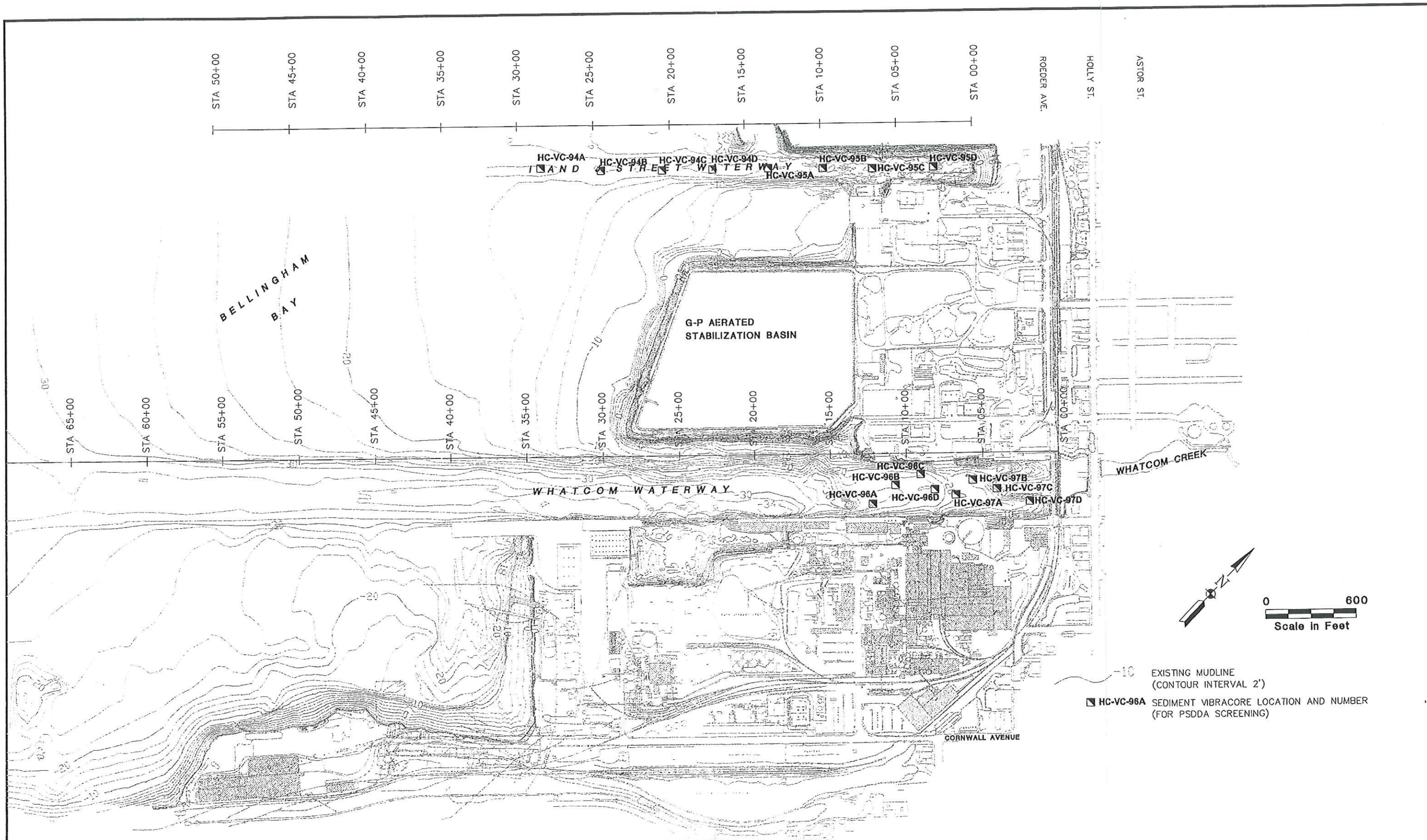
	N. virens		*M. nasuta*	
Sample ID	Mean	Standard Deviation	Mean	Standard Deviation
Negative Control	0.0155	0.00265	0.0248	0.01382
HC-CR-10	0.0120	0.00346	0.0183	0.00222
HC-CR-24	0.0175	0.00173	0.0175	0.00379
HC-VC-97-C1	0.0125	0.00238	0.0300	0.01398
HC-VC-94-C2	NA	NA	0.0300	NA

NOTE: NA - Insufficient sample volume

Table L-11. PSSDA Analysis Summary

	Chemical Exceedences					Confirmatory Biological Testing		Potential Disposal Options	
Sample ID	PSDDA SL Exceedances	PSDDA ML Exceedances	PSDDA BT Exceedances	SQS Exceedances	MCUL Exceedances	PSDDA Bioassay	Mercury Concentration Less Than Bioaccumulation Action Level (1)	Potentially Suitable for Unconfined Open-Water Disposal	Potentially Suitable for Beneficial Reuse
HC-VC-94-C1	Mercury; 1,2-Dichlorobenzene; N-Nitrosodiphenylamine	None	None	Mercury; 1,2,4-Trichlorobenzene (ER 1.61)	Mercury	Pass	NA	Yes	Yes
HC-VC-94-C2	Mercury; 1,2,4-Trichlorobenzene; N-Nitrosodiphenylamine; Total DDT	None	Mercury	Mercury; 1,2,4-Trichlorobenzene (ER 1.40)	Mercury	Pass	Yes	Yes	Yes
HC-VC-95-C1	Mercury; 2-Methylphenol; 2,4-Dimethylphenol; N-Nitrosodiphenylamine	2-Methylphenol	None	Mercury; 2-Methylphenol; 2,4-Dimethylphenol	Mercury; 2-Methylphenol; 2,4-Dimethylphenol	Pass (2)	NA	Yes	Yes
HC-VC-95-C2	2-Methylphenol; 2,4-Dimethylphenol	None	None	2-Methylphenol; 2,4-Dimethylphenol	2-Methylphenol; 2,4-Dimethylphenol	Pass	NA	Yes	Yes
HC-VC-96-C1	Mercury; Tributyltin; 4-Methylphenol; 1,2,4-Trichlorobenzene; Hexachlorobenzene; N-Nitrosodiphenylamine; Heptachlor; Total DDT; Total PCBs	Mercury; 4-Methylphenol	Mercury; Tributyltin	Mercury; Hexachlorobenzene (ER 1.04); 4-Methylphenol	Mercury; 4-Methylphenol	Fail	NA	No	No
HC-VC-96-C2	Cadmium; Mercury; 1,2,4-Trichlorobenzene; Hexachlorobenzene; 4-Methylphenol; 2,4-Dimethylphenol; N-Nitrosodiphenylamine; Heptachlor; Total DDT; Total PCBs	Mercury; 4-Methylphenol; Total DDT	Mercury; Total DDT	Cadmium; Mercury; 4-Methylphenol; 2,4-Dimethylphenol	Mercury; 4-Methylphenol; 2,4-Dimethylphenol	Fail	NA	No	No
HC-VC-97-C1	Mercury; Tributyltin; 1,2,4-Trichlorobenzene; 4-Methylphenol; N-Nitrosodiphenylamine; Dieldrin; Heptachlor; Total DDT; Total PCBs	4-Methylphenol	Mercury; Tributyltin	Mercury; 4-Methylphenol	Mercury; 4-Methylphenol	Pass (2)	Yes	Yes	Yes
HC-VC-97-C2	Mercury; 1,2,4-Trichlorobenzene; 4-Methylphenol; N-Nitrosodiphenylamine; Dieldrin; Heptachlor; Total DDT; Total PCBs	Mercury; 4-Methylphenol	Mercury	Mercury; 4-Methylphenol	Mercury; 4-Methylphenol	Fail	NA	No	No

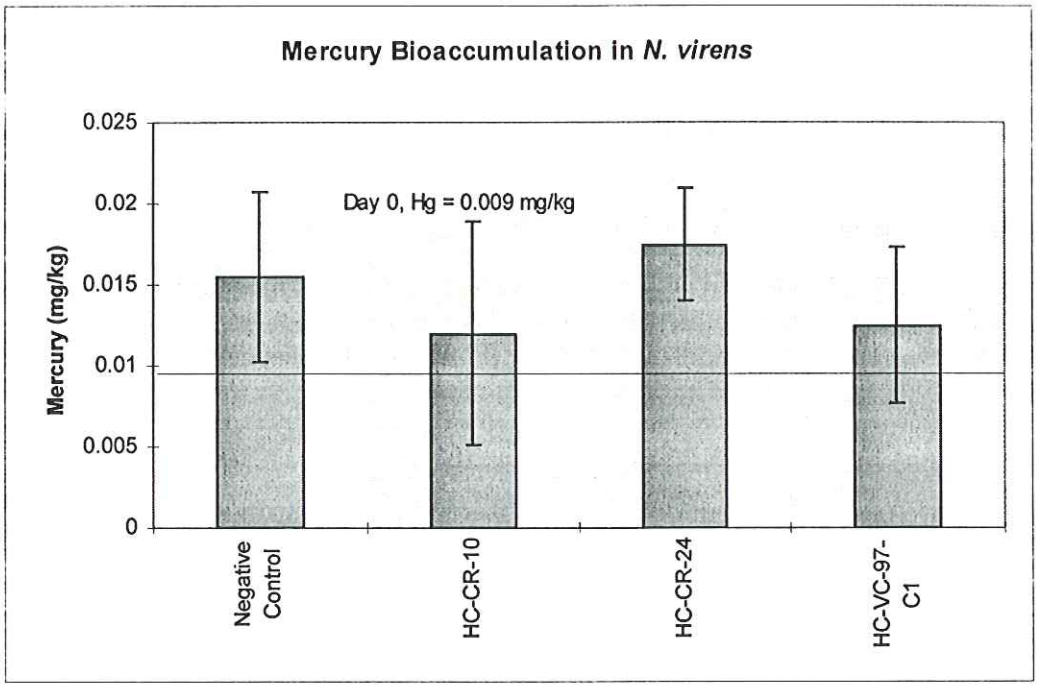
(1) - FDA action level of 1.0 mg/kg mercury in tissue (wet weight).
(2) - Although one chemical exceeds the PSDDA ML, the chemical does not exceed the ML by more than 100 percent.



ANCHOR ENVIRONMENTAL, L.L.C.

7/29/08 figs-1.dwg

Figure L-1
Screening Sample Location Plan
Whatcom Waterway Area



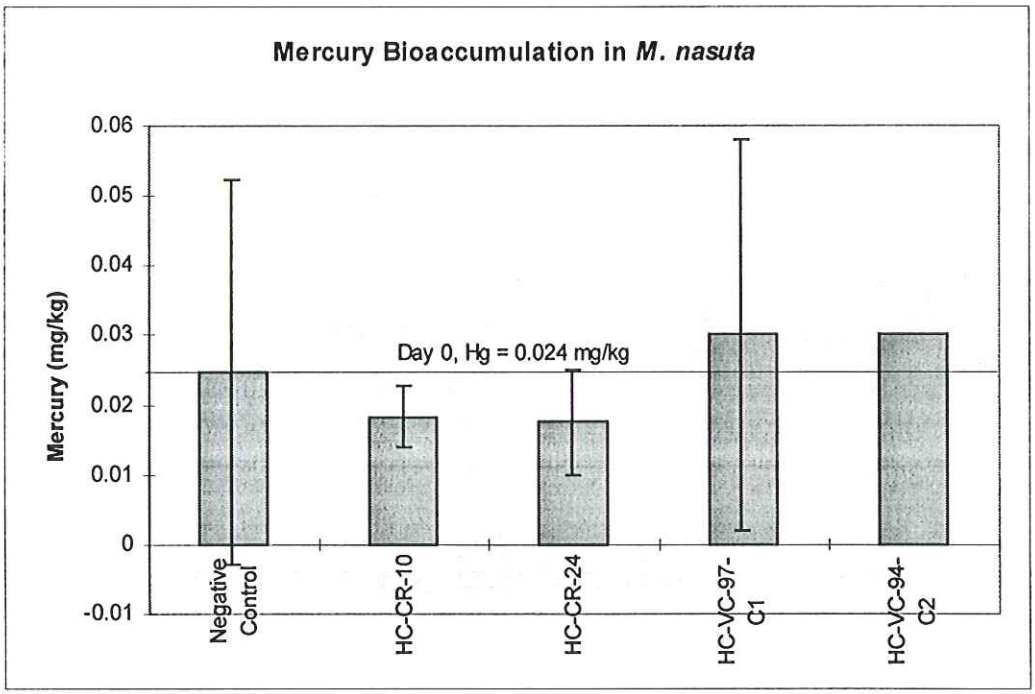


Figure L-2. Mercury Bioaccumulation in N. Virens and M. Nasuta

APPENDIX M
ASSESSMENT OF CONTAMINANT MOBILITY
SEQUENTIAL BATCH LEACHING TESTS

APPENDIX M
ASSESSMENT OF CONTAMINANT MOBILITY
SEQUENTIAL BATCH LEACHING TESTS

CONTENTS

M.1 Introduction ***M-1***
M.2 Sample Collection and Handling ***M-1***
M.3 Scope of Sequential Batch Leaching Tests ***M-2***
M.4 Contaminant Mobility Analysis ***M-3***

TABLES

M-1 SBLT Round 1 for Whatcom Waterway – Anoxic DDI
M-2 SBLT Round 2 for Whatcom Waterway – Oxic DDI
M-3 SBLT Round 3 for Whatcom Waterway – Anoxic Seawater
M-4 SBLT Round 4 for Whatcom Waterway – Anoxic DDI
M-5 Summary of SBLT Data Quality
M-6 SBLT Test Results as Compared to Prospective Disposal Scenarios

FIGURES

M-1 Sampling Location Plan
M-2 Copper Mobility versus Salinity
M-3 Lead Mobility versus Salinity
M-4 Mercury Mobility versus Salinity

APPENDIX M
ASSESSMENT OF CONTAMINANT MOBILITY
SEQUENTIAL BATCH LEACHING TESTS

M.1 Introduction

Sequential Batch Leaching Tests (SBLT) were performed to address the contaminant mobility of sediments being considered for possible confined aquatic, nearshore, and upland disposal sites. SBLT results can be used to predict the leachate quality from dredged sediments, and were used in the Whatcom Waterway feasibility study (FS) to evaluate potential surface water and groundwater quality impacts associated with long-term operation of alternative confined disposal facilities. Four SBLTs were performed on one composite sediment sample collected from the Whatcom Waterway as shown in Figure M-1 and as described below. The SBLT samples were collected within the Whatcom Waterway site sediment unit 1D (see Figure 12-3), a prospective dredge prism that contains some of the highest chemical concentrations, and is representative of material being considered for containment, in accordance with Corps test procedures (Myers et al., 1992). From the SBLT results, the potential long-term water quality impacts of alternative confined disposal designs and the engineering controls necessary to meet the applicable water quality criteria were evaluated and are presented in this Appendix. The SBLT results are also discussed in Section 14.0 of the FS report.

M.2 Sample Collection and Handling

Sediment core sampling, decontamination, and processing were conducted in accordance with the approved Addendum 2 Sampling and Analysis Plan (SAP) (Hart Crowser 1997b) and in Appendix A. A total of four cores (HC-VC-77 Drive 1 and 2; HC-VC-79 Drive 1 and 2) were collected in the Whatcom Waterway near previous sampling stations HC-VC-77 and HC-VC-79 (Figure M-1). After each core was extruded and logged, the surficial film of disturbed sediment along the sidewalls was removed. The remaining sediment from the selected lithologic unit was placed in a stainless steel bucket for compositing with other core sections. The surficial soft, black organic silt (identified in the remedial investigation sampling as contaminated) was collected from the mudline down to the sand/silt interface. A distinct lithologic change was evident in the four cores from the surficial black silt with abundant wood fragments to a dark gray sandy silt. Vertically composited depths from the surface to silt/sand contact ranged from 2.8 to 6.5-foot depths as follows:

- HC-VC-77L Drive 1 - 0 to 4.5
- HC-VC-77L Drive 2 - 0 to 4.0
- HC-VC-79L Drive 1 - 0 to 2.8

- HC-VC-79L Drive 2 - 0 to 6.5

Sediment from these cores was composited together using a stainless steel paddle wheel and drill until uniform in color and texture. Sediment from below the interface was not included in the composite sample. The composited sample, labeled HC-VC-77/79L, was placed into appropriate, pre-labeled, pre-cleaned containers and stored at 4 °C at Hart Crowser until testing.

M.3 Scope of Sequential Batch Leaching Tests

Four SBLTs were performed on a composite sediment sample representative of material to be contained within a nearshore CDF; two anoxic SBLTs and one oxic SBLT were performed for the analysis of metals, and one anoxic SBLT was performed for the analysis of organic constituents. The leachant used to perform each test consisted of either seawater or distilled deionized water (DDI) as described below.

M.3.1 Anoxic Sequential Batch Leaching Tests

Two anoxic SBLTs were performed for the analysis of metals; one was performed using deoxygenated seawater as the leachant and the other was performed using DDI water as the leachant. One anoxic SBLT was performed for the analysis of organic constituents using deoxygenated DDI water.

Metals. The anoxic SBLT using deoxygenated seawater leachant was designed to simulate the conditions in a CDF with limited groundwater influx, and where the water that is anticipated to flow through the disposed dredge material is similar to dredge material interstitial water. Thus the salinity of the seawater leachant was adjusted to the salinity level of the interstitial water from the sediment sample composite using DDI water.

The anoxic SBLT for metals using DDI water was designed to simulate the conditions in a CDF where there is unrestricted groundwater influx. As groundwater infiltrates the CDF, metals may be leached out of the sediments due to the gradual decrease in salinity and resultant "saltwater washout" (Myers et al., 1992 and Port of Tacoma, 1992).

Organic constituents. Deoxygenated DDI water was used for the SBLT performed for organic constituents. This methodology generally provides the most conservative estimate of the leaching ability of the organic constituents (i.e., no aerobic biodegradation).

M.3.2 Oxic Sequential Batch Leaching Tests

One oxic SBLT was performed for the analysis of metals using DDI water as the leachant. This SBLT was designed to conservatively estimate the leachability of metals from the dredge material to be contained in possible

higher elevation disposal areas within the CDF (i.e., above the static water level). In many instances, metals mobility is enhanced under oxic conditions. This test method followed the same procedures as described in the previous section for metals, except that the SBLT was performed in an oxic environment (i.e., ambient oxygen levels). In addition, the composite sediment sample for this test was air-dried for 12 hours prior to performing the oxic SBLT.

M.4 Contaminant Mobility Analysis

Results for each SBLT test are provided in Tables M-1 through M-4. The results were evaluated with respect to Washington State freshwater and marine chronic water quality criteria (Chapter 173-201A WAC) and Washington State's Model Toxics Control Act (MTCA) groundwater cleanup levels (Chapter 173-340) to determine the chemicals of potential concern (COPC) for this evaluation. The derivation of the COPCs are summarized in Table M-5.

Maximum dissolved concentrations of copper, lead, and mercury from the anoxic and oxic leachates were compared to salinity in Figures M-2 through M-4 to assess contaminant mobility for metals with respect to changing salinity. For both the anoxic and oxic leachates, the metals concentrations decreased significantly with increasing salinity, consistent with a "salt washout" effect. Oxic conditions resulted in a relatively minor increase in metal mobility. Metals concentrations decreased to levels below their respective method reporting limits around salinity concentrations of 10 parts per thousand.

The SBLT results for the COPCs were then evaluated with respect to three different prospective disposal scenarios: upland disposal, nearshore fill disposal, and confined aquatic disposal (CAD) (see Table M-6). Each scenario was paired with the most appropriate SBLT test results. In order to address the potential of interstitial water from the disposed sediments leaching through the upland disposal facility to freshwater and/or groundwater sources, the upland disposal scenario was evaluated with respect to the aerobic (oxic) freshwater SBLT test, freshwater quality criteria, and MTCA groundwater cleanup levels.

The nearshore fill scenario is not expected to impact freshwater or groundwater sources, and consequently was evaluated with respect to marine chronic water quality criteria. In addition, depending upon how the nearshore fill would be designed, the disposed sediment may be subjected to aerobic and/or anaerobic conditions. Therefore, the nearshore fill scenario was evaluated with respect to the maximum dissolved leachate concentration of all SBLT tests (aerobic, anaerobic, freshwater, and saline). The maximum exceedence ratio for the nearshore fill scenario is 248 for mercury.

Prospective CAD sites appropriate for Whatcom Waterway area sediment disposal are located in saline, anaerobic environments. Thus, the CAD scenario was evaluated with respect to marine chronic water quality criteria

and the anaerobic saline SBLT. Mercury was not detected in the anaerobic saline SBLT test. However, the mercury detection limit was slightly greater than the marine chronic water quality criteria.

In summary, the relative leachability of contaminants present in the Whatcom Waterway area sediments is expected to vary depending on which type of confined disposal site is used. The relative leachability ranking is as follows (compared to appropriate receiving water criteria):

Upland > Nearshore Fill >> CAD.

Table M-1 SBLT Round 1 for Whatcom Waterway - Anoxic DDI

Analyte	HC-LT-FB1	HC-LT-PB	HC-LT-01	HC-LT-02	HC-LT-03	HC-LT-04	HC-LT-05	HC-LT-06	HC-LT-07
Ammonia in mg/L	0.02 U	0.02 U	33	9.47	3.12	2.2	0.54	1.07	1.01
Salinity in ppt	0.0012	0.0017	9.6	2.1	0.62	0.24	0.16	0.13	0.11
Total Dissolved Solids	10 U	10 U	9600	2200	1100	390	280	230	190
Total Organic Carbon	0.5 U	1.7	32	31	39	24	19	16	14
Dissolved Metals in mg/L									
Arsenic	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Cadmium	0.0002 U	0.0002 U	0.0002 U	0.00042	0.0019	0.00094	0.0007	0.00093	0.00081
Chromium	0.01 U	0.01 U	0.01 U	0.015	0.043	0.023	0.021	0.015	0.019
Copper	0.002 U	0.006	0.002 U	0.019	0.099	0.055	0.048	0.049	0.034
Lead	0.0035	0.0057	0.003 U	0.013	0.1	0.079	0.089	0.071	0.054
Mercury	*0.0002 U*	*0.0002 U*	*0.0002 U*	0.00039	0.002	0.00104	0.00122	0.00114	0.00099
Nickel	0.005 U	0.005 U	0.005 U	0.0092	0.037	0.017	0.02	0.015	0.015
Silver	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Zinc	0.01 U	0.01 U	0.01 U	0.023	0.1	0.054	0.056	0.05	0.046
Field Parameters									
pH			8	8	8.8	9.1	9.3	9.9	9.9
Temperature			22.5	22	22.5	23.5	23.5	23	24
Conductivity			9000	3000	1000	440	310	260	260
DO			0.3	0	0	0	0	0	0

Note:

HC-LT-XX - Denotes an SBLT sample from round 1 and leaching cycle number XX.

FB1 - Denotes a filter blank sample.

PB - Denotes a preparation blank sample.

The italicized results exceed detection limits.

Table M-2 SBLT Round 2 for Whatcom Waterway - Oxic DDI

Analyte	HC-LT2-PB	HC-LT2-01	HC-LT2-02	HC-LT2-03	HC-LT2-04	HC-LT2-05	HC-LT2-06	HC-LT2-07
Ammonia in mg/L	33	0.02 U	10.7	4.94	3.22	2.61	2.62	2.65
Salinity in ppt	0.0017	11	2.4	0.79	0.37	0.29	0.23	0.21
Total Dissolved Solids	17	10000	2400	1200	900	610	390	350
Total Organic Carbon	0.7	41	39	44	31	23	18	12
Dissolved Metals in mg/L								
Arsenic	0.005 U	0.028	0.023	0.038	0.035	0.024	0.017	0.011
Cadmium	0.0002 U	0.0002 U	0.00072	0.0024	0.0053	0.0068	0.0036	0.0021
Chromium	0.01 U	0.01 U	0.01 U	0.036	0.064	0.038	0.032	0.02
Copper	0.0079	0.002 U	0.038	0.22	0.52	0.29	0.29	0.13
Lead	0.18	0.003	0.014	0.049	0.11	0.073	0.061	0.038
Mercury	*0.0002 U*	*0.0002 U*	0.00065	0.0025	0.0062	0.0004	0.00042	0.00025
Nickel	0.005 U	0.005 U	0.0094	0.036	0.066	0.038	0.035	0.022
Silver	0.0002 U	0.0002 U	0.0002 U	0.00047	0.0012	0.00064	0.00061	0.00028
Zinc	0.01 U	0.01 U	0.028	0.11	0.24	0.14	0.16	0.1
Field Parameters								
pH		7.9	7.9	8.4	8.6	8.7	8.5	8.3
Temperature		24	23.5	24	24	24.5	24	23.5
Conductivity		10500	3800	1040	650	600	420	380
DO		4.4	2.9	3.3	3.7	4.3	4.1	3.3

Note:

HC-LT2-XX - Denotes an SBLT sample from round 2 and leaching cycle number XX.

PB - Denotes a preparation blank sample.

The italicized results exceed detection limits.

Lead exceedences may be due to blank contamination.

Table M-3 SBLT Round 3 for Whatcom Waterway - Anoxic Seawater

Analyte	HC-LT3-SW	HC-LT3-01	HC-LT3-02	HC-LT3-03	HC-LT3-04	HC-LT3-05	HC-LT3-06	HC-LT3-07
Ammonia in mg/L	0.02 U	43	21	11.1	3.1			
Salinity in ppt	16	20	17	16	15	16	16	16
Total Dissolved Solids	16000	20000	NA	16000	14000	16000	16000	16000
Total Organic Carbon	2.3	24	9.2	7	6	5.3	5.3	5.3
Dissolved Metals in mg/L								
Arsenic	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Cadmium	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Copper	0.0039	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Lead	0.0054	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Mercury	*0.0002 U*	*0.0002 U*	*0.0002 U*	*0.0002 U*	*0.0002 U*	*0.0002 U*	*0.0002 U*	*0.0002 U*
Nickel	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Silver	0.0002 U	0.0004 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Zinc	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Field Parameters								
pH	8.3	7.3	7.5	7.5	7.5	7.5	7.6	7.8
Temperature	22.2	2.38	24.7	24.6	24.7	25.5	24.7	24.7
Conductivity	10500	13500	12500	19000	17500	21000	20500	20300
DO	0	0.1	0	0	0	0	0	0

Note:

HC-LT3-XX - Denotes an SBLT sample from round 3 and leaching cycle number XX.

SW - Denotes a seawater preparation blank sample.

The italicized results exceed detection limits.

Table M-4 SBLT Round 4 for Whatcom Waterway - Anoxic DDI

Analyte	HC-LT4-PB	HC-LT4-DI	HC-LT4-1	HC-LT4-02	HC-LT4-03	HC-LT4-04	HC-LT4-05	HC-LT4-06	HC-LT4-07
PAHs in ug/L									
Naphthalene	0.24 B	0.27 B	0.51 B	0.59 B	0.63 JB	0.69 JB	0.53 JB	0.41 JB	0.43 JB
2- Methylnapthalene	0.2 U	0.2 U	0.21	0.2 U	NA	NA	NA		
Acenapthylene	0.016 U	0.016 U	0.016 U	0.12	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Acenapthene	0.028 U	0.028 U	0.4	0.38	0.83 J	0.88 J	0.71 J	0.58 J	0.56 J
Fluorene	0.018 U	0.018 U	0.23	0.26	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Phenanthrene	0.043	0.015 U	0.32	0.47	0.7 J	0.78 J	0.73 J	0.49 J	0.45 J
Anthracene	0.013 U	0.013 U	0.056	0.013 U	0.5 J	0.28 J	0.19 J	0.12 J	0.12 J
Fluoranthene	0.011 U	0.011 U	0.17	0.63	0.51 J	0.66 J	0.5 J	0.32 J	0.31 J
Pyrene	0.014 U	0.014 U	0.15	0.57	0.58 J	0.53 J	1.3 U	0.23 J	0.21 J
Benzo(a)anthracene	0.013 U	0.013 U	0.013 U	0.098	*1.3 U*	*1.3 U*	*1.3 U*	*1.3 U*	*1.3 U*
Chrysene	0.012 U	0.012 U	0.012 U	0.081	0.1 J	0.093 J	0.07 J	1.3 U	1.3 U
Benzo(a)pyrene	0.01 U	0.01 U	0.01 U	0.027	*5 U*	*5 U*	*2.5 U*	*2.5 U*	*2.5 U*
Indeno(1,2,3-c,d)pyrene	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
Dibenzo(a,h)anthracene	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
Benzo(b)fluoranthene	0.009 U	0.009 U	0.009 U	0.009 UE	5 U	5 U	2.5 U	2.5 U	2.5 U
Benzo(k)fluoranthene	0.009 U	0.009 U	0.009 U	0.009 UE	5 U	5 U	2.5 U	2.5 U	2.5 U
Benzo(g,h,I)perlyene	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U
Total of Detected Carcinogenic PAHs	-----	-----	-----	0.206	0.1	0.093	0.07	-----	-----

Note:

HC-LT4-XX - Denotes an SBLT sample from round 4 and leaching cycle number XX.

PB - Denotes a preparation blank sample.

DI - Denotes a deionized distilled water sample.

Italicized results exceed detection limits due to matrix interference.

Carcinogenic PAHs are: benzo(a)anthracene, chrysene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(g,h,I)perylene.

Table M-5 Summary of SBLT Data Quality, Whatcom Waterway

Parameter	Detection Frequency	Maximum Detected Concentration	Water Quality Screening Criteria	Frequency of Exceedance
Conventionals:				
Ammonia in mg/L	21/21	43		
Salinity in ppt	21/21	20		
Total Dissolved Solids (%)	21/21	20000		
Total Organic Carbon (%)	21/21	44		
Metals in ug/L:				
Arsenic	7/21	38	5 (c)	7/21
Cadmium	12/21	6.8	0.42 (a)	12/21
Chromium	11/21	64	10 (a)	11/21
Copper	12/21	520	3.1 (b)	12/21
Lead	13/21	110	0.66 (a)	13/21
Mercury	12/21	6.2	0.012 (a)	12/21
Nickel	12/21	66	8.2 (b)	12/21
Silver	5/21	1.2	0.43 (a)	4/21
Zinc	12/21	240	38 (a)	10/21
LPAHs in ug/L:				
2-Methylnaphthalene	1/2	0.21	300 (d)	
Acenaphthene	7/7	0.88 J	300 (d)	
Acenaphthylene	1/7	0.12	300 (d)	
Anthracene	6/7	0.5 J	300 (d)	
Fluorene	2/7	0.26	300 (d)	
Naphthalene	7/7	0.69 JB	300 (d)	
Phenanthrene	7/7	0.78 J	300 (d)	
HPAHs in ug/L:				
Benz(a)anthracene	1/7	0.098	0.1 (c)	
Benzo(a)pyrene	1/7	0.027	0.1 (c)	
Benzo(b)fluoranthene	0/7	5 U	0.1 (c)	
Benzo(ghi)perylene	0/7	0.011 U	NA	
Benzo(k)fluoranthene	0/7	5 U	0.1 (c)	
Chrysene	4/7	0.1 J	0.1 (c)	
Dibenz(a,h)anthracene	0/7	0.012 U	0.1 (c)	
Fluoranthene	7/7	0.66 J	NA	
Indeno(1,2,3-cd)pyrene	0/7	0.012 U	0.1 (c)	
Pyrene	6/7	0.58 J	NA	
Total of Detected Carcinogenic PAHs	4/7	0.03 J	0.1 (c)	0/7

Note:

(a) Washington State freshwater quality criteria. Chapter 173-201A WAC.

(b) Washington State marine water quality criteria. Chapter 173-201A WAC.

(c) Washington State Model Toxics Control Act groundwater cleanup levels. Chapter 173-340 WAC.
Total carcinogenic PAH comarisons based on toxicity equivalency factors (Weiss, 1997).

(d) Clean Water Act lowest observable adverse effects level.

Table M-6 SBLT Test Results as Compared to Prospective Disposal Scenarios

Chemicals of Potential Concern	Prospective Upland Disposal Scenario				Prospective Nearshore Fill Disposal Scenario			Prospective Confined Aquatic Disposal Scenario		
	Maximum SBLT Concentration (1)	State Freshwater Chronic Criterion	MTCA Groundwater Cleanup Level	Maximum Exceedance Ratio	Maximum SBLT Concentration (2)	State Marine Chronic Criterion	Exceedance Ratio	Maximum SBLT Concentration (3)	State Marine Chronic Criterion	Exceedance Ratio
Dissolved Metals in ug/L										
Arsenic	38	190	5	7.6	38	21	1.8	5 ND	21	NA
Cadmium	6.8	0.42	5	16	6.8	9.3	NA	0.2 ND	9.3	NA
Chromium	64	10	50	6.4	64	50	1.3	10 ND	50b	NA
Copper	520	4.1	592	127	520	3.1	168	2 ND	3.1	NA
Lead	110	0.66	5	167	110	8.1	14	3 ND	8.1	NA
Mercury	6.2	0.012	2	517	6.2	0.025	248	0.2 ND	0.025	<8
Nickel	66	57	100	1.2	66	8.2	8.0	5 ND	8.2	NA
Silver	1.2	0.43	50	2.8	1.2	1.9	NA	0.4 ND	1.9	NA
Zinc	240	38	4800	6.3	240	81	3.0	10 ND	81	NA
Maximum Exceedance Ratios				517			248			<8

Notes:

(1) Maximum detected aerobic freshwater SBLT concentration.

(2) Maximum detected concentration from all SBLT tests (aerobic, anaerobic, freshwater, and saline)

(3) Maximum detected anaerobic saline SBLT concentration

Exceedance ratios were calculated by dividing the sample analyte concentration by the criteria value.

NA-Organic analysis was not applicable for this SBLT.

ND-Analyte was not detected.

Figure M-2. Copper Mobility versus Salinity, Whatcom Waterway Sequential Batch Leaching Tests.

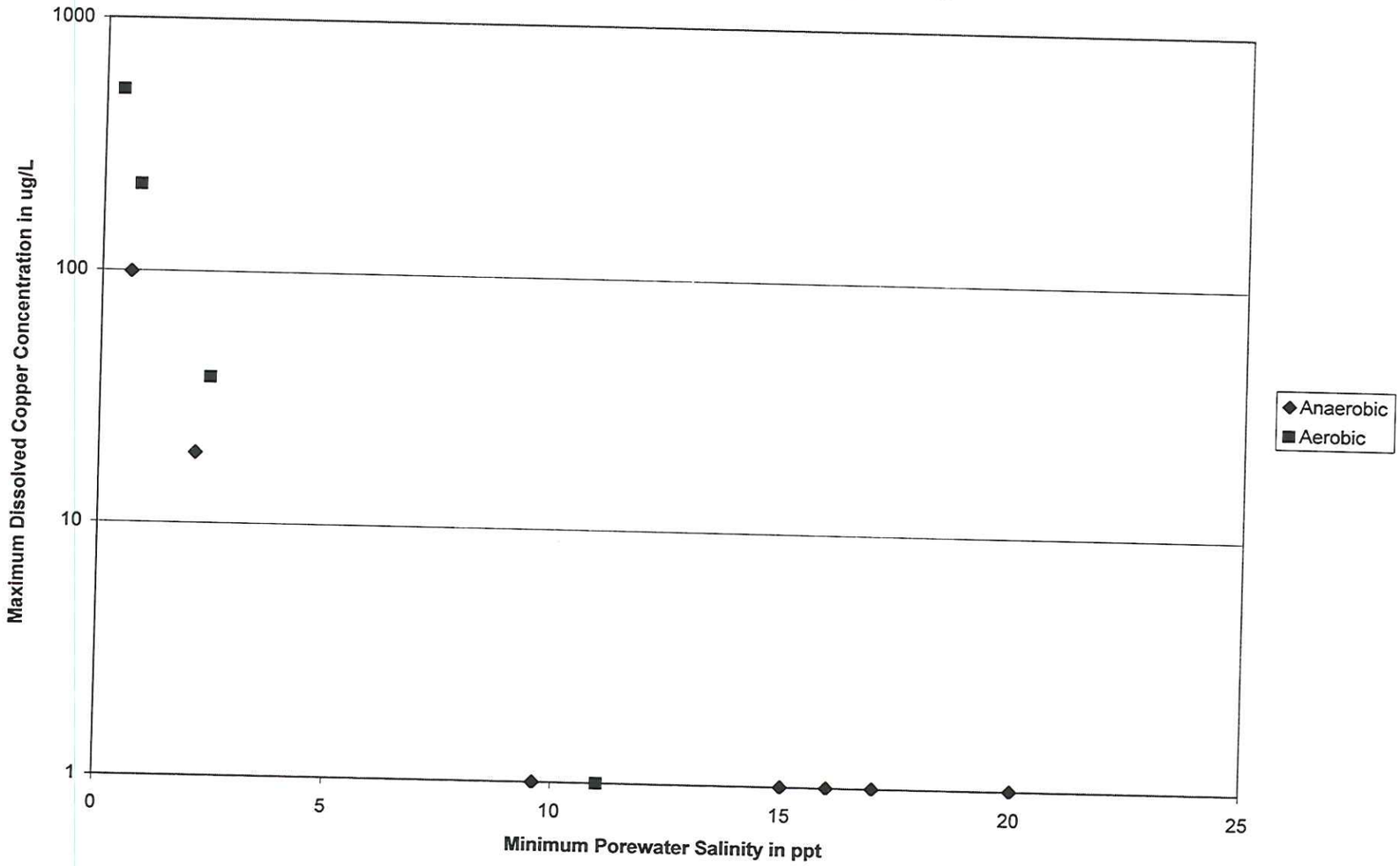


**Figure M-3. Lead Mobility versus Salinity,
Whatcom Waterway Sequential Batch Leaching Tests.**

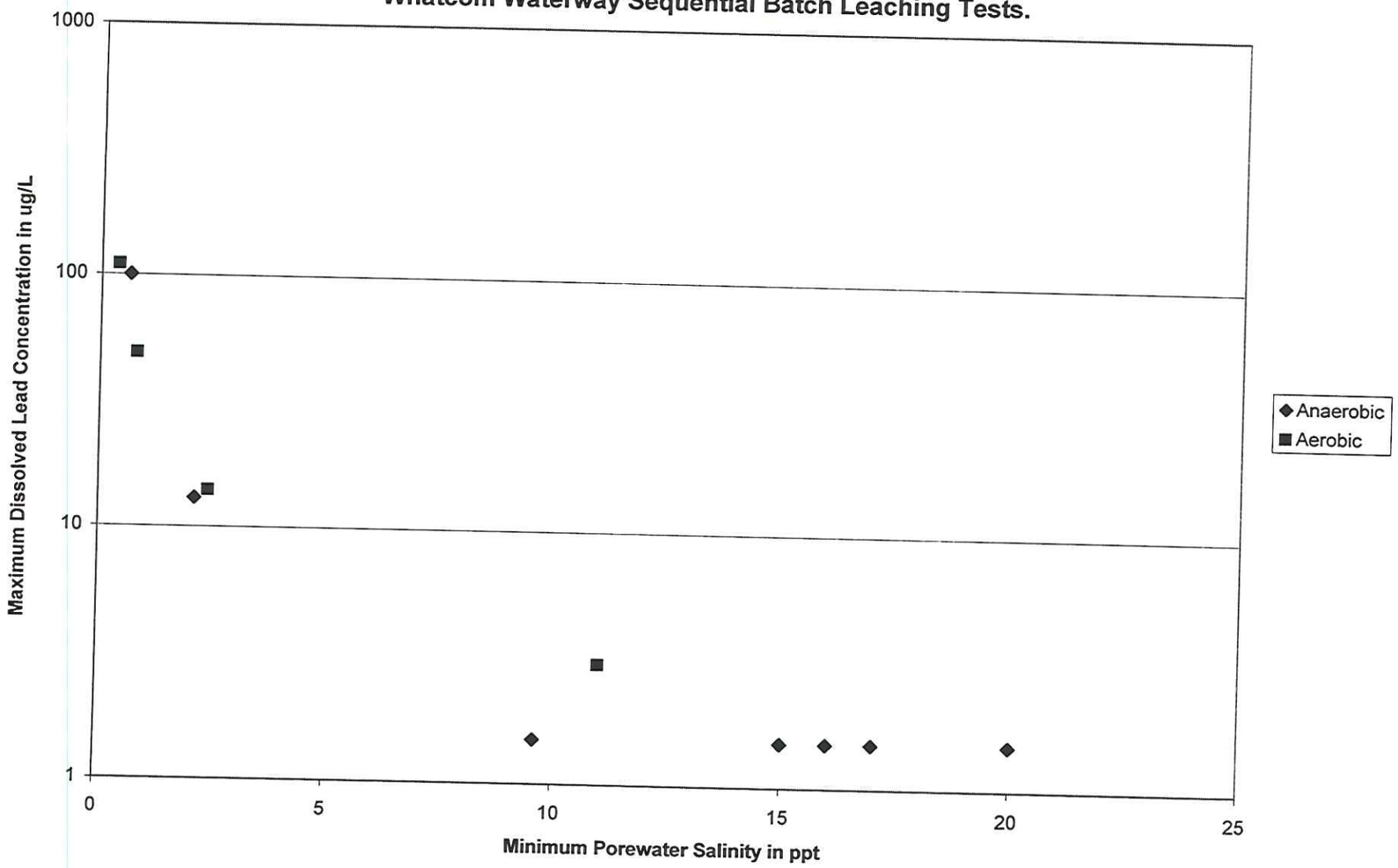
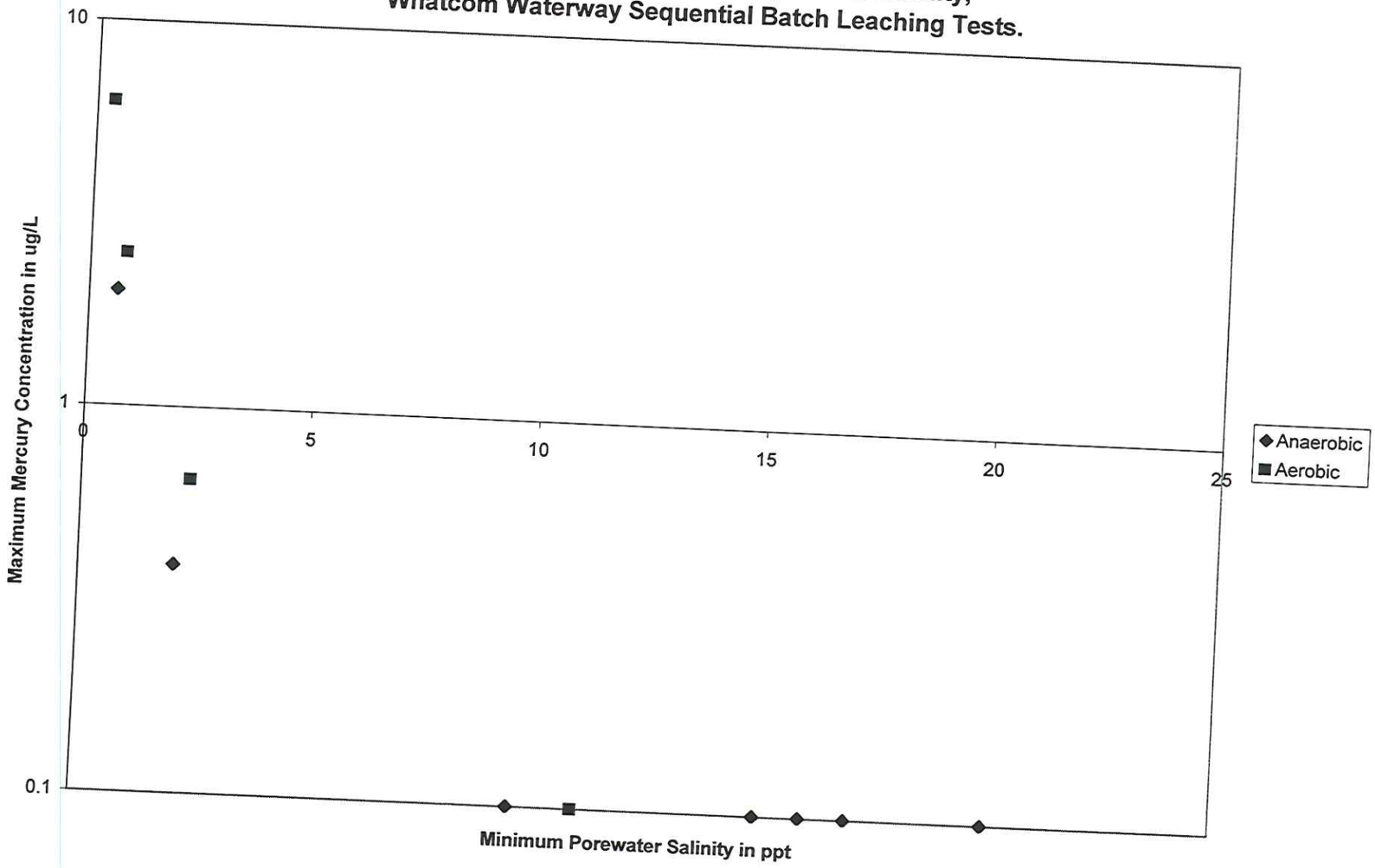


Figure M-4. Mercury Mobility versus Salinity, Whatcom Waterway Sequential Batch Leaching Tests.



APPENDIX N
ENGINEERING COST ESTIMATE
WHATCOM WATERWAY AREA

APPENDIX N
ENGINEERING COST ESTIMATE
WHATCOM WATERWAY AREA

CONTENTS

N.1 Removal, Transport, and Disposal at Aquatic CDFs	***N-1***
N.2* In situ *Capping	***N-2***
N.3 Nearshore Fill Construction	***N-2***
N.4 CAD Construction	***N-3***
N.5 Upland Disposal	***N-4***
N.6 Habitat Mitigation Costs	***N-4***
N.7 Mobilization/Demobilization	***N-5***
N.8 Engineering Design	***N-5***
N.9 Construction Management/Monitoring	***N-5***
N.10 Long-term Monitoring	***N-5***
N.11 Contingency	***N-6***

TABLES

N-1 Summary of Costs
N-2 Assumed Unit Costs
N-3 Remedial Action Alternative A
N-4 Remedial Action Alternative B
N-5 Remedial Action Alternative C
N-6 Remedial Action Alternative D
N-7 Remedial Action Alternative E
N-8 Remedial Action Alternative F
N-9 Remedial Action Alternative G
N-10 Remedial Action Alternative H
N-11 Remedial Action Alternative I

APPENDIX N
ENGINEERING COST ESTIMATE
WHATCOM WATERWAY AREA

This appendix summarizes the preliminary engineering cost estimate completed for the nine Whatcom Waterway Area remedial alternatives. Below each of the assumed unit costs are discussed. Table N-1 summarizes the estimated total costs for each alternative, Table N-2 defines the assumed unit costs, and Tables N-3 through N-11 present the breakdown of unit costs.

The following items are included in the cost estimates:

- Removal (both hydraulical and mechanical dredging), transport, and placement of contaminated sediment at the aquatic CDFs;
- *In situ* capping (both thin-layer and thick caps);
- Nearshore fill construction;
- CAD construction;
- Upland disposal;
- Habitat mitigation costs;
- Mobilization/demobilization costs;
- Engineering design;
- Construction monitoring/management;
- Long-term monitoring; and
- Contingency.

Each of these items are discussed in more detail below.

N.1 Removal, Transport, and Disposal at Aquatic CDFs

As discussed in Section 14.0, either mechanical or hydraulic dredging are feasible removal technologies. However, given the coupling of dredge volumes and disposal sites it is felt that mechanical dredging would likely be the most efficient means of removal. The higher dredge volume alternatives, which make hydraulic dredging cost-effective, involve CADs or upland disposal, which are not as suitable for hydraulic dredging. Therefore, cost

estimates were completed assuming mechanical dredging with transport to the CDFs via barges.

A contractor with a 5 to 10 CY bucket could probably dredge 5,000 to 7,000 CY per 24-hour day. They would probably only operate 18 hours per day with the remaining time for maintenance. The contractor would likely transport the dredged material on flat barges or dump scows depending on the CDF and water depth. Assumed unit costs for mechanical dredge and bottom dump barge transport and placement was $6.50 per CY of *in situ* material. Roughly $5.00 per CY was assumed to be associated with dredging and $1.50 per CY was assumed to be associated with transport and placement. Assumed unit costs for mechanical dredge and flat barge transport and placement was $17.50 per CY of *in situ* material. Roughly $5.00 per CY was assumed to be associated with dredging and $12.50 per CY was assumed to be associated with transport and placement. It was assumed that a clamshell or end loader would be required to offload the flat barges. These unit costs are based on the 1994 Sitcum Waterway Remediation Project construction bids (with assumed inflation) as well as other recently completed feasibility study cost estimates (City of Tacoma, 1998; Hylebos Cleanup Committee, 1998).

Volumes were estimated assuming the neat line volume plus two feet of overdredge.

N.2 In situ *Capping*

As discussed in Section 14.0, capping material would likely be placed either by clamshell bucket in confined areas or bottom dump barge. Capping material would either be obtained from an upland pit or using clean dredged material or utilizing another in-water source. A clamshell bucket operation most likely could place 3,000 CY per day assuming 10 hours operation each day. A bottom dump barge could most likely place 15,000 CY per day also assuming 10 hours operation each day. The assumed unit cost for cap placement was $15.00 per CY placed. This assumes an upland source of capping material and the majority of the capping material placed by clamshell bucket. These unit costs are based on the 1997 Eagle Harbor-WHOU construction bids, a study by Sumeri (1996), as well as other recently completed feasibility study cost estimates (Hylebos Cleanup Committee, 1998).

Thin-layer cap volumes were estimated assuming 1 foot of material placed; thick cap volumes were estimated assuming 4 feet of material placed.

N.3 Nearshore Fill Construction

As discussed in Section 14.0, the nearshore fill construction will entail the placement of a containment berm, disposal of contaminated sediments, and placement of a cap.

N.3.1 Containment Berm Construction

The containment berm would most likely be constructed of select fill with rip rap training dikes. Both items would likely be placed with a clamshell bucket at roughly 3,000 CY per day rate assuming 10 hours operation per day. The assumed unit costs for rip rap training dike purchase, haul, and placement is $40.50 per CY. The assumed unit costs for select fill purchase, haul, and placement is $15 per CY. Both of these unit costs are based on the 1997 Eagle Harbor-WHOU and on the 1994 Sitcum Waterway Remediation Project construction bids (with assumed inflation) as well as other recently completed feasibility study cost estimates (City of Tacoma, 1998; Hylebos Cleanup Committee, 1998).

N.3.2 Disposal of Contaminated Sediments

See Section N.1 above.

N.3.3 Cap Placement

The cap material would most likely be constructed of select fill. Because mechanical dredging is the likely means of sediment removal, the capping material will also likely be placed mechanically either via offloading from a barge or by truck placement. Either way the material will need to be double handled in order to be placed. Because of the double handling the cost for select fill presented in Section N.3.1 above was increased to $30 per CY of placed material.

N.4 CAD Construction

As discussed in Section 14.0 of the FS, the CAD construction will entail the placement of a containment berm, disposal of contaminated sediments, placement of a cap, and possible construction of a rip rap reef for long-term wave protection.

N.4.1 Containment Berm Construction

See Section N.3.1 above.

N.4.2 Disposal of Contaminated Sediments

See Section N.1 above.

N.4.3 Cap Placement

The cap material could be constructed of select fill or clean dredged material. We have assumed for this cost estimate that select fill would be used since a source of clean dredged material has not been identified at this time. However, costs would likely be lower if a dredging source were identified.

Because mechanical dredging is the likely means of sediment removal, the capping material will also likely be placed mechanically via offloading from a barge. The assumed unit cost for CAD cap placement is assumed to be the same as for select fill placement discussed in section N.3.1 above.

N.4.4 Rip Rap Reef Construction

The rip rap reef would likely be constructed in a manner similar to training dike construction presented in Section N.3.1 above. The same unit costs were assumed. The volumes for the reefs were estimated as shown on Figure 14-6 with 1H:1V side slope. The volumes also include an assumed self weight settlement of three feet below each reef.

N.5 Upland Disposal

Two upland disposal facilities were assumed available: 1) Roosevelt Regional Landfill, which is an existing sub title D landfill; and 2) the Whatcom-Skagit Phyllite Quarry landfill. Both landfills are described in Section 5.0 of the FS.

N.5.1 Roosevelt Regional Landfill

The assumed unit cost for dredging the sediments and hauling them to the off-loading facility is presented in Section N.1 above. The assumed unit cost to remove the sediments from the barge, transport via rail, and tipping fees is $45 per CY. This is based on a letter from Rabanco to the Bellingham Bay Pilot (BBWG,1998).

N.5.2 Whatcom-Skagit Phyllite Quarry Landfill

The assumed unit cost for dredging the sediments and hauling them to the off-loading facility is presented in Section N.1 above. The assumed unit cost to remove the sediments from the barge, transport via truck, construct a MFS landfill, and dispose the sediments at the site is $41.50 per CY dredged. This cost estimate is based on a detailed cost estimate completed as part of the Bellingham Bay Pilot (BBWG, 1998).

N.6 Habitat Mitigation Costs

Assumed habitat mitigation requirements are presented in Section 14.0 of the FS. These costs include acquisition, construction, and enhancement at priority habitat creation sites in the Bay. The assumed unit cost for mitigation is $267,800 per acre of filled aquatic land. This estimate reflects estimated local costs for upland land acquisition and habitat development, and is also similar to the mid-range mitigation cost incurred on previous habitat compensation and restoration projects in Puget Sound (BBWG, 1998).

N.7 Mobilization/Demobilization

Mobilization and demobilization costs cover expenses incurred by the contractor as they start and close out a project. EPA (1994) recommends a range of 5 to 20 percent of capital costs for this item. Based on the anticipated construction equipment and manpower requirements for this project, and considering recent Puget Sound bids for similar projects, a 2 percent mobilization/demobilization cost was assumed.

N.8 Engineering Design

Engineering design costs include preparing a final design package for the selected remedial action. This may include additional sampling and analysis, along with engineering, permitting, construction contract document preparation and contractor procurement. EPA (1994) recommends a range of 7 to 15 percent of capital costs for engineering expenses. Based on recent Puget Sound experience on similar projects, engineering design was assumed to be 10 percent.

N.9 Construction Management/Monitoring

Construction management and water/sediment monitoring during the implementation of remedial actions was estimated at 5 percent of capital costs. This estimate is based on recent Puget Sound experience and similar feasibility study/remedial design estimates within Commencement Bay and Elliott Bay. Construction management includes working with the contractor on design interpretation, contracting, and pay issues. Water quality monitoring during construction would normally be performed during capping, dredging, and disposal operations, and would include both routine and "intensive" monitoring elements appropriate for various phases of construction. Sediment monitoring during construction would include bathymetric surveys of dredge cuts and cap placement, along with post-dredge sampling and analysis to verify that contaminated sediments have been removed.

N.10 Long-term Monitoring

Long-term monitoring was assumed to be necessary to verify the performance of natural recovery, capping, CAD, confined disposal, and habitat enhancement elements. Based on recent Puget Sound experience and similar feasibility study/remedial design estimates within Puget Sound, the following present worth estimates were assumed:

- Natural recovery/capping - $300,000;
- CAD - $300,000;
- Upland and nearshore CDFs - $500,000; and

- Habitat enhancement - $200,000.

The cost estimates include periodic bathymetric surveys, surface sediment sampling, groundwater/seep sampling (CDFs only), and benthic habitat assessments.

N.11 Contingency

Contingency costs cover unanticipated conditions such as increased dredge or cap volumes, slower production rates, construction market effects on costs, on other items. EPA (1994) recommends a range of 25 to 30 percent of capital costs for screening level feasibility studies. Contingency was assumed to be 30 percent.

Table N-1 - Summary of Costs
Whatcom Waterway Area

Remedial Action Alternative	Remedial Action Alternative Description	Total Estimated Cost	Cap Volume CY	Dredge Volume CY	Estimated Unit Cost[1] $/CY
A	No action/natural recovery	$0	0	0	NA
B	Natural recovery with capping	$4,937,000	200,200	0	NA
C	Limited dredging with log pond nearshore fill disposal	$19,404,000	262,200	157,800	$123
D	Limited dredging with upland disposal	$19,154,000	308,200	157,800	$121
E	Removal & capping to achieve authorized channel depths with CAD	$23,776,000	641,385	360,000	$66
F	Removal & capping to achieve authorized depths with upland disposal	$36,479,000	377,000	360,000	$101
G	Full removal from navigation areas with CAD	$35,974,000	855,885	760,000	$47
H	Full removal from navigation areas with upland disposal	$91,378,000	306,900	1,080,000	$85
I	Full removal with upland disposal	$157,030,000	34,100	2,060,000	$76

[1]Based on dredge volume; includes other costs such as capping.

Table N-2 - Assumed Unit Costs
Whatcom Waterway Area

Remedial Task Item	Unit	Assumed Unit Cost	Notes
Removal - Contaminated Sediment			
Hydraulic Dredge and Transport to Nearshore Fill	CY	$2.5	
Mechanical Dredge and Transport to Nearshore Fill	CY	$5.0	
Mechanical Dredge and Transport to CAD	CY	$5.0	
Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	
In Situ Capping			
Cap	CY	$15.0	1'-3' cap (assume 2' for est.) for cap.
Nearshore Fill Construction			
Rip rap training dikes	CY	$40.5	Purchase, haul, and place rip rap.
Berm construction	CY	$15.0	Purchase, haul, and place select fill.
CDF cap	CY	$30.0	Purchase, haul, and place select fill.
CAD Construction			
Excavate Pit (w/ PSDDA disposal)	CY	$4.0	
Rip rap training dikes	CY	$40.5	Purchase, haul, and place rip rap.
Berm construction	CY	$15.0	Purchase, haul, and place select fill.
CDF cap	CY	$15.0	Purchase, haul, and place select fill.
Rip rap reef	CY	$40.5	Purchase, haul, and place rip rap.
Upland Disposal			
Offload, Haul, and Place at Roosevelt Regional Landfill	CY	$45.0	
Offload, Haul, and Place at Phyllite Pit (Incl. Misc. const.)	CY	$41.5	From BBWG cost estimate for 145,000 CY (Assume $35 for 240kCY)
Contaminated Sediment Placement in CAD or Nearshore Fill			
Bottom dump barge placement (below -5' MLLW)	CY	$1.5	
Clamshell off of barge placement (above -5' MLLW)	CY	$12.5	Double handling off of barge into CDF.
Mitigation			
Cost per acre for lost/filled aquatic land	ACRE	$267,800	Land acquisition and initial habitat development.
Mobilization/Demobilization	PERCENT	2%	
Engineering Design	PERCENT	10%	
Construction Monitoring/Management	PERCENT	5%	Includes Env. Monitoring and project management.
Long-term Monitoring (Present Worth)			
Natural Recovery/Capping		$300,000	
CAD Site		$300,000	
Upland or Nearshore Fill Site		$500,000	
Habitat		$200,000	
Contingency	PERCENT	30%	

Table N-3 - Remedial Action Alternative A
No Action/Natural Recovery
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$0	$0
Outer/Mid Whatcom Waterway - SSU 1				
- No Action	-	-	-	-
Head of Whatcom Waterway (30' Channel) - SSU 2				
- No Action	-	-	-	-
Head of Whatcom Waterway (18' Channel) - SSU 3				
- No Action	-	-	-	-
G-P Log Pond - SSU 4				
- No Action	-	-	-	-
G-P ASB - SSU 5				
- No Action	-	-	-	-
Port Log Rafting Area - SSU 6				
- No Action	-	-	-	-
Starr Rock - SSU 7				
- No Action	-	-	-	-
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - No Material is Generated				
- Not Applicable	-	-	-	-
Engineering Design	PERCENT	10%	$0	$0
Construction Monitoring/Management	PERCENT	5%	$0	$0
Long-term Monitoring	LS	$0	1	$0
Contingency	PERCENT	30%	$0	$0
TOTAL ESTIMATED COST				$0

Table N-4 - Remedial Action Alternative B
Natural Recovery with Limited Capping
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$3,003,000	$45,000
Outer/Mid Whatcom Waterway - SSU 1				
- No Action	-	-	-	-
Head of Whatcom Waterway (30' Channel) - SSU 2				
- No Action	-	-	-	-
Head of Whatcom Waterway (18' Channel) - SSU 3				
- No Action	-	-	-	-
G-P Log Pond - SSU 4				
- Cap	CY	$15.0	46,000	$690,000
G-P ASB - SSU 5				
- Cap	CY	$15.0	117,200	$1,758,000
Port Log Rafting Area - SSU 6				
- No Action	-	-	-	-
Starr Rock - SSU 7				
- Cap	CY	$15.0	37,000	$555,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - No Material is Generated				
- Not Applicable	-	-	-	-
Engineering Design	PERCENT	10%	$3,003,000	$300,000
Construction Monitoring/Management	PERCENT	5%	$3,003,000	$150,000
Long-term Monitoring	LS	$300,000	1	$300,000
Contingency	PERCENT	30%	$3,798,000	$1,139,000
TOTAL ESTIMATED COST				$4,937,000

Table N-5 - Remedial Action Alternative C
Limited Dredging with Log Pond Disposal
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$12,125,000	$182,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	108,000	$1,620,000
- Mechanical Dredge and Transport to Nearshore Fill	CY	$5.0	157,800	$789,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- No Action	-	-	-	-
Head of Whatcom Waterway (18' Channel) - SSU 3				
- No Action	-	-	-	-
G-P Log Pond - SSU 4				
- To be covered with NSF	-	-	-	-
G-P ASB - SSU 5				
- Cap	CY	$15.0	117,200	$1,758,000
Port Log Rafting Area - SSU 6				
- No Action	-	-	-	-
Starr Rock - SSU 7				
- Cap	CY	$15.0	37,000	$555,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Log Pond Nearshore Fill				
- Rip rap training dikes	CY	$40.5	10,540	$427,000
- Berm construction	CY	$15.0	52,700	$791,000
- CDF cap	CY	$30.0	33,300	$999,000
- Bottom dump barge placement (below -5' MLLW)	CY	$1.5	10,300	$15,000
- Clamshell off of barge placement (above -5' MLLW)	CY	$12.5	92,700	$1,159,000
Disposal - Excess to Roosevelt Landfill				
- Offload, Haul, and Place at Roosevelt Regional Landfill	CY	$45.0	54,800	$2,466,000
Mitigation				
- Mitigation for lost/filled aquatic land	ACRE	$267,800	6	$1,546,000
Engineering Design	PERCENT	10%	$12,125,000	$1,213,000
Construction Monitoring/Management	PERCENT	5%	$12,125,000	$606,000
Long-term Monitoring	LS	$800,000	1	$800,000
Contingency	PERCENT	30%	$14,926,000	$4,478,000
TOTAL ESTIMATED COST				$19,404,000

Table N-6 - Remedial Action Alternative D
Limited Dredging with Upland Disposal
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$11,961,000	$179,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	108,000	$1,620,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	157,800	$789,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- No Action	-	-	-	-
Head of Whatcom Waterway (18' Channel) - SSU 3				
- No Action	-	-	-	-
G-P Log Pond - SSU 4				
- Cap	CY	$15.0	46,000	$690,000
G-P ASB - SSU 5				
- Cap	CY	$15.0	117,200	$1,758,000
Port Log Rafting Area - SSU 6				
- No Action	-	-	-	-
Starr Rock - SSU 7				
- Cap	CY	$15.0	37,000	$555,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Phyllite Quarry and/or Roosevelt				
- Offload, Haul, and Place at Phyllite Pit (Incl. Misc. const.)	CY	$41.5	157,800	$6,549,000
Engineering Design	PERCENT	10%	$11,961,000	$1,196,000
Construction Monitoring/Management	PERCENT	5%	$11,961,000	$598,000
Long-term Monitoring	LS	$800,000	1	$800,000
Contingency	PERCENT	30%	$14,734,000	$4,420,000
TOTAL ESTIMATED COST				$19,154,000

Table N-7 - Remedial Action Alternative E
Removal and Capping to Achieve Authorized Channel Depths w/ CAD Disposal (Pilot No. 2A)
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$15,260,000	$229,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	10,700	$161,000
- Mechanical Dredge and Transport to CAD	CY	$5.0	210,000	$1,050,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- Cap	CY	$15.0	34,800	$522,000
- Mechanical Dredge and Transport to CAD	CY	$5.0	80,000	$400,000
Head of Whatcom Waterway (18' Channel) - SSU 3				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to CAD	CY	$5.0	20,000	$100,000
G-P Log Pond - SSU 4				
- CAD	-	-	-	-
G-P ASB - SSU 5				
- Cap	CY	$15.0	136,200	$2,043,000
- Mechanical Dredge and Transport to CAD	CY	$5.0	10,000	$50,000
Port Log Rafting Area - SSU 6				
- Cap	CY	$15.0	48,900	$734,000
- Mechanical Dredge and Transport to CAD	CY	$5.0	40,000	$200,000
Starr Rock - SSU 7				
- Cap	CY	$15.0	149,600	$2,244,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Log Pond and Starr Rock CADs				
- Construct rip rap training dikes	CY	$40.5	26,800	$1,085,000
- Construct containment berm	CY	$15.0	134,000	$2,010,000
- Place CAD cap	CY	$15.0	261,185	$3,918,000
- Bottom dump barge placement (below -5' MLLW)	CY	$1.5	360,000	$540,000
- Clamshell off of barge placement (above -5' MLLW)	CY	$12.5	0	$0
- Construct rip rap reef	CY	$40.5	5,000	$203,000
Engineering Design	PERCENT	10%	$15,260,000	$1,526,000
Construction Monitoring/Management	PERCENT	5%	$15,489,000	$774,000
Long-term Monitoring	LS	$500,000	1	$500,000
Contingency	PERCENT	30%	$18,289,000	$5,487,000
TOTAL ESTIMATED COST				$23,776,000

Table N-8 - Remedial Action Alternative F
Removal and Capping to Achieve Authorized Channel Depths w/ Upland Disposal (Pilot No. 2B)
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$23,657,000	$355,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	10,700	$161,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	210,000	$1,050,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- Cap	CY	$15.0	34,800	$522,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	80,000	$400,000
Head of Whatcom Waterway (18' Channel) - SSU 3				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	20,000	$100,000
G-P Log Pond - SSU 4				
- Cap	CY	$15.0	38,900	$584,000
G-P ASB - SSU 5				
- Cap	CY	$15.0	136,200	$2,043,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	10,000	$50,000
Port Log Rafting Area - SSU 6				
- Cap	CY	$15.0	48,900	$734,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	40,000	$200,000
Starr Rock - SSU 7				
- Cap	CY	$15.0	107,500	$1,613,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Upland				
- Offload, Haul, and Place at Roosevelt Regional Landfill	CY	$45.0	360,000	$16,200,000
Engineering Design	PERCENT	10%	$23,657,000	$2,366,000
Construction Monitoring/Management	PERCENT	5%	$23,657,000	$1,183,000
Long-term Monitoring	LS	$500,000	1	$500,000
Contingency	PERCENT	30%	$28,061,000	$8,418,000
TOTAL ESTIMATED COST				$36,479,000

Table N-9 - Remedial Action Alternative G
Full Removal from Navigation Areas (Pilot No. 2C)
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$23,324,000	$350,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	42,800	$642,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	570,000	$2,850,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- Cap	CY	$15.0	34,000	$510,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	80,000	$400,000
Head of Whatcom Waterway (18' Channel) - SSU 3				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	40,000	$200,000
G-P Log Pond - SSU 4				
- CAD	-	-	-	-
G-P ASB - SSU 5				
- Cap	CY	$15.0	146,700	$2,201,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	10,000	$50,000
Port Log Rafting Area - SSU 6				
- Cap	CY	$15.0	48,700	$731,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	60,000	$300,000
Starr Rock - SSU 7				
- Cap	CY	$15.0	145,900	$2,189,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Log Pond and Starr Rock CADs				
- Construct rip rap training dikes	CY	$40.5	46,240	$1,873,000
- Construct containment berm	CY	$15.0	231,200	$3,468,000
- Place CAD cap	CY	$15.0	437,785	$6,567,000
- Bottom dump barge placement (below -5' MLLW)	CY	$1.5	760,000	$1,140,000
- Clamshell off of barge placement (above -5' MLLW)	CY	$12.5	0	$0
- Construct rip rap reef	CY	$40.5	5,000	$203,000
Engineering Design	PERCENT	10%	$23,324,000	$2,332,000
Construction Monitoring/Management	PERCENT	5%	$23,324,000	$1,166,000
Long-term Monitoring	LS	$500,000	1	$500,000
Contingency	PERCENT	30%	$27,672,000	$8,302,000
TOTAL ESTIMATED COST				$35,974,000

Table N-10 - Remedial Action Alternative H
Full Removal from Navigation Areas and Partial Removal from G-P ASB Area w/ Upland Disposal (Pilot No. 2D)
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$59,906,000	$899,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	570,000	$2,850,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- Cap	CY	$15.0	34,100	$512,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	80,000	$400,000
Head of Whatcom Waterway (18' Channel) - SSU 3				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	40,000	$200,000
G-P Log Pond - SSU 4				
- Cap	CY	$15.0	38,900	$584,000
G-P ASB - SSU 5				
- Cap	CY	$15.0	77,700	$1,166,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	200,000	$1,000,000
Port Log Rafting Area - SSU 6				
- Cap	CY	$15.0	48,700	$731,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	60,000	$300,000
Starr Rock - SSU 7				
- Cap	CY	$15.0	107,500	$1,613,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$15.0	130,000	$1,950,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Upland				
- Offload, Haul, and Place at Roosevelt Regional Landfill	CY	$45.0	1,080,000	$48,600,000
Engineering Design	PERCENT	10%	$59,906,000	$5,991,000
Construction Monitoring/Management	PERCENT	5%	$59,906,000	$2,995,000
Long-term Monitoring	LS	$500,000	1	$500,000
Contingency	PERCENT	30%	$70,291,000	$21,087,000
TOTAL ESTIMATED COST				$91,378,000

Table N-11 - Remedial Action Alternative I
Full Dredging with Upland Disposal
Whatcom Waterway Area

Item	Unit	Unit Cost	No. of Units	Total Cost
Mobilization/Demobilization	PERCENT	2%	$103,512,000	$1,553,000
Outer/Mid Whatcom Waterway - SSU 1				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	570,000	$2,850,000
Head of Whatcom Waterway (30' Channel) - SSU 2				
- Cap	CY	$15.0	34,100	$512,000
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	80,000	$400,000
Head of Whatcom Waterway (18' Channel) - SSU 3				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	90,000	$450,000
G-P Log Pond - SSU 4				
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	150,000	$750,000
G-P ASB - SSU 5				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	470,000	$2,350,000
Port Log Rafting Area - SSU 6				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	220,000	$1,100,000
Starr Rock - SSU 7				
- Cap	CY	$15.0	0	$0
- Mechanical Dredge and Transport to Upland Offload Facility	CY	$5.0	480,000	$2,400,000
I&J Street Waterway - SSU 8				
- No Action	-	-	-	-
Disposal - Upland				
- Offload, Haul, and Place at Roosevelt Regional Landfill	CY	$45.0	2,060,000	$92,700,000
Engineering Design	PERCENT	10%	$103,512,000	$10,351,000
Construction Monitoring/Management	PERCENT	5%	$103,512,000	$5,176,000
Long-term Monitoring	LS	$200,000	1	$200,000
Contingency	PERCENT	30%	$120,792,000	$36,238,000
TOTAL ESTIMATED COST				$157,030,000