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BIOASSAYS ON ILLINOIS WATERWAY DREDGED MATERIAL

by

David W. Moore, Alfreda B. Gibson, Thomas M. Dillon

Environmental Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

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Sediment from the Illinois Waterway navigation channel is hydraulically dredged by the US Army Engineer District, Rock Island, and placed in the near-shore environment via pipeline. Water returning to the river can have a high-suspended solids load approaching fluid mud consistency. There is a concern that this return water may exceed the State of Illinois water quality standards for ammonia and have adverse effects on aquatic life. To address these concerns, composite sediment samples and site water collected from selected sites in the Illinois Waterway were evaluated in toxicity tests. Acute (48-hr) toxicity tests were conducted with two species, *Pimephales promelas* (the fathead minnow) and *Daphnia magna* (a freshwater cladoceran). A chronic (21-day) toxicity test was also conducted using *Daphnia magna*. Animals were exposed separately to different concentrations of filtered and unfiltered elutriates prepared from

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Illinois Waterway dredged material. Total ammonia concentrations were measured in all tests and the un-ionized fraction was calculated by adjusting for temperature and pH. Tests were conducted at the US Army Engineer Waterways Experiment Station, Vicksburg, MS. In addition, as part of an interlaboratory effort, a 48-hr acute toxicity test with *Pimephales pomelas* fry was conducted concurrently by the Hygienic Laboratory of the University of Iowa, Des Moines, IA.

PREFACE

Section 404(b)(1) of the Clean Water Act (Public Law 92-500, as amended) requires that dredging operations in navigable waters of the United States be assessed for their potential to cause unacceptable adverse impacts to the environment. Bioassays may be required if there is sufficient reason to believe physical and/or chemically related impacts are possible.

Since 1982, portions of the Illinois Waterway have been dredged by the US Army Engineer District, Rock Island, under a variance issued by the Illinois Pollution Control Board. The variance was necessary because preliminary testing indicated that state water quality standards (especially ammonia) may be violated during dredging operations. The variance is a temporary measure, intended to allow dredging to proceed until a permanent solution can be found. This report documents the results of bioassays sponsored by the Rock Island District as part of an ongoing investigation to asses the impacts of bank line disposal of dredged material on aquatic biota.

The work reported herein was performed by the Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. The authors gratefully acknowledge the technical support and reviews provided by Ms. Joan U. Clarke and Dr. Henry E. Tatem of the Ecosystem Research and Simulation Division (ERSD), EL.

The Principal Investigator for this study was Dr. Thomas M. Dillon, Aquatic Biological Effects Team (ABET), ERSD. The study was conducted by Ms. Alfreda B. Gibson, ABET. The report was prepared by Dr. David W. Moore, ABET, and Ms. Gibson. The work was performed under the general supervision of Dr. Bobby L. Folsom, Jr., Chief, Contaminant Mobility Regulatory Criteria Group. The Chief of ERSD was Mr. Donald L. Robey, and Director of the Environmental Laboratory was Dr. John Harrison. Dr. Clinton A. Beckert of the US Army Engineer District, Rock Island, was Project Supervisor.

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BIOASSAYS ON ILLINOIS WATERWAY DREDGED MATERIAL

PART I: INTRODUCTION

1. Navigation in the Illinois Waterway is maintained by the US Army Engineer District, Rock Island, via hydraulic dredging with pipeline discharge to the nearshore environment. A hydraulic dredge is a self-contained unit that handles both phases of dredging, i.e., digging as well as disposal. The hydraulic cutterhead is lowered to the bottom of the river where it digs into the sediment. The sediment is first loosened and mixed with water by the cutterhead before it is pumped into the pipeline for disposal. Disposal of this material usually requires a large area that is close to the dredging site. Because of the uncertainty in predicting where dredging will be required and because the removal of the sediment must be done in a timely fashion, bank line disposal (placement of the dredged material on the shore) of the material has proven to be the most effective mode of disposal. Residence time on the shore for this discharge is very low (<1 min), while solids retention of the coarser fractions is high (50 to 75 percent). Thus, dredged material returning to the river is a high-density fluid mud with concentrations of suspended material ranging from 1 to 10 g/ℓ.

2. Since 1982, portions of the Illinois Waterway have been dredged by the Rock Island District under a variance issued by the Illinois Pollution Control Board (IPCB). Concerns expressed by the Illinois Environmental Protection Agency (IEPA) that water quality standards, especially ammonia, were being violated during these dredging operations resulted in the denial of applications for 401 water quality certification at critical times. This prompted the Corps to request a variance from the standards to allow dredging to continue while field studies were conducted to determine the water quality impacts associated with bank line disposal operations. The state standard for ammonia is met when total ammonia concentrations are <1.5 mg/ℓ. When concentrations are between 1.5 mg/ℓ and 15 mg/ℓ un-ionized ammonia concentrations must be calculated and values must not exceed 0.04 mg/ℓ. Concentrations of total ammonia >15 mg/ℓ is a violation of the State water quality standard. State determination of potential water quality violations has not recognized a mixing zone because the Corps has been unable to document the shape and size of the impacted area. The Rock Island District's water quality variance

expires in September 1992, at which time the IPCB has indicated it might grant a site-specific rules change if it is shown to be in the State's best interest, both environmentally and economically. Recently the State of Illinois attempted to develop a mixing zone policy document, but it was unacceptable to the US Environmental Protection Agency (USEPA).

3. To assess the potential effects associated with dredging and dredged material disposal in the Illinois Waterway on aquatic biota, acute and chronic bioassays were conducted on the elutriates of selected sediments and site water. Results of these studies will aid in the development of site-specific guidelines for dredging operations in the Illinois Waterway.

PART II: MATERIALS AND METHODS

4. Acute (48-hr) and chronic (21-day) bioassays were conducted on two organisms, (*Daphina magna* and *Pimephales promelas*) with test sediment elutriates and site water. End points examined included survival in the acute tests, and survival and reproduction in the chronic tests. Additionally, ammonia toxicity tests were conducted with both *D. magna* (acute and chronic exposures) and *P. promelas* (acute exposures). A cadmium chloride reference toxicity test was also conducted concurrently with each of the bioassays to provide a measure of organism health. Finally, results of acute exposures with *Pimephales promelas* fry were compared with results from tests conducted concurrently by the Hygienic Laboratory of the University of Iowa, Des Moines, IA.

Test Organisms

5. The organisms used in this study were a cladoceran crustacean (*Daphnia magna*) and cyprinodon fish (*Pimephales promelas*). Both of these organisms are endemic to the study area. In addition, both are widely used as toxicity test organisms, and test protocols are well developed.

Daphnia magna

6. *Daphnia magna* were obtained from the Aquatic Biology Branch, Environmental Monitoring Systems Laboratory, USEPA, Newtown, OH. Animals were slowly acclimated to laboratory test conditions (i.e., temperature = 20 °C, hardness = 165 to 170 mg/ℓ $CaCO_3$). Daphnids were maintained in a laboratory culture so that tests could be initiated with acclimated daphnids less than 48 hr old. The cultures were fed three times a week on a feeding suspension consisting of trout chow, alfalfa, and yeast (TCY) (USEPA 1985c). The TCY suspension was made in a single batch and divided among several 100-mℓ Teflon capped glass vials. The vials were frozen until ready for use. Prior to feeding, the TCY suspension was allowed to warm to room temperature. As suggested by the USEPA, only animals from the third and subsequent broods were used in toxicity tests (USEPA 1989).

Pimephales promelas

7. *Pimephales promelas* (fathead minnow) fry were obtained from Aquatic BioSystems, Inc., of Fort Collins, CO. Fry were slowly acclimated to laboratory test conditions (i.e., temperature = 20 °C, hardness = 165 to 170 mg/ℓ

$CaCO_3$) over a 2- to 3-day period. Fry were fed ad libitum freshly hatched brine shrimp nauplii that had been briefly rinsed in distilled water. Feeding was confirmed by presence of nauplii in the transparent gut of the fry. Feeding continued throughout the bioassays. Only fish that had progressed from an epibenthic habit (ca. 1 to 4 days old) to a truly nektonic existence (>5 days old) were used in laboratory toxicity tests.

Test Sediments and Site Water

Test sediments

8. Two different sediments from the Illinois Waterway were evaluated in sediment toxicity tests in this study. These included composited sediment samples collected by Rock Island District personnel from a reference area representative of the nearshore environs (NSE) and the project area Quiver Island (QI). The NSE reference sediment was collected from an area adjacent to where the project material (QI) is discharged. Sediments were shipped to the US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, in sealed, plastic, 5-gal buckets packed in ice. Following receipt at WES, sediments were stored in a cold room maintained at 4 °C. Prior to use, the sediments homogenized in an aged, 50-gal polypropylene drum using a portable mixer equipped with a stainless steel shaft and impeller.

Site water

9. Site water (SW) collected from the Illinois Waterway by Rock Island District personnel was also evaluated in toxicity tests. SW was shipped in three 1-gal sealed plastic jugs packed in ice. Upon receipt at WES, the containers of SW were stored in a cold room at 4 °C. Both filtered and unfiltered SW was evaluated in acute toxicity tests.

Elutriate Bioassays

10. Elutriate bioassays were conducted to address concerns over water quality criteria compliance. Sediment elutriates were prepared according to procedures outlined in the Ocean Dumping Implementation manual (USEPA/US Army Corps of Engineers (USACE) 1991). Both unfiltered (whole) and filtered elutriates were evaluated. To obtain filtered elutriate, whole elutriate was placed in a 5-gal stainless steel pressurized Millipore filtration unit connected to a stainless steel cartridge containing a 0.45 μm filter. After

passing through the filtration unit, the liquid was collected in a 1-gal glass jar. Both filtered and unfiltered elutriates were proportionally diluted with reconstituted water for testing. In addition, tests were also conducted on dilutions of whole and filtered (0.45 μm filter) SW. The time between elutriate/SW preparation and test initiation was ≤24 hr.

Acute exposures to filtered and unfiltered elutriates

11. The acute elutriate bioassays were conducted with *Daphnia magna* neonates ≤24 hr of age. Tests were conducted with filtered and unfiltered phases of NSE and QI sediments and SW. For each treatment there were five replicates of each dilution (0-, 1-, 10-, 50-, and 100-percent elutriate). The test containers were 250-ml plastic beakers containing 200 ml of test elutriate. A total of four neonates were added to each beaker. Test were conducted under static conditions without renewal. Animals were not fed during the test. At the end of 48 hr, the number of both surviving and dead organisms per beaker were recorded. Tests were conducted in temperature-controlled water baths maintained at 20 °C. Gentle aeration was provided to each test chamber. Lights were placed on an automatic timer to provide a photoperiod of 16 hr of light and 8 hr of dark. Tests were conducted in reconstituted hard water (American Public Health Association (APHA)) prepared using reverse osmosis (RO) water and reagent-grade chemicals. Water quality (dissolved oxygen (DO) (milligrams per liter), pH, and temperature (degrees Celsius)) was measured initially and at 48 hr. Water samples (10 ml) for hardness were collected from the controls at the beginning and end of the test. Hardness (milligrams equivalent $CaCO_3/\ell$) was measured according to the procedures described in (APHA 1985). Samples for total suspended solids were pooled by treatment and taken initially and at 48 hr. Samples for total suspended solids were analyzed according to procedures described in Standard Methods (APHA 1985) except filters were dried at a temperature of 85 °C for 24 hr. Ammonia samples were collected initially and at 24 and 48 hr. Ammonia samples (30 ml) were preserved with 50 ml 1 M HCl, refrigerated, and subsequently analyzed for total ammonia using an Orion ion-selective electrode.

12. An acute elutriate bioassay using the same experimental design described above was also conducted with *Pimephales promelas* fry. Departures from the procedures described above were that different elutriate concentrations were prepared (i.e., 100, 50, 25, 12, and 6 percent), and ammonia samples were composited for each treatment at 0 and 48 hr.

Chronic exposures to
unfiltered elutriates

13. The same experimental design used for the acute elutriate bioassays was used in the chronic elutriate bioassays except only *Daphnia magna* were exposed to unfiltered elutriates of NSE and QI sediment. There were 10 replicates per dilution per sediment treatment with one daphnid per container. The daphnids were fed 0.1 ml of TCY suspension three times per week. The test elutriates were renewed on a weekly basis (approximately 80 percent of volume), at which time samples for total suspended solids concentration and ammonia analysis were taken. Water quality monitoring was conducted prior to weekly renewal of test elutriates.

Ammonia Toxicity Tests

Acute toxicity tests

14. Ammonia toxicity tests were conducted separately for the two organisms. The nominal concentrations of ammonia (as ammonium chloride) for the acute toxicity test with *Daphnia magna* and *Pimephales promelas* were 0.01, 0.1, 1.0, and 100 mg/ℓ. There were five replicates per concentration with four animals per replicate. The tests were conducted for 48 hr with the same general laboratory design as the other acute bioassays.

Chronic toxicity tests

15. The same general procedure used in the acute study was duplicated for the chronic test. However, only *Daphnia magna* were exposed in a 21-day chronic test, and there were 10 replicates per concentration with only one animal per replicate. The nominal ammonia exposure concentrations were 1.0, 10, 100, 500, and 1,000 mg/ℓ. Samples for ammonia analysis were taken on a weekly basis prior to water renewal.

Standard Reference Toxicant Tests

16. A standard reference toxicant test was conducted to assess the health of the organisms used in toxicity tests. Separate standard reference toxicant tests with *Daphnia magna* and *Pimephales promelas* were conducted concurrently with acute tests on Illinois Waterway material. The nominal concentrations of cadmium chloride for the test with *Daphnia magna* were 0.1, 1.0, 10.0, 100, and 1000 μg/ℓ. Nominal concentrations for the test with *Pimephales*

promelas were 37, 75, 150, 300, and 600 $\mu g/\ell$. There were five replicates per treatment with four organisms per replicate. Samples for cadmium analysis were taken at the beginning and end of the test. Water samples were subsequently analyzed for free cadmium (Cd^{++}) using an Orion ion selective electrode. At the end of 48 hr, the number of surviving and dead organisms in each beaker was recorded. The median lethal concentration (LC_{50}) at 48 hr was calculated and compared with published values for each test species.

Interlaboratory Comparison

17. The Hygienic Laboratory conducted acute elutriate bioassays with *Pimephales promelas* fry concurrently with the WES tests. Test sediments were homogenized and split by WES for toxicity testing by both laboratories. Test procedures and conditions were identical to those used in the WES tests. *Pimephales promelas* fry were obtained from the same supplier, and tests at each laboratory were initiated simultaneously (i.e., within 24 hr). Because of a miscommunication, elutriate concentrations prepared by WES were 100, 50, 25, 12, and 6 percent, while concentrations prepared by the Hygienic lab were 100, 50, 10, 1, 0.1 percent. Therefore, interlaboratory comparisons of percent survival, total suspended solids concentration, and ammonia levels were made only for the 100- and 50-percent elutriates. An interlaboratory analysis of split ammonia samples of filtered and unfiltered NSE and QI elutriates was conducted by WES, the Applied Research and Development Laboratory (ARDL) of Mt. Vernon, IL., and the Hygienic Laboratory.

18. WES and the Hygienic lab conducted a standard reference toxicant test with *Pimephales promelas* fry. Results from the standard reference toxicant test for each lab were compared on the basis of the exposure concentrations and percent survival.

Data Analysis

19. The statistical analysis was conducted using SYSTAT, a statistical software package (Wilkinson 1988). The homogeneity of variance of the reproductive data was calculated using Bartlett's Test for Homogeneity (Sokal and Rohlf 1981). Treatment effects were analyzed using one-way analysis of variance with subsequent mean separation via Tukey's HSD (Honestly Significant Difference) test (Sokal and Rohlf 1981). Survival results for interlaboratory

comparison were evaluated at specific concentrations using a two-sample t-test. All tests for significance were conducted at a significance level of $\sigma = 0.05$. If survival of animals in exposure concentrations was statistically different from controls, an LC_{50} value (the median lethal concentration) was calculated. All LC_{50} values were calculated using the Logit procedure in SYSTAT (Steinburg and Colla 1990).

20. The fraction of un-ionized ammonia (F_u) was calculated using the equation of Emerson et al. (1975) with a $pK_a = 9.401$ (based on a temperature of 20 °C). The concentration of un-ionized ammonia was then calculated by multiplying the measured concentration of total ammonia by F_u.

PART III: RESULTS

Acute (48-hr) Bioassays with *Daphnia magna*

Elutriate bioassays

21. Unfiltered elutriate. Survival was high (85 to 100 percent) in all unfiltered elutriate concentrations of QI (Table 1) and NSE samples (Table 2). Survival in exposed animals was not significantly different from controls. Total ammonia and un-ionized ammonia in the unfiltered elutriates of the QI treatment ranged from 0.06 to 3.79 mg/ℓ and from 0.004 to 0.175 mg/ℓ, respectively. Total and un-ionized ammonia in the unfiltered elutriates of the NSE treatment ranged from 0.04 to 1.08 mg/ℓ and from 0.003 to 0.083 mg/ℓ, respectively. Suspended solids concentrations in both the unfiltered QI and NSE elutriates decreased during the test (Table 4). In all the acute exposures, initial concentrations of suspended solids were up to three orders of magnitude higher than the final concentrations measured at the end of 48 hr. The geometric mean (average of $\log_{10}$-transformed means) was calculated to approximate the average suspended solids concentration to which the organisms were exposed. The geometric mean in the QI exposure ranged from 8 to 293 mg/ℓ and from 5 to 610 mg/ℓ in the NSE exposure.

22. Filtered elutriate. Survival was high (90 to 100 percent) in all filtered elutriate concentrations of QI (Table 1) and NSE treatments (Table 2). Survival in animals exposed to the filtered elutriates was not significantly different from controls. Total and un-ionized ammonia in the unfiltered elutriates of the QI treatment ranged from 0.04 to 0.33 mg/ℓ and from 0.003 to 0.022 mg/ℓ, respectively. Total and un-ionized ammonia in the filtered elutriates of the NSE treatment ranged from 0.04 to 0.93 mg/ℓ and from 0.003 to 0.06 mg/ℓ, respectively.

23. SW. Survival was high (95 to 100 percent) in all dilutions of whole (unfiltered) and filtered SW (Table 3). Survival in animals exposed to SW was not significantly different from controls. Ammonia concentrations in both whole and filtered SW was very similar. Total and un-ionized ammonia ranged from 0.04 to 0.10 mg/ℓ and from 0.003 to 0.007 mg/ℓ, respectively. The suspended solids concentration in the unfiltered SW was low, ranging from 0.4 to 3.8 mg/ℓ.

Ammonia toxicity test

24. Survival was high (95 to 100 percent) in all concentrations of ammonia tested (Table 5). Subsequent analysis indicated very low concentrations of both total both total (0.05 to 0.99 mg/ℓ) and un-ionized ammonia (0.005 to 0.08 mg/ℓ), suggesting a possible dilution error in preparing nominal concentrations. High survival precluded calculation of an LC_{50}.

Standard reference toxicant test

25. Survival was high (95 to 100 percent) at measured free cadmium concentrations ≤10 μg/ℓ. At higher concentrations, survival was affected in a dose responsive manner. Based on measured concentrations, the 48-hr LC_{50} (95 percent CI) was 125.2 μg/ℓ (64.1 to 260.0) (Table 6).

Acute (48-hr) Bioassays with *Pimephales promelas*

Elutriate bioassays

26. Unfiltered elutriate. Survival was adversely affected (0 to 70 percent) in all QI unfiltered elutriate exposures ≥12 percent elutriate (Table 7). Survival among animals exposed to the unfiltered elutriates of the QI sediment was significantly different from control survival at elutriate concentrations ≥12 percent elutriate. The 48-hr LC_{50} (95 percent CI) estimate for unfiltered QI elutriates was 15 percent (6 to 27 percent). Survival of animals exposed to the unfiltered elutriates of NSE sediments ranged from 60 to 90 percent and was not significantly different from controls (Table 8). Survival in animals exposed to the QI elutriates decreased with increasing elutriate concentration. Survival of animals exposed to elutriates of NSE sediment was not affected in a dose responsive manner. Survival among control animals was high (95 percent). Total and un-ionized ammonia in the elutriates of QI sediment ranged from 0.72 to 9.7 mg/ℓ and from 0.065 to 1.4 mg/ℓ, respectively. Ammonia concentrations in the unfiltered NSE elutriates were not as high, ranging from 0.22 to 1.40 mg/ℓ and from 0.018 to 0.12 mg/ℓ for total and un-ionized ammonia, respectively. Geometric means of the suspended solids concentrations ranged from 38 to 667 mg/ℓ in QI elutriates and 48 to 946 mg/ℓ in the NSE elutriates (Table 10).

27. Filtered elutriate. Survival (0 to 65 percent) was adversely affected in filtered QI elutriate concentrations ≥25-percent elutriate (Table 7). Survival in the 25- and 100-percent QI elutriates was significantly different from the controls. Though not statistically significant,

survival in the 50-percent elutriate was low relative to the controls. The 48-hr LC_{50} (95 percent CI) estimate for filtered QI elutriates was 27 percent (18 to 40 percent). Survival in the NSE filtered elutriates ranged from 40 to 95 percent (Table 8). Survival in animals exposed to the 100-percent NSE filtered elutriate concentration was significantly different from controls. The 48-hr LC_{50} (95 percent CI) for *Pimephales promelas* fry exposed to filtered elutriates of NSE sediment was 91 percent (53 to 360 percent). Total and un-ionized ammonia in the elutriates of QI sediment ranged from 0.20 to 0.73 mg/ℓ and from 0.017 to 0.10 mg/ℓ, respectively. Ammonia concentrations in the filtered NSE elutriates were slightly higher, ranging from 0.08 to 1.82 mg/ℓ and from 0.006 to 0.16 mg/ℓ for total and un-ionized ammonia, respectively.

28. SW. Survival was high (85 to 100 percent) in all dilutions of filtered and unfiltered SW and was not significantly different from the controls (Table 9). Ammonia concentrations in both whole and filtered SW were very similar. Total and un-ionized ammonia ranged from 0.02 to 0.16 mg/ℓ and from 0.002 to 0.014 mg/ℓ, respectively. The suspended solids concentration in the unfiltered SW was low, ranging from 0.2 to 2.6 mg/ℓ.

Ammonia toxicity test

29. Survival of *Pimephales promelas* fry was affected at total and un-ionized ammonia concentrations ≥0.07 and 0.005 mg/ℓ, respectively (Table 11). The 48-hr LC_{50}s (95 percent CI) for total and un-ionized ammonia were 1.04 mg/ℓ (0.40 to 2.89) and 0.056 mg/ℓ (0.013 to 0.183), respectively.

Standard reference toxicant test

30. Survival of *Pimephales promelas* fry was reduced at concentrations of $Cd^{++} \geq 69 \mu g/\ell$. Based on measured concentrations, the 48-hr LC_{50} (95 percent CI) was 61.1 µg/ℓ (19.7 to 80.8) (Table 12).

Chronic (21-day) Bioassays with *Daphnia magna*

Unfiltered elutriate bioassays

31. Survival was high (80 to 90 percent) in all elutriate concentrations of QI and NSE (Table 13). High survival precluded calculation of an LC_{50}-value. Reproduction (neonates/surviving adult) was not affected in a dose-responsive manner, although reductions were noted in some treatments (e.g., 1-percent QI and the 1- and 10-percent NSE). The mean number of neonates produced in the 1-percent elutriate of NSE sediment (5), was significantly lower than the mean number of neonates produced in the controls (17).

Total ammonia and un-ionized ammonia in the QI sediment ranged from 0.04 to 1.5 mg/ℓ and from 0.017 to 0.09 mg/ℓ, respectively. Total and un-ionized ammonia concentrations were slightly lower in NSE elutriates ranging from 0.13 to 0.22 mg/ℓ and from 0.003 to 0.011 mg/ℓ, respectively. Geometric means of the suspended solids concentrations ranged from 69 to 1,224 mg/ℓ in QI elutriates and 110 to 1,386 mg/ℓ in the NSE elutriates (Table 14).

Ammonia toxicity test

32. Although this test was intended to be a 21-day exposure, none of the animals survived beyond 14 days in ammonia concentrations ≥8.1 mg/ℓ (measured total ammonia) or 0.32 mg/ℓ (un-ionized ammonia) (Table 15). The 7-and 14-day LC_{50} values for total ammonia were 3.5 mg/ℓ (2.2 to 5.5) and 1.5 mg/ℓ (0.84 to 2.4), respectively. The 7- and 14-day LC_{50} estimates (95 percent CI) for un-ionized ammonia were 0.15 mg/ℓ (0.10 to 0.23) and 0.06 mg/ℓ (0.04 to 0.11), respectively.

Interlaboratory Comparisons

33. The acute toxicity bioassays with *Pimephales promelas* conducted by the WES and Hygienic laboratories were not comparable. Test results for both the 100- and 50-percent elutriates are shown in Tables 16 and 17, respectively. Percent survival in the 100-percent elutriates were comparable except for filtered NSE where survival in the WES test (40 percent) was significantly lower than that in the Hygienic test (100 percent) (Table 16). A comparison of survival in the 50-percent elutriates indicated consistently lower survival in the WES test (55 to 75 percent) relative to the Hygienic test (95 to 100 percent) with significant differences in the filtered and unfiltered QI elutriates and the unfiltered NSE elutriate (Table 17). A comparison of suspended solids analysis indicated widely disparate results between the two laboratories (i.e., Hygienic reporting total suspended solids concentrations two orders of magnitude higher than WES). Both total and un-ionized ammonia levels were comparable except for the filtered QI elutriate where Hygienic reported levels an order of magnitude higher than WES (e.g., 4.1 mg/ℓ versus 0.44 mg/ℓ).

34. In addition to the acute toxicity bioassays, both labs conducted a cadmium chloride reference toxicant test with *Pimephales promelas* fry (Table 18). Nominal exposure concentrations used in the WES test ranged from 37 to 600 μg/ℓ. The nominal concentrations used by Hygienic Laboratory ranged

from 44 to 700 $\mu g/\ell$. While the nominal exposure concentrations reported by both labs were very similar, there was a significant difference in the percent survival. WES observed 100-percent mortality in the highest measured concentration of 270 $\mu g/\ell$. Hygienic reported 65-percent survival in its highest nominal concentration of 700 $\mu g/\ell$. Nominal concentrations in the WES test were confirmed by subsequent cadmium analysis. Only the highest exposure concentration was confirmed in the Hygienic test. A WES analysis of the Hygienic Laboratory's 700-$\mu g/\ell$ exposure concentration indicated that the analytical techniques of both labs gave comparable results (580 $\mu g/\ell$ for WES, 670 $\mu g/\ell$ for Hygienic Laboratory).

35. An interlaboratory comparison of split ammonia samples was performed by WES, ARDL, and the Hygienic Laboratory. The samples analyzed were 10-percent filtered and 10-percent unfiltered NSE and 100-percent filtered and 100-percent unfiltered QI elutriates. Results obtained by the three labs were in close agreement (Table 19).

PART IV: DISCUSSION

36. *Daphnia magna* survived acute exposures (48-hr) to filtered and unfiltered elutriates of QI and NSE sediments very well, while the second test species, *Pimephales promelas*, did not. Two possible explanations for this difference in toxicity are: *Pimephales promelas* fry were stressed prior to testing and/or concentrations of ammonia in the test material were acutely toxic to *Pimephales promelas* fry.

37. During the shipment from the supplier to WES, *Pimephales promelas* fry underwent a -8 °C temperature change in a 24-hr period (they were shipped at 24 °C, arrived at WES at 16 °C, and were tested at 20 °C). Results of the interlaboratory comparison suggest that this temperature fluctuation may have stressed the organisms. *Pimephales* fry used in the Hygienic elutriate bioassays with Illinois Waterway dredged material had higher survival than those animals used by WES in analogous tests. Additionally, animals evaluated in the standard reference toxicant test by WES appeared to be less tolerant to cadmium exposure (they had lower survival) than those animals tested by the Hygienic lab. However, the 48-hr LC_{50} (61.1 $\mu g\ Cd^{++}/\ell$) for animals used in the WES test was in close agreement with the USEPA's species mean acute value of 30.5 $\mu g\ Cd^{++}/\ell$ and other published LC_{50} values (8 to 300 $\mu g\ Cd^{++}/\ell$) (USEPA 1985a; Hall et al. 1986; Sherman, Gloss, and Lion 1987; Carrier and Beitinger 1988). Increasing hardness has been shown to increase Cd^{++} toxicity (USEPA 1985b). The WES reference toxicant test was conducted at a hardness of 191 ± 0.75 mg $CaCO_3/\ell$. While hardness data for the Hygienic test was not available, a lower hardness value is thought to be what could explain the discrepancy in toxicity between the two reference toxicant tests (i.e., WES versus Hygienic).

38. Results from the ammonia toxicity tests indicate that the *Pimephales promelas* fry used in the WES tests were acutely sensitive to low concentrations of ammonia (Table 11). The toxicity of ammonia to aquatic organisms is due primarily to the un-ionized fraction, while total ammonia is less toxic (Armstrong et al. 1978; Thurston, Russo, and Phillips 1983). Concentrations of un-ionized ammonia (0.017 to 1.4 mg/ℓ) in bioassays with the elutriates of QI and NSE sediments were within the range of acute toxicity (Tables 7 and 8) for the organisms tested by WES. The 48-hr LC_{50} (95 percent CI) value for animals used in the WES test was 0.056 mg un-ionized ammonia/ℓ (0.013 to 0.183). This value is slightly lower than USEPA's species mean acute value of 2.07 mg/ℓ and other published LC_{50} values for *Pimephales* fry

(0.73 to 2.73 mg un-ionized ammonia/ℓ (USEPA 1985b; Thurston, Russo, and Phillips 1983; DeGraeve, Overcast, and Bergman 1980; Ankley, Katko, and Arthur 1990). Heightened sensitivity to un-ionized ammonia is thought to have contributed to the poor survival of *Pimephales promelas* exposed to QI and NSE elutriates in the WES test. This heightened sensitivity may have arisen from the temperature changes encountered by the test animals during shipment to WES prior to testing. High survival (85 to 100 percent) in animals exposed to SW (Table 9) with relatively low levels of un-ionized ammonia (0.002 to 0.005 mg/ℓ) supports this speculation.

39. The high survival (i.e., *Daphnia magna* and *Pimephales promelas*) and reproduction (i.e., *Daphnia magna* only) observed in the unfiltered 100-percent elutriates suggest that neither *Daphnia magna* nor *Pimephales promelas* are affected by the physical impact of high-suspended solids concentrations. The geometric means of suspended solids concentrations measured in the 100-percent elutriates ranged from 294 to 1,386 mg/ℓ. Survival of *Daphnia magna* was high (80 to 100 percent) during both acute and chronic exposures to the unfiltered 100-percent elutriates of QI and NSE sediments. Similarly, survival of *Pimephales promelas* was high (90 to 100 percent) during exposures to the unfiltered 100-percent elutriates of NSE sediment. As speculated above, the poor survival of *Pimephales promelas* exposed to the unfiltered 100-percent elutriates of QI sediment was probably due to un-ionized ammonia toxicity.

40. Survival and reproduction in *Daphnia magna* were unaffected by chronic exposures to the unfiltered elutriates of Illinois Waterway sediments. The mean number of neonates produced per adult was higher in the 100-percent elutriates of both QI and NSE sediments than in the three lower percent elutriates. Only the lowest concentration of the NSE elutriate showed a significant difference in neonate production relative to the controls (Table 13). Measured concentrations of ammonia during the chronic tests with QI and NSE elutriates ranged from 0.003 to 0.09 mg un-ionized ammonia/ℓ and were below the levels shown to produce chronic toxicity in *Daphnia magna*.

41. Both acute and chronic exposures to ammonia were conducted with *Daphnia magna*. Measured concentrations in the acute test were very low (<0.08 mg un-ionized ammonia/ℓ) and did not result in toxicity (survival ranged from 95 to 100 percent). The low-measured concentrations were probably a result of a dilution error when test concentrations were initially prepared. Published 48-hr LC_{50} values for *Daphnia magna* range from 0.53 to 4.94 mg un-ionized ammonia/ℓ (USEPA 1985a; DeGraeve, Overcast, and Bergman 1980;

Parkhurst et al. 1981). The chronic ammonia toxicity test with *Daphnia magna* resulted in 7- and 14-day LC_{50} (95 percent CI) values for un-ionized ammonia of 0.15 mg/ℓ (0.10 to 0.23) and 0.06 mg/ℓ (0.04 to 0.11), respectively. These LC_{50}'s were lower than the chronic values for *Daphnia magna* cited in the USEPA criteria document, which were based on full life-cycle exposures and ranged from 0.37 to 1.6 mg un-ionized ammonia/ℓ (USEPA 1985a).

42. The cadmium chloride standard reference toxicant tests with *Daphnia magna* resulted in a 48-hr LC_{50} (95 percent CI) of 125.2 μg Cd^{++}/ℓ (64.07 to 259.82). This was within the range of published LC_{50} values (5.0 to 127.0 μg Cd^{++}/ℓ reported for *Daphnia* (USEPA 1985b; Hall et al. 1986; Attar and Maly 1982, Nebeker et al. 1986) and suggests the organisms were in good health prior to testing.

PART V: CONCLUSIONS

43. Conclusions are as follows:

a. Survival and reproduction in *Daphnia magna* were unaffected in both acute and chronic exposures to elutriates of QI and the NSE sediment.

b. Survival of *Pimephales promelas* fry during acute exposures to unfiltered elutriates of QI sediment was significantly reduced at concentrations ≥12-percent elutriate.

c. Survival of *Pimephales promelas* fry during acute exposures to filtered elutriates of QI sediment was significantly reduced at concentrations ≥25-percent elutriate.

d. Survival of *Pimephales promelas* fry during acute exposures to filtered elutriates of the NSE sediment was significantly reduced only in the 100-percent elutriate concentration.

e. Measured ammonia levels in elutriates of QI and NSE sediment were within a range (0.03 to 1.4 mg un-ionized ammonia/ℓ) shown to be acutely toxic to *Pimephales promelas* fry.

f. Cadmium chloride reference toxicant test with both test species resulted in 48-hr LC_{50} values (i.e., 125.2 μg Cd^{++}/ℓ for *Daphnia magna*, 61.1 μg CD^{++}/ℓ for *Pimephales promelas* fry) that were comparable with published values.

g. The 48-hr LC_{50} (95 percent CI) for *Pimephales promelas* fry exposed to unfiltered elutriates of QI sediment was 15 percent elutriate (27 to 65 percent).

h. The 48-hr LC_{50} (95 percent CI) for *Pimephales promelas* fry exposed to filtered elutriates of QI sediment was 27 percent elutriate (18 to 40 percent).

i. The 48-hr LC_{50} (95 percent CI) for *Pimephales promelas* fry exposed to filtered elutriates of NSE sediment was 91 percent elutriate (53 to 360 percent).

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Table 1

Survival of *Daphnia magna* following 48-hr Exposures to Elutriates of Quiver Island Sediment

Percent Elutriate	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ		Un-ionized Ammonia** mg/ℓ		Percent Survival †	
			Unfiltered				
0.1	8	0.06	(0.007)	0.004	(0.0005)	100	(0.0)
1	21	0.15	(0.031)	0.012	(0.0029)	100	(0.0)
10	70	0.48	(0.017)	0.033	(0.0023)	85	(6.1)
50	108	1.80	(0.150)	0.108	(0.0111)	95	(5.0)
100	293	3.79	(0.260)	0.175	(0.0233)	90	(6.1)
			Filtered				
0.1		0.04	(0.003)	0.003	(0.0004)	90	(6.1)
1		0.13	(0.069)	0.009	(0.0043)	95	(5.0)
10		0.25	(0.047)	0.016	(0.0023)	100	(0.0)
50		0.33	(0.105)	0.022	(0.0086)	95	(5.0)
100	<0.01	0.19	(0.029)	0.007	(0.0008)	100	(0.0)
			Control				
0	<0.01	0.05	(0.006)	0.003	(0.0005)	95	(5.0)

* Geometric means from Table 4.
** Mean (standard error), n = 10, given in parentheses.
† Mean (standard error), n = 5, given in parentheses.

Table 2

Survival of *Daphnia magna* following 48-hr Exposures to Elutriates of Nearshore Environs Sediment

Percent Elutriate	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ		Un-ionized Ammonia** mg/ℓ		Percent Survival †	
			Unfiltered				
0.1	5	0.05	(0.010)	0.004	(0.0011)	95	(5.0)
1	60	0.04	(0.007)	0.003	(0.0006)	100	(0.0)
10	133	0.11	(0.007)	0.009	(0.0011)	95	(5.0)
50	252	0.40	(0.037)	0.028	(0.0014)	100	(0.0)
100	610	1.08	(0.135)	0.083	(0.0046)	100	(0.0)
			Filtered				
0.1		0.04	(0.004)	0.003	(0.0003)	100	(0.0)
1		0.04	(0.003)	0.003	(0.0003)	100	(0.0)
10		0.09	(0.012)	0.005	(0.0007)	90	(10.0)
50		0.53	(0.006)	0.037	(0.0022)	95	(5.0)
100	<0.01	0.93	(0.003)	0.060	(0.0120)	100	(0.0)
			Control				
0	<0.01	0.05	(0.006)	0.003	(0.0005)	95	(5.0)

* Geometric means from Table 4.
** Mean (standard error), n = 10, given in parentheses.
† Mean (standard error), n = 5, given in parentheses.

Table 3

Survival of *Daphnia magna* following 48-hr Exposures to Elutriates to Whole and Filtered Site Water from the Illinois Waterway

Percent Elutriate	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ	Un-ionized Ammonia** mg/ℓ	Percent Survival †
		Unfiltered		
0.1	0.4 (0.04)	0.04 (0.007)	0.003 (0.0007)	100 (0.0)
1	1.0 (0.08)	0.04 (0.007)	0.003 (0.0006)	95 (5.0)
10	1.1 (0.06)	0.04 (0.006)	0.003 (0.0006)	100 (0.0)
50	1.9 (0.03)	0.07 (0.001)	0.006 (0.0013)	100 (0.0)
100	3.8 (0.03)	0.08 (0.007)	0.007 (0.0012)	100 (0.0)
		Filtered		
0.1		0.04 (0.007)	0.003 (0.0006)	100 (0.0)
1		0.05 (0.005)	0.003 (0.0004)	100 (0.0)
10		0.05 (0.008)	0.003 (0.0006)	100 (0.0)
50		0.10 (0.006)	0.006 (0.0004)	100 (0.0)
100	<0.01	0.10 (0.026)	0.007 (0.0019)	100 (0.0)
		Control		
0	<0.01	0.05 (0.007)	0.003 (0.0005)	95 (5.0)

* Mean (standard error), n = 3, given in parentheses.
** Mean (standard error), n = 10, given in parentheses.
† Mean (standard error), n = 5, given in parentheses.

Table 4

Suspended Solids Concentrations (mg/ℓ) during 48-hr Exposures of *Daphnia magna* to Unfiltered Elutriates of Quiver Island Sediment (QI) and Nearshore Environs Sediment (NSE)

Percent Elutriate	Measured* Initial	Measured* Final	Geometric Mean**
	QI		
0.1	41 (0.4)	1.5 (0.4)	8
1	120 (0.7)	3.6 (0.3)	21
10	291 (0.4)	17 (0.7)	70
50	436 (2.5)	27 (1.1)	108
100	2,045 (2.8)	42 (0.7)	293
	NSE		
0.1	65 (0.9)	4.0 (0.7)	5
1	16 (0.3)	22 (0.7)	60
10	63 (0.9)	38 (4.6)	133
50	794 (0.4)	80 (1.4)	252
100	3,053 (1.2)	122 (0.4)	610

* Mean (standard error), n = 5, given in parentheses.

** Geometric mean = average of $\log_{10}$-transformed means (n = 2).

Table 5

Survival of *Daphnia magna* following 48-hr Exposure to Ammonia

Ammonia Concentrations			
Nominal mg/ℓ	Measured* mg/ℓ	Un-ionized mg/ℓ	Percent Survival*
0	0.05 (0.006)	0.003 (0.0005)	95 (5.0)
0.01	0.05 (0.013)	0.005 (0.0012)	95 (5.0)
0.1	0.08 (0.005)	0.01 (0.0017)	100 (0.0)
1.0	0.33 (0.008)	0.03 (0.0008)	100 (0.0)
10	0.99 (0.060)	0.08 (0.0041)	100 (0.0)
100	0.92 (0.027)	0.07 (0.0067)	100 (0.0)

* Mean (standard error), n = 5, given in parentheses.

Table 6

Survival of *Daphnia magna* following 48-hr Exposure to a Cadmium Chloride Standard Reference Toxicant (LC_{50} (95 percent CI) = 125.2 µg/ℓ (64.07 to 259.82))

Cadmium Concentrations		Percent Survival**
Nominal µg Cd^{++}/ℓ	Measured* µg Cd^{++}/ℓ	µg Cd^{++}/ℓ
0	<0.01	95 (5.0)
0.1	0.1 (0.1)	95 (5.0)
1.0	1.1 (0.1)	100 (0.0)
10	9.5 (0.3)	100 (0.0)
100	98.7 (0.6)	65 (6.1)
1,000	998.2 (1.2)	0 (0.0)

* Mean (standard error), n = 3, given in parentheses.
** Mean (standard error), n = 5, given in parentheses.

Table 7

Survival of *Pimephales promelas* following 48-hr Exposures to Elutriates of Quiver Island Sediment

Percent Elutriate	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ		Un-ionized Ammonia** mg/ℓ		Percent Survival†	
			Unfiltered				
6	38	0.72	(0.014)	0.065	(0.0019)	70	(5.0)
12	88	1.3	(0.03)	0.13	(0.003)	35††	(12.8)
25	196	2.5	(0.07)	0.24	(0.009)	50††	(13.7)
50	363	4.8	(0.07)	0.58	(0.006)	55††	(9.4)
100	667	9.7	(0.14)	1.4	(0.01)	0††	(0.0)
			Filtered				
6		0.58	(0.066)	0.056	(0.0064)	90	(6.1)
12		0.20	(0.025)	0.017	(0.0022)	65	(12.8)
25		0.27	(0.038)	0.028	(0.0036)	50††	(13.7)
50		0.44	(0.028)	0.046	(0.0029)	55	(18.4)
100	<0.01	0.73	(0.075)	0.10	(0.010)	0††	(0.0)
			Control				
0	<0.01	0.02	(0.003)	0.002	(0.0003)	95	(5.0)

* Geometric means from Table 10.
** Mean (standard error), n = 3, given in parentheses.
† Mean (standard error), n = 5, given in parentheses.
†† Significantly different from control (P<0.05).

Table 8

Survival of *Pimephales promelas* following 48-hr Exposures to Elutriates of Nearshore Environs Sediment

Percent Elutriate	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ		Un-ionized Ammonia** mg/ℓ		Percent Survival†	
			Unfiltered				
6	48	0.22	(0.017)	0.018	(0.0013)	60	(15.0)
12	138	0.27	(0.007)	0.022	(0.0005)	60	(10.0)
25	289	0.28	(0.102)	0.021	(0.0078)	80	(5.0)
50	306	0.66	(0.003)	0.043	(0.0175)	70	(5.0)
100	946	1.40	(0.047)	0.12	(0.005)	90	(6.1)
			Filtered				
6		0.08	(0.002)	0.006	(0.0002)	95	(5.0)
12		0.24	(0.005)	0.020	(0.0006)	80	(9.4)
25		0.29	(0.005)	0.021	(0.0004)	80	(12.2)
50		0.74	(0.009)	0.067	(0.0024)	75	(15.8)
100	<0.01	1.82	(0.054)	0.16	(0.005)	40††	(15.0)
			Control				
0	<0.01	0.02	(0.003)	0.002	(0.0003)	95	(5.0)

* Geometric means from Table 10.
** Mean (standard error), n = 10, given in parentheses.
† Mean (standard error), n = 5, given in parentheses.
†† Significantly different from control (P<0.05).

Table 9

Survival of *Pimephales promelas* following 48-hr Exposures to Whole and Filtered Site Water from the Illinois Waterway

Percent Site Water	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ	Un-ionized Ammonia** mg/ℓ	Percent Survival*
Unfiltered Site Water				
6	0.20 (0.06)	0.02 (0.002)	0.002 (0.0002)	95 (5.0)
12	0.52 (0.06)	0.04 (0.007)	0.003 (0.0006)	95 (5.0)
25	1.2 (0.02)	0.04 (0.009)	0.003 (0.0007)	90 (6.1)
50	1.4 (0.02)	0.08 (0.025)	0.007 (0.0023)	95 (5.0)
100	2.6 (0.03)	0.16 (0.065)	0.014 (0.0059)	95 (5.0)
Filtered Site Water				
6		0.02 (0.001)	0.002 (0.0001)	100 (0.0)
12		0.04 (0.003)	0.002 (0.0002)	90 (6.1)
25		0.02 (0.002)	0.002 (0.0003)	90 (6.1)
50		0.04 (0.008)	0.004 (0.0008)	85 (6.1)
100	<0.01	0.05 (0.014)	0.005 (0.0012)	85 (6.1)
Control				
0	<0.01	0.02 (0.003)	0.002 (0.0003)	95 (5.0)

* Mean (standard error), n = 3, given in parentheses.
** Mean (standard error), n = 10, given in parentheses.

Table 10

Suspended Solids Concentrations during 48-hr Exposures of *Pimephales promelas* to Unfiltered Elutriates of Quiver Island Sediment (QI) and Nearshore Environs Sediment (NSE)

Percent Elutriate	Measured Initial* mg/ℓ		Measured Final* mg/ℓ		Geometric Mean**
			QI		
6	132	(1.1)**	11	(1.0)	38
12	296	(0.9)	26	(0.7)	88
25	521	(0.8)	74	(0.3)	196
50	1,109	(1.7)	119	(1.1)	363
100	2,378	(2.2)	187	(1.9)	667
			NSE		
6	174	(0.9)	13	(1.2)	48
12	366	(0.9)	52	(0.9)	138
25	701	(0.7)	119	(0.7)	289
50	973	(1.8)	196	(1.8)	437
100	3,164	(2.9)	283	(0.9)	946

* Mean (standard error), n = 5, given in parentheses.
** Geometric mean = average of $\log_{10}$-transformed means (n = 2).

Table 11

Survival of *Pimephales promelas* following 48-hr Exposure to Ammonia

Ammonia Concentrations			
Nominal mg/ℓ	Measured* mg/ℓ	Un-ionized* mg/ℓ	Percent Survival**
0.00	0.02 (0.003)	0.002 (0.0003)	95 (5.0)
0.01	0.07 (0.003)	0.005 (0.0002)	55 (14.6)
0.1	0.38 (0.003)	0.026 (0.0002)	70 (9.4)
1	1.14 (0.005)	0.068 (0.0002)	55 (5.0)
10	11.7 (0.05)	0.97 (0.005)	35 (6.1)
100	97.3 (0.07)	8.00 (0.01)	0 (0.0)

Note: LC_{50} (95 percent CI) for total ammonia = 1.04 mg/ℓ (0.40 to 2.89). LC_{50} for un-ionized ammonia (95 percent CI) = 0.056 mg/ℓ (0.013 to 0.183).

* Mean (standard error), n = 10, given in parentheses.

** Mean (standard error), n = 5, given in parentheses.

Table 12

Survival of *Pimephales promelas* following 48-hr Exposure to a Cadmium Chloride Standard Reference Toxicant

Cadmium Concentrations		
Nominal $\mu g\ Cd^{++}/\ell$	Measured $\mu g\ Cd^{++}/\ell$	Percent Survival**
0	<0.01	95 (5.0)
37	69 (4.7)	20 (12.2)
75	83 (0.7)	55 (5.0)
150	117 (3.3)	45 (16.6)
300	133 (3.3)	5 (5.0)
600	270 (0.0)	0 (0.0)

Note: LC_{50} (95 percent CI) = 61.1 $\mu g/\ell$ (19.7 to 80.8).
* Mean (standard error), n = 3, given in parentheses.
** Mean (standard error), n = 5, given in parentheses.

Table 13

Survival and Reproduction (Total Neonates Produced/Adult) of *Daphnia magna* following 21-day Exposure to Unfiltered Elutriates from Quiver Island (QI) and the Nearshore Environs (NSE)

Percent Elutriate	Suspended Solids* mg/ℓ	Total Ammonia** mg/ℓ	Un-ionized Ammonia** mg/ℓ	Percent Survival†	Reproduction †
			QI		
1	69	0.04 (0.107)	0.017 (0.0040)	90 (10.0)	14 (4.5)
10	122	0.43 (0.092)	0.013 (0.0038)	90 (10.0)	19 (3.6)
50	349	0.69 (0.317)	0.042 (0.0210)	80 (13.3)	16 (4.7)
100	1,224	1.5 (0.60)	0.090 (0.0421)	80 (13.3)	21 (5.7)
			NSE		
1	110	0.22 (0.050)	0.011 (0.0025)	90 (10.0)	5†† (3.1)
10	275	0.13 (0.029)	0.003 (0.0005)	80 (13.3)	8 (3.1)
50	458	0.16 (0.027)	0.005 (0.0012)	90 (10.0)	11 (3.2)
100	1,386	0.13 (0.037)	0.007 (0.0024)	80 (13.3)	11 (2.8)
			Control		
0	<0.01	0.06 (0.007)	0.003 (0.0004)	90 (10.0)	17 (2.0)

* Suspended solids data for elutriates are geometric means from Table 14.
** Mean (standard error), n = 30, given in parentheses.
† Mean (standard error), n = 10, given in parentheses.
†† Significantly different from control ($P<0.05$).

Table 14

Suspended Solids Concentrations during 21-day Unfiltered Elutriate Bioassays with *Daphnia magna* and Quiver Island Sediment (QI) and Nearshore Environs Sediment (NSE)

Percent Elutriate	Renewal Periods* Week 1 Initial mg/ℓ	Week 1 Final mg/ℓ	Week 2 Initial mg/ℓ	Week 2 Final mg/ℓ	Week 3 Initial mg/ℓ	Week 3 Final mg/ℓ	Geometric Mean**
			QI				
1	110 (0.6)	32 (0.3)	136 (0.9)	45 (0.8)	131 (0.6)	37 (0.8)	69
10	282 (1.6)	71 (0.4)	260 (1.2)	63 (0.8)	281 (2.0)	35 (0.6)	122
50	608 (0.7)	213 (1.0)	599 (0.9)	201 (0.8)	637 (1.2)	182 (0.3)	349
100	2,699 (1.9)	517 (0.8)	2,713 (1.4)	585 (0.9)	2,748 (4.8)	522 (0.9)	1,224
			NSE				
1	226 (0.6)	42 (0.2)	283 (0.3)	51 (0.2)	317 (0.3)	40 (0.6)	110
10	436 (0.8)	178 (0.3)	472 (0.7)	184 (0.4)	491 (0.6)	130 (0.4)	275
50	773 (2.6)	301 (1.0)	694 (1.1)	283 (0.4)	769 (0.9)	261 (1.2)	458
100	3,204 (13)	624 (0.6)	3,191 (11)	570 (0.6)	3,264 (8.8)	596 (1.0)	1,386

* Weekly renewals: Initial = beginning of renewal period. Final = prior to renewal. Mean (standard error), n = 3, shown in parentheses.

** Geometric mean = average of $\log_{10}$-transformed means (n = 6).

Table 15

Survival of *Daphnia magna* following 14-day Exposure to Ammonia

Ammonia Concentrations			Percent Survival	
Nominal mg/ℓ	Measured* mg/ℓ	Un-ionized* mg/ℓ	7 days**	14 days**
0	0.06 (0.007)	0.003 (0.0004)	90 (10.0)	90 (10.0)
0.1	0.65 (0.045)	0.027 (0.0037)	100 (0.0)	80 (13.3)
1.0	2.4 (0.30)	0.12 (0.024)	80 (13.3)	50 (16.7)
10	8.1 (0.86)	0.32 (0.048)	10 (10.0)	0 (0.0)
50	50.0 (0.02)	1.7 (0.29)	0 (0.0)	0 (0.0)
100	98.5 (0.52)	3.3 (0.59)	0 (0.0)	0 (0.0)

Note: The 7- and 14-day LC_{50} values for total ammonia were 3.5 mg/ℓ (2.2 to 5.5) and 1.5 mg/ℓ (0.84 to 2.4), respectively. The 7- and 14-day LC_{50} estimates (95 percent CI) for un-ionized ammonia were 0.15 mg/ℓ (0.10 to 0 .23) and 0.06 mg/ℓ (0.04 to 0.11), respectively.

* Mean (standard error), n = 10, given in parentheses.

** Mean (standard error), n = 5, given in parentheses.

Table 16

Comparison of WES and Hygienic Laboratory Toxicity Data for 48-hr Elutriate Bioassays with *Pimephales promelas* and the 100-percent Elutriates of Quiver Island (QI) and Nearshore Environs (NSE) Sediment

Laboratory	Percent Survival*	Suspended Solids** mg/ℓ	Ammonia† Measured mg/ℓ	Ammonia† Un-ionized†† mg/ℓ
		QI Sediment 100% Unfiltered Elutriate		
WES	0 (0.0)	236-238	9.7 (0.14)	1.4 (0.011)
Hygienic	5 (4.5)	29,850-37,650	8.3 (0.77)	1.0 (0.031)
		QI Sediment 100% Filtered Elutriate		
WES	0 (0.0)	<0.01	0.24 (0.022)	0.10 (0.010)
Hygienic	0 (0.0)	<1	8.1 (1.40)	1.10 (0.043)
		NSE Sediment 100% Unfiltered Elutriate		
WES	90 (6.1)	315-316	1.4 (0.05)	0.12 (0.005)
Hygienic	95 (4.5)	90,000-111,600	1.6 (0.05)	0.15 (0.001)
		NSE Sediment 100% Filtered Elutriate		
WES	40 (15.0)	<0.01	1.8 (0.05)	0.16 (0.005)
Hygienic	100† (0.0)	<1	1.5 (0.02)	0.14 (0.001)
		Control		
WES	95 (5.0)	<0.01	0.02 (0.003)	0.002(0.0003)
Hygienic	95-100‡‡	<1	<0.1	<0.01

* Mean (standard error), n = 5, given in parentheses.
** Range of replicate observations throughout bioassay.
† Mean (standard error), n = 3, given in parentheses.
†† Un-ionized ammonia concentration calculated using mean temperature and pH data at each sampling time.
‡ Asterisk = significant difference between laboratories ($p<0.05$).
‡‡ Range of control survival reported for all Hygienic tests.

Table 17

Comparison of WES and Hygienic Laboratory Toxicity Data for 48-hr Elutriate Bioassays with *Pimephales promelas* and the 50-percent Elutriates of Quiver Island (QI) and Nearshore Environs (NSE) Sediment

	Percent Survival*	Suspended Solids** mg/ℓ	Ammonia† Measured mg/ℓ	Ammonia† Un-ionized†† mg/ℓ
		QI Sediment 50% Unfiltered Elutriate		
WES	55 (9.4)	201-637	4.8 (0.07)	0.58 (0.006)
Hygienic	95‡ (5.0)	14,760-18,220	4.8 (0.38)	0.50 (0.066)
		QI Sediment 50% Filtered Elutriate		
WES	55 (18.4)	<0.01	0.44 (0.028)	0.05 (0.003)
Hygienic	100‡ (0.0)	<1	4.1 (0.49)	0.52 (0.062)
		NSE Sediment 50% Unfiltered Elutriate		
WES	70 (5.0)	261-769	0.66 (0.003)	0.04 (0.018)
Hygienic	100‡ (0.0)	44,250-52,700	1.2 (0.14)	0.11 (0.019)
		NSE Sediment 50% Filtered Elutriate		
WES	75 (15.8)	<0.01	0.74 (0.009)	0.07 (0.002)
Hygienic	100 (0.0)	<1	0.80 (0.058)	0.09 (0.009)
		Control		
WES	95 (5.0)	<0.01	0.02 (0.003)	0.002(0.0003)
Hygienic	95-100‡‡	<1	<0.1	<0.01

* Mean (standard error), n = 5, given in parentheses.
** Range of replicate observations throughout bioassay.
† Mean (standard error), n = 3, given in parentheses.
†† Un-ionized ammonia concentration calculated using mean temperature and pH data at each sampling time.
‡ Significant difference between laboratories ($p<0.05$).
‡‡ Range of control survival reported for all Hygienic tests.

Table 18

Comparison of WES and Hygienic Laboratory Toxicity Data for Cadmium Chloride Standard Reference Toxicant Tests with *Pimephales promelas* Fry

WES			Hygienic		
Nominal $\mu g\ cd^{++}/\ell$	Measured* $\mu g\ cd^{++}/\ell$	Percent Survival**	Nominal $\mu g\ cd^{++}/\ell$	Measured† $\mu g\ cd^{++}/\ell$	Percent Survival**
0	<0.01	95 (5.0)	0	-	95 (5.0)
37	69 (0.04)	20 (12.2)	44	-	100 (0.0)
75	83 (0.001)	55 (5.0)	88	-	90 (10.0)
150	117 (0.003)	45 (16.6)	175	-	95 (5.0)
300	133 (0.003)	5 (5.0)	350	-	95 (5.0)
600	270 (0.006)	0 (0.0)	700	-	65 (6.1)

* Mean (standard error), n = 3, given in parentheses.
** Mean (standard error), n = 5, given in parentheses.
† Nominal exposure concentrations not analytically confirmed.

Table 19

Comparison of Ammonia Analysis of Split Elutriate Samples

Elutriate Sample	WES*	HYGIENIC**	ARDL**
10% unfiltered elutriate NSE	0.62 (0.009)	0.1	0.4
10% filtered elutriate NSE	0.36 (0.005)	0.2	0.4
100% filtered elutriate QI	6.1 (0.004)	6.1	6.5
100% unfiltered elutriate	4.6 (0.009)	7.0	13

Note: NSE = Nearshore Environs, QI = Quiver Island, ARDL = Applied Research and Development Laboratory of Mt. Vernon, IL.

* Mean (standard error), n = 3, given in parentheses.

** No variance statistic reported.

APPENDIX A: RAW DATA FOR ACUTE BIOASSAYS WITH *DAPHNIA MAGNA*

Table A1

Acute Elutriate Bioassay - Survival and Water Quality Parameters in Quiver Island Unfiltered (QIU) Elutriates and Controls

Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
QIU 0.1-1	20	20	8.5	8.3	8.14	8.32	4
QIU 0.1-2	20	20	8.6	8.5	8.12	8.30	4
QIU 0.1-3	20	20	8.6	8.0	8.15	8.31	4
QIU 0.1-4	20	20	8.6	8.4	8.14	8.27	4
QIU 0.1-5	20	20	8.6	8.2	8.16	8.28	4
QIU 1.0-1	20	20	8.6	8.2	8.16	8.34	4
QIU 1.0-2	20	20	8.7	8.4	8.17	8.41	4
QIU 1.0-3	20	20	8.7	8.0	8.18	8.38	4
QIU 1.0-4	20	20	8.7	8.3	8.19	8.37	4
QIU 1.0-5	20	20	8.8	8.1	8.18	8.40	4
QIU 10-1	20	20	8.7	8.3	8.16	8.31	4
QIU 10-2	20	20	8.6	8.0	8.14	8.33	3
QIU 10-3	20	20	8.6	8.8	8.14	8.36	4
QIU 10-4	20	20	8.6	8.4	8.14	8.48	3
QIU 10-5	20	20	8.6	8.1	8.15	8.45	3
QIU 50-1	20	20	8.2	8.6	7.98	8.52	3
QIU 50-2	20	20	8.2	8.2	7.99	8.44	4
QIU 50-3	20	20	8.2	7.9	7.98	8.32	4
QIU 50-4	20	20	8.2	8.4	7.97	8.37	4
QIU 50-5	20	20	8.2	8.0	7.97	8.52	4
QIU 100-1	20	20	7.3	8.0	7.80	8.47	3
QIU 100-2	20	20	7.4	8.4	7.81	8.28	4
QIU 100-3	20	20	7.6	8.1	7.80	8.44	4
QIU 100-4	20	20	7.6	8.6	7.81	8.22	4
QIU 100-5	20	20	7.7	7.5	7.79	8.21	3
Control-1	20	20	8.4	8.0	8.10	8.19	4
Control-2	20	20	8.5	8.1	8.10	8.33	3
Control-3	20	20	8.5	8.6	8.11	8.30	4
Control-4	20	20	8.6	7.8	8.11	8.18	4
Control-5	20	20	8.6	8.3	8.12	8.13	4

Table A2

Acute Elutriate Bioassay - Survival and Water Quality Parameters in Quiver Island Filtered (QIF) Elutriates and Controls

Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
QIF 0.1-1	20	20	8.8	8.5	8.31	8.44	3
QIF 0.1-2	20	20	8.8	8.0	8.27	8.40	4
QIF 0.1-3	20	20	8.8	8.4	8.25	8.42	3
QIF 0.1-4	20	20	8.7	8.2	8.25	8.40	4
QIF 0.1-5	20	20	8.8	8.0	8.25	8.30	4
QIF 1.0-1	20	20	8.8	8.1	8.25	8.29	4
QIF 1.0-2	20	20	8.8	8.4	8.24	8.38	4
QIF 1.0-3	20	20	8.8	8.2	8.23	8.34	4
QIF 1.0-4	20	20	8.7	8.6	8.22	8.38	3
QIF 1.0-5	20	20	8.8	8.0	8.22	8.40	4
QIF 10-1	20	20	8.9	8.1	8.19	8.40	4
QIF 10-2	20	20	8.8	8.7	8.18	8.34	4
QIF 10-3	20	20	8.7	8.4	8.18	8.31	4
QIF 10-4	20	20	8.7	8.0	8.18	8.39	4
QIF 10-5	20	20	8.7	8.3	8.19	8.30	4
QIF 50-1	20	20	7.8	8.1	7.97	8.31	4
QIF 50-2	20	20	8.0	8.3	7.96	8.32	4
QIF 50-3	20	20	8.0	8.5	7.96	8.26	4
QIF 50-4	20	20	8.0	8.4	7.97	8.34	4
QIF 50-5	20	20	8.0	8.0	7.94	8.33	3
QIF 100-1	20	20	6.4	8.3	7.78	8.24	4
QIF 100-2	20	20	6.6	8.5	7.78	8.38	4
QIF 100-3	20	20	6.5	8.0	7.77	8.23	4
QIF 100-4	20	20	6.5	8.2	7.75	8.34	4
QIF 100-5	20	20	6.5	8.1	7.76	8.30	4
Control-1	20	20	8.4	8.0	8.10	8.19	4
Control-2	20	20	8.5	8.1	8.10	8.33	3
Control-3	20	20	8.5	8.6	8.11	8.30	4
Control-4	20	20	8.6	7.8	8.11	8.18	4
Control-5	20	20	8.6	8.3	8.12	8.13	4

Table A3

Acute Elutriate Bioassay - Survival and Water Quality Parameters in Nearshore Environs Unfiltered Elutriate (NSEU) and Controls

Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
NSEU 0.1-1	20	20	8.7	8.1	8.21	8.52	3
NSEU 0.1-2	20	20	8.8	8.3	8.22	8.52	4
NSEU 0.1-3	20	20	8.7	7.6	8.21	8.32	4
NSEU 0.1-4	20	20	8.7	8.0	8.21	8.30	4
NSEU 0.1-5	20	20	8.8	8.2	8.22	8.41	4
NSEU 1.0-1	20	20	8.8	8.5	8.24	8.38	4
NSEU 1.0-2	20	20	8.8	8.3	8.24	8.34	4
NSEU 1.0-3	20	20	8.7	8.0	8.24	8.40	4
NSEU 1.0-4	20	20	8.7	8.2	8.25	8.43	4
NSEU 1.0-5	20	20	8.8	8.4	8.25	8.32	4
NSEU 10-1	20	20	8.8	8.2	8.23	8.30	3
NSEU 10-2	20	20	8.8	8.3	8.22	8.38	4
NSEU 10-3	20	20	8.7	8.3	8.21	8.43	4
NSEU 10-4	20	20	8.7	8.5	8.21	8.37	4
NSEU 10-5	20	20	8.7	8.2	8.20	8.46	4
NSEU 50-1	20	20	8.7	8.3	8.22	8.40	4
NSEU 50-2	20	20	8.6	7.9	8.24	8.30	4
NSEU 50-3	20	20	8.7	7.6	8.24	8.50	4
NSEU 50-4	20	20	8.7	8.0	8.25	8.29	4
NSEU 50-5	20	20	8.8	8.4	8.26	8.40	4
NSEU 100-1	20	20	8.5	8.4	8.21	8.55	4
NSEU 100-2	20	20	8.5	8.2	8.23	8.44	4
NSEU 100-3	20	20	8.6	8.0	8.24	8.59	4
NSEU 100-4	20	20	8.6	7.5	8.24	8.37	4
NSEU 100-5	20	20	8.6	8.1	8.26	8.42	4
Control-1	20	20	8.4	8.0	8.10	8.19	4
Control-2	20	20	8.5	8.1	8.10	8.33	3
Control-3	20	20	8.5	8.6	8.11	8.30	4
Control-4	20	20	8.6	7.8	8.11	8.18	4
Control-5	20	20	8.6	8.3	8.12	8.13	4

Table A4

Acute Elutriate Bioassay - Survival and Water Quality Parameters in Nearshore Environs Filtered (NSEF) Elutriate and Controls

Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
NSEF 0.1-1	20	20	9.0	8.1	8.31	8.21	4
NSEF 0.1-2	20	20	8.9	8.0	8.27	8.32	4
NSEF 0.1-3	20	20	8.8	8.3	8.25	8.35	4
NSEF 0.1-4	20	20	8.8	8.1	8.25	8.33	4
NSEF 0.1-5	20	20	8.8	8.3	8.24	8.45	4
NSEF 1.0-1	20	20	8.9	8.5	8.24	8.18	4
NSEF 1.0-2	20	20	8.8	8.1	8.24	8.19	4
NSEF 1.0-3	20	20	8.8	8.4	8.24	8.30	4
NSEF 1.0-4	20	20	8.7	8.2	8.24	8.19	4
NSEF 1.0-5	20	20	8.8	8.0	8.24	8.19	4
NSEF 10-1	20	20	8.9	8.1	8.20	8.12	4
NSEF 10-2	20	20	8.8	8.3	8.19	8.28	4
NSEF 10-3	20	20	8.8	8.5	8.18	8.20	4
NSEF 10-4	20	20	8.8	8.0	8.18	8.19	2
NSEF 10-5	20	20	8.7	8.4	8.18	8.24	4
NSEF 50-1	20	20	8.9	8.0	8.17	8.26	4
NSEF 50-2	20	20	8.7	8.4	8.20	8.44	4
NSEF 50-3	20	20	8.7	8.2	8.22	8.35	4
NSEF 50-4	20	20	8.7	8.3	8.22	8.41	4
NSEF 50-5	20	20	8.7	8.5	8.23	8.20	3
NSEF 100-1	20	20	7.0	8.5	7.82	8.55	4
NSEF 100-2	20	20	6.9	8.1	7.81	8.35	4
NSEF 100-3	20	20	6.9	8.2	7.79	8.41	4
NSEF 100-4	20	20	7.0	8.0	7.79	8.53	4
NSEF 100-5	20	20	7.0	8.4	7.78	8.50	4
Control-1	20	20	8.4	8.0	8.10	8.19	4
Control-2	20	20	8.5	8.1	8.10	8.33	3
Control-3	20	20	8.5	8.6	8.11	8.30	4
Control-4	20	20	8.6	7.8	8.11	8.18	4
Control-5	20	20	8.6	8.3	8.12	8.13	4

Table A5

Acute Elutriate Bioassay - Survival and Water Quality Parameters in Unfiltered Site Water (SWU) and Controls

Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
SWU 0.1-1	20	20	8.8	8.0	8.11	8.32	4
SWU 0.1-2	20	20	8.7	8.0	8.11	8.31	4
SWU 0.1-3	20	20	8.7	8.0	8.10	8.33	4
SWU 0.1-4	20	20	8.8	8.4	8.10	8.43	4
SWU 0.1-5	20	20	8.8	8.0	8.10	8.32	4
SWU 1.0-1	20	20	8.7	8.0	8.10	8.28	4
SWU 1.0-2	20	20	8.6	8.3	8.09	8.49	4
SWU 1.0-3	20	20	8.7	8.4	8.10	8.44	4
SWU 1.0-4	20	20	8.7	8.1	8.11	8.27	3
SWU 1.0-5	20	20	8.8	8.0	8.12	8.32	4
SWU 10-1	20	20	8.9	8.3	8.10	8.43	4
SWU 10-2	20	20	8.8	8.3	8.11	8.37	4
SWU 10-3	20	20	8.8	8.4	8.12	8.45	4
SWU 10-4	20	20	8.8	8.0	8.13	8.30	4
SWU 10-5	20	20	8.8	8.2	8.14	8.33	4
SWU 50-1	20	20	8.9	8.5	8.09	8.52	4
SWU 50-2	20	20	8.8	8.1	8.11	8.35	4
SWU 50-3	20	20	8.8	8.5	8.13	8.49	4
SWU 50-4	20	20	8.8	8.4	8.13	8.40	4
SWU 50-5	20	20	8.9	8.4	8.14	8.46	4
SWU 100-1	20	20	8.9	8.4	8.09	8.57	4
SWU 100-2	20	20	8.9	8.1	8.09	8.40	4
SWU 100-3	20	20	8.9	8.6	8.10	8.46	4
SWU 100-4	20	20	8.9	8.3	8.10	8.43	4
SWU 100-5	20	20	8.9	8.5	8.11	8.46	4
Control-1	20	20	8.4	8.0	8.10	8.19	4
Control-2	20	20	8.5	8.1	8.10	8.33	3
Control-3	20	20	8.5	8.6	8.11	8.30	4
Control-4	20	20	8.6	7.8	8.11	8.18	4
Control-5	20	20	8.6	8.3	8.12	8.13	4

Table A6

Acute Elutriate Bioassay - Survival and Water Quality Parameters in Filtered Site Water (SWF) and Controls

Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
SWF 0.1-1	20	20	8.6	8.0	8.17	8.28	4
SWF 0.1-2	20	20	8.7	8.1	8.13	8.29	4
SWF 0.1-3	20	20	8.7	8.1	8.13	8.30	4
SWF 0.1-4	20	20	8.7	8.2	8.13	8.33	4
SWF 0.1-5	20	20	8.6	8.3	8.13	8.33	4
SWF 1.0-1	20	20	8.8	8.1	8.12	8.28	4
SWF 1.0-2	20	20	8.8	8.3	8.13	8.29	4
SWF 1.0-3	20	20	8.7	8.2	8.13	8.30	4
SWF 1.0-4	20	20	8.8	8.4	8.13	8.33	4
SWF 1.0-5	20	20	8.7	8.5	8.12	8.35	4
SWF 10-1	20	20	8.8	8.0	8.12	8.26	4
SWF 10-2	20	20	8.8	8.2	8.13	8.36	4
SWF 10-3	20	20	8.7	8.2	8.13	8.42	4
SWF 10-4	20	20	8.7	8.3	8.14	8.26	4
SWF 10-5	20	20	8.8	8.0	8.14	8.26	4
SWF 50-1	20	20	8.8	8.0	8.18	8.17	4
SWF 50-2	20	20	8.7	8.0	8.20	8.21	4
SWF 50-3	20	20	8.7	8.2	8.21	8.23	4
SWF 50-4	20	20	8.7	8.5	8.21	8.37	4
SWF 50-5	20	20	8.7	8.1	8.22	8.24	4
SWF 100-1	20	20	8.8	8.1	8.29	8.43	4
SWF 100-2	20	20	8.7	8.0	8.30	8.27	4
SWF 100-3	20	20	8.7	8.0	8.30	8.31	4
SWF 100-4	20	20	8.6	8.0	8.31	8.27	4
SWF 100-5	20	20	8.6	8.2	8.30	8.28	4
Control-1	20	20	8.4	8.0	8.10	8.19	4
Control-2	20	20	8.5	8.1	8.10	8.33	3
Control-3	20	20	8.5	8.6	8.11	8.30	4
Control-4	20	20	8.6	7.8	8.11	8.18	4
Control-5	20	20	8.6	8.3	8.12	8 13	4

Table A7

Acute Elutriate Bioassay - Measured Ammonia (NH_3) Levels in Unfiltered Quiver Island Elutriate (QIU) and Controls

	Time = 0 hr			Time = 48 hr		
Concentration	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
QIU 0.1-1	0.02	0.0520	0.0010	0.09	0.0766	0.0069
QIU 0.1-2	0.07	0.0498	0.0035	0.05	0.0734	0.0037
QIU 0.1-3	0.06	0.0531	0.0033	0.04	0.0750	0.0036
QIU 0.1-4	0.06	0.0520	0.0031	0.07	0.0689	0.0048
QIU 0.1-5	0.03	0.0543	0.0015	0.08	0.0704	0.0056
QIU 1.0-1	0.06	0.0543	0.0030	0.27	0.0799	0.0216
QIU 1.0-2	0.05	0.0555	0.0030	0.24	0.0926	0.0222
QIU 1.0-3	0.04	0.0567	0.0024	0.25	0.0870	0.0217
QIU 1.0-4	0.06	0.0580	0.0037	0.23	0.0852	0.0196
QIU 1.0-5	0.05	0.0567	0.0028	0.24	0.0907	0.0218
QIU 10-1	0.58	0.0543	0.0315	0.44	0.0750	0.0330
QIU 10-2	0.51	0.0520	0.0260	0.44	0.0783	0.0344
QIU 10-3	0.52	0.0520	0.0270	0.48	0.0834	0.0400
QIU 10-4	0.48	0.0543	0.0261	0.46	0.1071	0.0493
QIU 10-5	0.52	0.0531	0.0276	0.38	0.1007	0.0383
QIU 50-1	2.10	0.0365	0.0767	1.46	0.1162	0.1697
QIU 50-2	2.31	0.0374	0.0863	1.48	0.0986	0.1460
QIU 50-3	2.10	0.0365	0.0768	1.40	0.0766	0.1072
QIU 50-4	2.42	0.0357	0.0865	1.00	0.0852	0.0852
QIU 50-5	2.30	0.0357	0.0822	1.40	0.1162	0.1627
QIU 100-1	4.41	0.0244	0.1078	3.00	0.1049	0.3148
QIU 100-2	4.60	0.0250	0.1150	2.81	0.0704	0.1970
QIU 100-3	4.82	0.0244	0.1178	3.00	0.0986	0.2958
QIU 100-4	4.61	0.0250	0.1153	3.00	0.0618	0.1855
QIU 100-5	4.60	0.0239	0.1099	3.10	0.0605	0.1876
Control-1	0.03	0.0476	0.0014	0.09	0.0580	0.0052
Control-2	0.04	0.0476	0.0018	0.08	0.0783	0.0063
Control-3	0.03	0.0487	0.0017	0.06	0.0734	0.0044
Control-4	0.03	0.0487	0.0016	0.05	0.0567	0.0028
Control-5	0.04	0.0497	0.0018	0.05	0.0508	0.0025

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A8

Acute Elutriate Bioassay - Measured Ammonia (NH_3) Levels in Filtered Quiver Island Elutriate (QIF) and Controls

Concentration	Time = 0 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
QIF 0.1-1	0.05	0.0750	0.0039	0.04	0.0986	0.0040
QIF 0.1-2	0.03	0.0689	0.0021	0.05	0.0907	0.0045
QIF 0.1-3	0.03	0.0660	0.0020	0.04	0.0946	0.0038
QIF 0.1-4	0.02	0.0660	0.0013	0.05	0.0907	0.0047
QIF 0.1-5	0.03	0.0660	0.0020	0.05	0.0734	0.0035
QIF 1.0-1	0.13	0.0660	0.0059	0.06	0.0719	0.0044
QIF 1.0-2	0.04	0.0646	0.0026	0.05	0.0870	0.0042
QIF 1.0-3	0.78	0.0632	0.0493	0.04	0.0799	0.0030
QIF 1.0-4	0.05	0.0618	0.0049	0.04	0.0870	0.0034
QIF 1.0-5	0.05	0.0618	0.0031	0.03	0.0907	0.0029
QIF 10-1	0.40	0.0580	0.0232	0.27	0.0907	0.0100
QIF 10-2	0.42	0.0567	0.0238	0.24	0.0799	0.0078
QIF 10-3	0.38	0.0567	0.0216	0.25	0.0750	0.0090
QIF 10-4	0.40	0.0567	0.0227	0.23	0.0888	0.0085
QIF 10-5	0.38	0.0580	0.0220	0.24	0.0734	0.0066
QIF 50-1	0.13	0.0357	0.0046			
QIF 50-2	0.13	0.0350	0.0045	0.02	0.0766	0.0015
QIF 50-3	0.13	0.0350	0.0045	0.84	0.0674	0.0566
QIF 50-4	0.13	0.0357	0.0046	0.86	0.0799	0.0688
QIF 50-5	0.14	0.0334	0.0047	0.60	0.0783	0.0470
QIF 100-1	0.27	0.0234	0.0063	0.21	0.0646	0.0136
QIF 100-2	0.27	0.0234	0.0063	0.12	0.0870	0.0104
QIF 100-3	0.28	0.0228	0.0064	0.08	0.0632	0.0051
QIF 100-4	0.27	0.0218	0.0059	0.07	0.0799	0.0056
QIF 100-5	0.27	0.0223	0.0060	0.06	0.0734	0.0041
Control-1	0.03	0.0476	0.0014	0.09	0.0580	0.0052
Control-2	0.04	0.0476	0.0018	0.08	0.0783	0.0063
Control-3	0.03	0.0487	0.0017	0.06	0.0734	0.0044
Control-4	0.03	0.0487	0.0016	0.05	0.0567	0.0028
Control-5	0.04	0.0497	0.0018	0.05	0.0508	0.0025

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A9

Acute Elutriate Bioassay - Measured Ammonia (NH_3) Levels in Unfiltered Nearshore Environs Elutriate (NSEU) and Controls

Concentration	Time = 0 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
NSEU 0.1-1	0.02	0.0605	0.0012	0.10	0.1162	0.0116
NSEU 0.1-2	0.02	0.0618	0.0012	0.06	0.1162	0.0070
NSEU 0.1-3	0.01	0.0605	0.0006	0.07	0.0766	0.0054
NSEU 0.1-4	0.01	0.0605	0.0006	0.06	0.0734	0.0044
NSEU 0.1-5	0.03	0.0618	0.0019	0.09	0.0926	0.0083
NSEU 1.0-1	0.02	0.0646	0.0013	0.08	0.0870	0.0070
NSEU 1.0-2	0.02	0.0646	0.0013	0.06	0.0799	0.0048
NSEU 1.0-3	0.02	0.0646	0.0013	0.05	0.0907	0.0045
NSEU 1.0-4	0.03	0.0660	0.0020	0.04	0.0966	0.0039
NSEU 1.0-5	0.02	0.0660	0.0013	0.07	0.0766	0.0054
NSEU 10-1	0.09	0.0632	0.0057	0.12	0.0734	0.0088
NSEU 10-2	0.10	0.0618	0.0062	0.11	0.0870	0.0095
NSEU 10-3	0.09	0.0605	0.0054	0.16	0.0966	0.0154
NSEU 10-4	0.09	0.0605	0.0054	0.13	0.0852	0.0110
NSEU 10-5	0.09	0.0592	0.0053	0.13	0.1028	0.0134
NSEU 50-1	0.50	0.0618	0.0309	0.24	0.0907	0.0218
NSEU 50-2	0.50	0.0646	0.0323	0.34	0.0734	0.0250
NSEU 50-3	0.52	0.0646	0.0336	0.23	0.1116	0.0257
NSEU 50-4	0.50	0.0660	0.0323	0.36	0.0719	0.0259
NSEU 50-5	0.51	0.0674	0.0344	0.25	0.0907	0.0227
NSEU 100-1	1.50	0.0605	0.0908	0.60	0.1235	0.0741
NSEU 100-2	1.50	0.0632	0.0948	0.62	0.0986	0.0611
NSEU 100-3	1.50	0.0646	0.0968	0.52	0.1338	0.0696
NSEU 100-4	1.50	0.0646	0.0964	0.74	0.0852	0.0630
NSEU 100-5	1.50	0.0674	0.1011	0.82	0.0946	0.0775
Control-1	0.03	0.0476	0.0014	0.09	0.0580	0.0052
Control-2	0.04	0.0476	0.0018	0.08	0.0783	0.0063
Control-3	0.03	0.0487	0.0017	0.06	0.0734	0.0044
Control-4	0.03	0.0487	0.0016	0.05	0.0567	0.0028
Control-5	0.04	0.0497	0.0018	0.05	0.0508	0.0025

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A10

Acute Elutriate Bioassay - Measured Ammonia (NH_3) Levels in Filtered Nearshore Environs (NSEF) and Controls

Concentration	Time = 0 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
NSEF 0.1-1	0.02	0.0750	0.0015	0.06	0.0605	0.0037
NSEF 0.1-2	0.03	0.0689	0.0021	0.06	0.0766	0.0043
NSEF 0.1-3	0.03	0.0660	0.0020	0.04	0.0816	0.0034
NSEF 0.1-4	0.03	0.0660	0.0020	0.04	0.0783	0.0028
NSEF 0.1-5	0.03	0.0646	0.0019	0.04	0.1007	0.0037
NSEF 1.0-1	0.03	0.0646	0.0019	0.04	0.0567	0.0022
NSEF 1.0-2	0.02	0.0646	0.0013	0.04	0.0580	0.0025
NSEF 1.0-3	0.03	0.0646	0.0019	0.06	0.0734	0.0041
NSEF 1.0-4	0.03	0.0646	0.0019	0.04	0.0580	0.0024
NSEF 1.0-5	0.03	0.0646	0.0019	0.04	0.0580	0.0024
NSEF 10-1	0.13	0.0592	0.0077	0.09	0.0498	0.0045
NSEF 10-2	0.10	0.0580	0.0058	0.09	0.0704	0.0063
NSEF 10-3	0.02	0.0567	0.0011	0.13	0.0592	0.0077
NSEF 10-4	0.02	0.0567	0.0011	0.07	0.0580	0.0043
NSEF 10-5	0.12	0.0567	0.0068	0.07	0.0646	0.0044
NSEF 50-1	0.54	0.0555	0.0300	0.50	0.0674	0.0337
NSEF 50-2	0.54	0.0592	0.0320	0.52	0.0986	0.0513
NSEF 50-3	0.54	0.0618	0.0334	0.50	0.0816	0.0408
NSEF 50-4	0.56	0.0618	0.0346	0.52	0.0926	0.0482
NSEF 50-5	0.54	0.0632	0.0341	0.56	0.0592	0.0332
NSEF 100-1	0.92	0.0256	0.0235	0.92	0.1235	0.1136
NSEF 100-2	0.92	0.0254	0.0230	0.92	0.0816	0.0751
NSEF 100-3	0.94	0.0239	0.0225	0.94	0.0926	0.0871
NSEF 100-4	0.92	0.0239	0.0220	0.92	0.1186	0.1091
NSEF 100-5	0.94	0.0234	0.0220	0.94	0.1116	0.1049
Control-1	0.03	0.0476	0.0014	0.09	0.0580	0.0052
Control-2	0.04	0.0476	0.0018	0.08	0.0783	0.0063
Control-3	0.03	0.0487	0.0017	0.06	0.0734	0.0044
Control-4	0.03	0.0487	0.0016	0.05	0.0567	0.0028
Control-5	0.04	0.0497	0.0018	0.05	0.0508	0.0025

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A11

Acute Elutriate Bioassay - Measured Ammonia (NH_3) Levels in Unfiltered Site Water (SWU) and Controls

Concentration	Time = 0 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
SWU 0.1-1	0.02	0.0487	0.0010	0.07	0.0766	0.0050
SWU 0.1-2	0.04	0.0487	0.0019	0.06	0.0750	0.0045
SWU 0.1-3	0.02	0.0476	0.0009	0.06	0.0783	0.0045
SWU 0.1-4	0.10	0.0476	0.0005	0.07	0.0966	0.0096
SWU 0.1-5	0.01	0.0476	0.0005	0.07	0.0966	0.0070
SWU 1.0-1	0.04	0.0476	0.0019	0.07	0.0704	0.0049
SWU 1.0-2	0.05	0.0466	0.0023	0.05	0.1093	0.0055
SWU 1.0-3	0.02	0.0476	0.0010	0.06	0.0986	0.0061
SWU 1.0-4	0.01	0.0487	0.0005	0.06	0.0689	0.0041
SWU 1.0-5	0.01	0.0498	0.0005	0.06	0.0766	0.0047
SWU 10-1	0.04	0.0476	0.0019	0.05	0.0966	0.0050
SWU 10-2	0.02	0.0487	0.0010	0.05	0.0852	0.0044
SWU 10-3	0.02	0.0498	0.0010	0.04	0.1007	0.0036
SWU 10-4	0.02	0.0508	0.0010	0.05	0.0734	0.0040
SWU 10-5	0.04	0.0520	0.0021	0.08	0.0783	0.0060
SWU 50-1	0.02	0.0466	0.0009	0.10	0.1162	0.0116
SWU 50-2	0.09	0.0487	0.0044	0.10	0.0816	0.0082
SWU 50-3	0.07	0.0508	0.0035	0.10	0.1093	0.0109
SWU 50-4	0.02	0.0508	0.0010	0.10	0.0907	0.0091
SWU 50-5	0.01	0.0520	0.0005	0.10	0.1028	0.0103
SWU 100-1	0.06	0.0466	0.0028	0.10	0.1286	0.0129
SWU 100-2	0.07	0.0466	0.0033	0.10	0.0907	0.0091
SWU 100-3	0.07	0.0476	0.0033	0.10	0.1028	0.0103
SWU 100-4	0.07	0.0476	0.0033	0.10	0.0966	0.0097
SWU 100-5	0.03	0.0487	0.0015	0.10	0.1028	0.0103
Control-1	0.03	0.0476	0.0014	0.09	0.0580	0.0052
Control-2	0.04	0.0476	0.0018	0.08	0.0783	0.0063
Control-3	0.03	0.0487	0.0017	0.06	0.0734	0.0044
Control-4	0.03	0.0487	0.0016	0.05	0.0567	0.0028
Control-5	0.04	0.0497	0.0018	0.05	0.0508	0.0025

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A12

Acute Elutriate Bioassay - Measured Ammonia (NH_3) Levels in Site Water Filtered Elutriate (SWF) and Controls

Concentration	Time = 0 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
SWF 0.1-1	0.03	0.0508	0.0014	0.06	0.0704	0.0042
SWF 0.1-2	0.02	0.0508	0.0010	0.06	0.0719	0.0043
SWF 0.1-3	0.02	0.0508	0.0010	0.04	0.0734	0.0029
SWF 0.1-4	0.03	0.0508	0.0015	0.07	0.0783	0.0055
SWF 0.1-5	0.03	0.0508	0.0015	0.08	0.0783	0.0063
SWF 1.0-1	0.04	0.0498	0.0020	0.07	0.0704	0.0049
SWF 1.0-2	0.02	0.0508	0.0010	0.05	0.0719	0.0036
SWF 1.0-3	0.04	0.0508	0.0020	0.06	0.0734	0.0044
SWF 1.0-4	0.03	0.0508	0.0015	0.04	0.0783	0.0031
SWF 1.0-5	0.06	0.0498	0.0030	0.04	0.0817	0.0033
SWF 10-1	0.03	0.0498	0.0015	0.09	0.0674	0.0061
SWF 10-2	0.04	0.0508	0.0020	0.06	0.0834	0.0050
SWF 10-3	0.04	0.0508	0.0020	0.03	0.0946	0.0028
SWF 10-4	0.03	0.0520	0.0015	0.04	0.0766	0.0030
SWF 10-5	0.03	0.0520	0.0015	0.10	0.0674	0.0067
SWF 50-1	0.07	0.0567	0.0040	0.08	0.0555	0.0047
SWF 50-2	0.08	0.0592	0.0048	0.12	0.0605	0.0073
SWF 50-3	0.11	0.0605	0.0066	0.12	0.0632	0.0076
SWF 50-4	0.09	0.0605	0.0054	0.08	0.0852	0.0066
SWF 50-5	0.09	0.0618	0.0055	0.12	0.0645	0.0077
SWF 100-1	0.02	0.0719	0.0014	0.12	0.0966	0.0116
SWF 100-2	0.02	0.0734	0.0014	0.24	0.0689	0.0165
SWF 100-3	0.02	0.0734	0.0015	0.16	0.0750	0.0120
SWF 100-4	0.02	0.0750	0.0015	0.17	0.0689	0.0117
SWF 100-5	0.02	0.0750	0.0015	0.19	0.0704	0.0133
Control-1	0.03	0.0476	0.0014	0.09	0.0580	0.0052
Control-2	0.04	0.0476	0.0018	0.08	0.0783	0.0063
Control-3	0.03	0.0487	0.0017	0.06	0.0734	0.0044
Control-4	0.03	0.0487	0.0016	0.05	0.0567	0.0028
Control-5	0.04	0.0497	0.0018	0.05	0.0508	0.0025

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A13

Acute Elutriate Bioassays - Total Suspended Solids in Unfiltered and Filtered Site Water and Controls

Concentration	Rep*	Total Suspended Solids mg/ℓ Time - 0 hr	Time - 48 hr
		Unfiltered	
0.1%	1	0.844	0.400
	2	0.820	0.311
	3	0.862	0.353
1.0%	1	2.40	1.11
	2	2.00	0.998
	3	2.14	0.780
10.0%	1	3.32	1.16
	2	3.24	1.11
	3	3.22	0.92
50.0%	1	4.62	1.75
	2	4.52	1.88
	3	4.68	1.92
100.0%	1	7.22	3.89
	2	7.26	3.86
	3	7.47	3.78
		Filtered	
100.0%	1	<0.01	<0.01
	2	<0.01	<0.01
	3	<0.01	<0.01
		Controls	
	1	<0.01	<0.01
	2	<0.01	<0.01
	3	<0.01	<0.01

* Composite samples.

Table A14

Acute Elutriate Bioassays - Hardness Measurements for Controls

Concentration	Rep*	Hardness** Time - 0 hr	Time - 48 hr
Control	1	180	188
Control	2	179	186
Control	3	180	190

* Composite samples.
** Hardness expressed as milligrams equivalent $CaCO_3/\ell$.

Table A15

Ammonia Toxicity Test - Water Quality Parameters

in the Ammonia Toxicity Test

Nominal Concentration	Temperature °C		Dissolved Oxygen mg/ℓ		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
0.01-1	20	20	8.2	8.3	8.47	8.51	4
0.01-2	20	20	8.3	8.6	8.51	8.49	4
0.01-3	20	20	8.1	8.0	8.47	8.48	4
0.01-4	21	20	8.3	8.5	8.44	8.44	3
0.01-5	20	20	8.2	8.7	8.40	8.40	4
0.10-1	20	20	8.2	8.5	8.44	8.41	4
0.10-2	20	20	8.1	8.0	8.48	8.36	4
0.10-3	20	20	8.1	8.4	8.42	8.35	4
0.10-4	20	20	8.2	8.5	8.43	8.38	4
0.10-5	20	20	8.1	8.1	8.41	8.41	4
1.0-1	20	20	8.3	8.2	8.36	8.41	4
1.0-2	20	20	8.1	8.9	8.37	8.36	4
1.0-3	20	20	8.0	8.5	8.38	8.35	4
1.0-4	20	20	8.1	8.0	8.38	8.38	4
1.0-5	20	20	8.2	8.1	8.40	8.41	4
10.0-1	20	20	8.2	8.5	8.32	8.27	4
10.0-2	20	20	8.1	8.8	8.28	8.32	4
10.0-3	21	20	8.0	8.4	8.29	8.31	4
10.0-4	20	20	8.1	8.5	8.31	8.35	4
10.0-5	20	20	8.1	8.1	8.37	8.36	4
100.0-1	20	20	8.2	8.0	8.33	8.31	4
100.0-2	20	20	8.0	8.4	8.34	8.31	4
100.0-3	20	20	8.0	8.2	8.31	8.30	4
100.0-4	21	20	8.0	8.6	8.24	8.22	4
100.0-5	20	20	8.1	8.1	8.27	8.27	4

Table A16

Ammonia Toxicity Test - Measured (Total and Un-ionized) Ammonia

Concentration		Time = 0 hr			Time = 48 hr		
		NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
0.01	1	0.02	0.1049	0.0021			
	2	0.03	0.1139	0.0030	0.06	0.1093	0.0063
	3	0.02	0.1049	0.0023	0.10	0.1071	0.0105
	4	0.02	0.0986	0.0020	0.08	0.0986	0.0079
	5	0.03	0.0907	0.0022	0.01	0.0907	0.0109
0.1	1	0.04	0.0986	0.0035	0.11	0.0926	0.0102
	2	0.04	0.1071	0.0041	0.09	0.0834	0.0075
	3	0.04	0.0946	0.0037	0.13	0.0817	0.0162
	4	0.04	0.0966	0.0037	0.07	0.0870	0.0064
	5	0.03	0.0926	0.0032	0.19	0.0926	0.0176
1.0	1	0.35	0.0834	0.0292	0.35	0.0926	0.0324
	2	0.29	0.0852	0.0247	0.29	0.0834	0.0242
	3	0.36	0.0870	0.0313	0.36	0.0817	0.0294
	4	0.34	0.0870	0.0296	0.34	0.0870	0.0296
	5	0.33	0.0907	0.0299	0.33	0.0926	0.0306
10.0	1	1.1	0.0766	0.0843	0.82	0.0689	0.0565
	2	1.2	0.0704	0.0844	0.86	0.0766	0.0659
	3	1.4	0.0719	0.1006	0.86	0.0751	0.0645
	4	1.0	0.0750	0.0750	0.84	0.0817	0.0686
	5	1.0	0.0852	0.0852	0.86	0.0834	0.0717
100.0	1	0.99	0.0688	0.0682	0.94	0.0750	0.0705
	2	0.97	0.0782	0.0759	0.96	0.0750	0.0720
	3	0.96	0.0760	0.0767	0.88	0.0734	0.0646
	4	0.98	0.0750	0.0735	0.72	0.0618	0.0445
	5	0.98	0.0645	0.0633	0.82	0.0689	0.0565

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table A17

Cadmium Chloride Reference Toxicant Test - Water Quality Parameters and Survival, CD^{++} in $\mu g/\ell$

Nominal Concentration	Temperature °C		Dissolved Oxygen		pH		Number Alive
	Time, hr						
	0	48	0	48	0	48	48
0.1-1	20	20	8.1	8.4	8.37	8.41	4
0.1-2	20	20	8.1	8.6	8.40	8.42	4
0.1-3	20	20	8.2	8.8	8.41	8.43	4
0.1-4	20	20	8.2	8.7	8.37	8.36	4
0.1-5	20	20	8.2	8.9	8.37	8.37	3
1.0-1	20	20	8.1	8.1	8.39	8.35	4
1.0-2	20	20	8.1	8.4	8.33	8.34	4
1.0-3	20	20	8.2	8.6	8.34	8.34	4
1.0-4	20	20	8.0	8.0	8.37	8.31	4
1.0-5	20	20	8.3	8.3	8.34	8.36	4
10-1	20	20	8.2	8.5	8.34	8.33	4
10-2	20	20	8.0	8.0	8.37	8.34	4
10-3	20	20	8.2	8.4	8.35	8.33	4
10-4	20	20	8.2	8.8	8.37	8.33	4
10-5	20	20	8.1	8.1	8.32	8.34	4
100-1	20	20	8.1	8.0	8.30	8.25	3
100-2	20	20	8.1	8.2	8.27	8.25	2
100-3	20	20	8.1	8.6	8.25	8.26	3
100-4	20	20	8.0	8.7	8.24	8.25	2
100-5	20	20	8.0	8.5	8.26	8.25	3
1,000-1	20	21	8.0	8.2	8.30	8.32	0
1,000-2	20	20	8.0	8.8	8.31	8.33	0
1,000-3	20	20	8.1	8.5	8.34	8.33	0
1,000-4	20	20	8.1	8.7	8.29	8.31	0
1,000-5	20	20	8.1	8.0	8.30	8.31	0

Table A18

Cadmium Chloride Reference Toxicant Test -

Measured Cd++ (μg/ℓ) at 48 hr

Nominal Concentration	Rep	Cd++*
0.1	1	0.10
	2	0.10
	3	0.11
1.0	1	1.2
	2	1.1
	3	1.0
10.0	1	9.8
	2	9.0
	3	9.8
100.0	1	98
	2	100
	3	98
1,000.0	1	966
	2	988
	3	1,000

* Each of the three cadmium samples analyzed were composited from all five replicates.

APPENDIX B: RAW DATA FOR ACUTE BIOASSAYS WITH *PIMEPHALES PROMELAS*

Table B1

Acute Elutriate Bioassay - Water Quality Parameters and Survival in Quiver Island Unfiltered Elutriates and Controls

Percent Elutriate	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
6	20	21	20	7.6	7.8	7.8	8.34	8.35	8.36	3
	20	20	20	7.8	7.7	7.7	8.38	8.41	8.39	3
	20	20	20	7.9	7.9	7.9	8.40	8.44	8.42	3
	20	20	20	7.8	7.9	7.9	8.40	8.42	8.38	3
	20	20	20	7.7	7.8	7.8	8.44	8.47	8.46	2
12	20	20	20	7.9	7.9	7.8	8.38	8.38	8.36	1
	20	21	20	7.8	7.8	7.8	8.42	8.46	8.44	1
	20	20	20	7.8	7.8	7.8	8.42	8.47	8.44	3
	20	20	21	7.8	7.8	7.7	8.44	8.46	8.45	2
	20	20	20	7.6	7.7	7.7	8.44	8.47	8.46	0
25	20	20	20	7.8	7.8	7.8	8.44	8.49	8.47	1
	20	20	21	7.8	7.9	7.8	8.50	8.48	8.47	2
	20	20	21	7.8	7.8	7.8	8.45	8.45	8.43	4
	20	20	20	7.8	7.8	7.8	8.34	8.38	8.36	2
	20	20	20	7.8	7.8	7.7	8.42	8.45	8.42	1
50	20	20	20	7.8	7.8	7.7	8.42	8.46	8.44	3
	20	21	20	7.8	7.8	7.8	8.54	8.56	8.53	2
	20	20	20	7.9	7.9	7.9	8.52	8.54	8.56	1
	21	20	20	7.8	7.9	7.9	8.56	8.59	8.58	3
	20	20	21	7.8	7.9	7.9	8.58	8.58	8.58	2
100	20	21	20	7.8	7.8	7.7	8.52	8.58	8.55	0
	20	20	21	7.6	7.8	7.7	8.65	8.67	8.66	0
	20	20	21	7.7	7.8	7.8	8.66	8.64	8.65	0
	21	21	20	7.5	7.7	7.6	8.65	8.66	8.66	0
	20	20	21	7.2	7.5	7.4	8.65	8.66	8.65	0
Control										
1	20	20	20	7.8	7.7	7.8	8.32	8.30	8.32	3
2	20	20	20	7.9	7.9	7.9	8.32	8.38	8.38	4
3	20	20	20	7.8	7.9	7.9	8.31	8.30	8.31	4
4	20	21	20	7.9	7.9	7.9	8.30	8.31	8.31	4
5	20	20	20	7.9	7.9	7.9	8.30	8.30	8.30	4

Table B2

Acute Elutriate Bioassay - Water Quality Parameters and Survival in Quiver Island Filtered Elutriates and Controls

Percent Elutriate	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
6-1	20	20	20	7.7	7.8	7.9	8.44	8.47	8.46	4
6-2	20	21	20	7.9	7.9	8.0	8.46	8.49	8.48	4
6-3	20	21	20	7.9	7.9	7.9	8.40	8.38	8.36	3
6-4	20	21	20	7.8	7.9	7.8	8.38	8.39	8.38	4
6-5	20	20	20	7.8	7.9	7.9	8.46	8.48	8.48	3
12-1	21	20	20	7.8	7.8	7.9	8.36	8.36	8.34	2
12-2	20	20	20	7.7	7.8	7.9	8.34	8.36	8.32	1
12-3	20	21	20	7.9	7.8	7.9	8.36	8.37	8.36	3
12-4	20	21	20	7.8	7.9	7.8	8.40	8.40	8.42	3
12-5	20	21	20	7.8	7.8	7.9	8.40	8.42	8.43	4
25-1	20	20	20	7.8	7.8	7.8	8.44	8.47	8.48	4
25-2	20	20	20	7.6	7.6	7.5	8.46	8.47	8.48	1
25-3	20	20	20	7.8	7.8	7.9	8.46	8.46	8.46	2
25-4	20	20	20	7.9	7.9	8.0	8.44	8.44	8.47	1
25-5	20	21	20	7.9	7.8	7.9	8.48	8.48	8.51	2
50-1	20	20	20	7.8	7.8	7.8	8.46	8.44	8.44	3
50-2	21	20	20	7.8	7.8	7.8	8.48	8.49	8.49	4
50-3	20	20	20	7.8	7.8	7.9	8.47	8.88	8.47	3
50-4	20	20	20	7.8	7.8	7.7	8.44	8.45	8.44	0
50-5	20	20	20	7.8	7.7	7.8	8.48	8.49	8.49	1
100-1	20	21	20	7.7	7.8	7.8	8.60	8.62	8.61	0
100-2	20	20	20	7.8	7.9	7.8	8.60	8.61	8.60	0
100-3	20	20	20	7.8	7.8	7.8	8.61	8.60	8.63	0
100-4	20	20	20	7.8	7.9	7.8	8.60	8.63	8.67	0
100-5	20	20	20	7.8	7.7	7.6	8.64	8.65	8.65	0
Control										
1	20	20	20	7.8	7.7	7.8	8.32	8.30	8.32	3
2	20	20	20	7.9	7.9	7.9	8.32	8.38	8.38	4
3	20	20	20	7.8	7.9	7.9	8.31	8.30	8.31	4
4	20	21	20	7.9	7.9	7.9	8.30	8.31	8.31	4
5	20	20	20	7.9	7.9	7.9	8.30	8.30	8.30	4

Table B3

Acute Elutriate Bioassay - Water Quality Parameters and Survival in Nearshore Environs Unfiltered Elutriates and Controls

Percent Elutriate	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
6	21	20	20	7.9	8.0	8.0	8.34	8.34	8.35	3
	20	21	20	7.9	7.9	7.9	8.38	8.37	8.35	4
	20	20	20	7.9	7.8	7.7	8.33	8.35	8.36	1
	20	21	20	7.8	7.8	7.8	8.36	8.38	8.38	1
	20	20	21	7.8	7.8	7.9	8.36	8.37	8.38	3
12	20	21	20	8.1	8.0	8.0	8.39	8.40	8.41	2
	20	20	20	7.8	7.9	7.9	8.35	8.40	8.39	1
	20	20	21	7.9	7.9	8.0	8.36	8.35	8.35	3
	20	20	20	7.8	7.8	7.8	8.40	8.37	8.33	3
	20	20	20	7.9	7.8	7.8	8.31	8.31	8.29	3
25	20	21	20	7.8	7.8	8.0	8.29	8.29	8.33	3
	20	20	20	7.6	7.7	7.9	8.33	8.33	8.35	3
	21	20	20	7.8	7.8	8.0	8.36	8.38	8.39	3
	20	20	20	7.8	7.8	7.9	8.32	8.31	8.29	3
	20	20	20	7.8	7.8	7.7	8.31	8.31	8.33	4
50	20	21	20	7.8	7.9	7.8	8.38	8.37	8.37	3
	21	20	21	7.9	7.8	7.8	8.44	8.41	8.39	3
	20	20	20	7.8	7.8	7.8	8.43	8.42	8.44	3
	20	20	21	7.8	7.8	7.8	8.41	8.41	8.42	3
	20	21	20	7.8	7.7	7.7	8.38	8.37	8.37	2
100	20	20	20	7.7	7.7	7.8	8.38	8.37	8.37	3
	20	20	20	7.6	7.7	7.7	8.37	8.38	8.39	4
	20	21	20	7.5	7.8	7.8	8.40	8.42	8.44	4
	20	20	20	7.7	7.8	7.7	8.42	8.43	8.42	4
	20	21	20	7.7	7.5	7.0	8.41	8.32	8.32	3
Control										
1	20	20	20	7.8	7.7	7.8	8.32	8.30	8.32	3
2	20	20	20	7.9	7.9	7.9	8.32	8.38	8.38	4
3	20	20	20	7.8	7.9	7.9	8.31	8.30	8.31	4
4	20	21	20	7.9	7.9	7.9	8.30	8.31	8.31	4
5	20	20	20	7.9	7.9	7.9	8.30	8.30	8.30	4

Table B4

Acute Elutriate Bioassay - Water Quality Parameters

and Survival in Nearshore Environs

Filtered Elutriates

Percent Elutriate	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
6	20	20	20	7.9	8.0	8.0	8.31	8.29	8.29	4
	20	20	20	7.9	7.9	7.8	8.40	8.40	8.39	4
	21	21	20	7.9	7.8	7.8	8.30	8.29	8.26	4
	20	21	20	7.8	7.8	7.8	8.33	8.32	8.33	4
	20	21	21	7.8	7.8	7.9	8.30	3.31	8.31	3
12	20	20	20	8.1	8.0	8.0	8.36	8.30	8.30	3
	20	20	20	7.8	7.9	7.9	8.34	8.34	8.38	3
	20	20	21	7.9	8.0	8.0	8.36	8.35	8.34	4
	20	20	20	7.8	7.8	7.8	8.40	8.37	8.39	4
	20	20	21	7.9	7.8	7.8	8.40	8.39	8.38	2
25	20	20	20	7.8	7.9	8.0	8.25	8.27	8.26	4
	20	20	20	7.6	7.8	7.9	8.29	8.28	8.28	2
	20	20	20	7.8	7.9	8.0	8.27	8.28	8.29	4
	20	20	20	7.8	7.9	7.9	8.30	8.29	8.30	4
	20	20	20	7.8	7.7	7.7	8.29	8.29	8.29	2
50	20	20	20	7.8	7.8	7.8	8.38	8.37	8.39	4
	20	20	20	7.9	7.8	7.8	8.44	8.38	8.39	4
	20	20	20	7.9	7.9	7.9	8.47	8.37	8.38	2
	21	20	20	7.8	7.8	7.7	8.40	8.37	8.37	1
	20	20	20	7.9	7.8	7.8	8.46	8.43	8.42	4
100	20	20	20	7.9	7.9	7.9	8.38	8.35	8.35	3
	20	20	20	7.8	7.9	7.9	8.40	8.39	8.38	1
	20	20	20	7.9	7.8	7.7	8.41	8.42	8.42	0
	20	20	20	7.9	7.8	7.8	8.40	8.41	8.40	3
	20	20	20	7.6	7.8	7.6	8.44	8.44	8.42	1
Control										
1	20	20	20	7.8	7.7	7.8	8.32	8.30	8.32	3
2	20	20	20	7.9	7.9	7.9	8.32	8.38	8.38	4
3	20	20	20	7.8	7.9	7.9	8.31	8.30	8.31	4
4	20	21	20	7.9	7.9	7.9	8.30	8.31	8.31	4
5	20	20	20	7.9	7.9	7.9	8.30	8.30	8.30	4

Table B5

Acute Site Water Bioassay - Water Quality Parameters and Survival in Unfiltered Site Water and Controls

Percent Elutriate	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
6	20	20	20	7.9	7.8	7.8	8.40	8.40	8.41	3
	20	20	20	7.8	7.9	7.9	8.39	8.39	8.38	4
	20	21	20	7.8	7.8	7.9	8.37	8.38	8.40	4
	21	21	20	7.8	7.9	7.8	8.39	8.39	8.40	4
	20	21	21	7.7	7.8	7.8	8.38	8.37	8.36	4
12	20	21	20	7.9	7.9	7.8	8.42	8.41	8.40	4
	20	20	20	7.9	7.8	7.9	8.39	8.38	8.37	4
	20	20	21	7.9	7.9	7.9	8.37	8.38	8.38	4
	20	20	20	7.9	7.9	7.9	8.35	8.37	8.37	4
	20	20	21	7.9	7.8	7.8	8.37	8.36	8.36	3
25	20	20	20	7.9	7.8	7.8	8.37	8.38	8.37	3
	20	20	20	7.9	7.8	7.9	8.40	8.38	8.36	4
	20	20	21	7.8	7.8	7.8	8.31	8.36	8.37	4
	20	20	20	7.9	7.8	7.9	8.38	8.35	8.36	3
	20	20	20	7.8	7.9	7.8	8.36	8.39	8.40	4
50	20	20	20	7.8	7.9	7.8	8.36	8.40	8.43	4
	20	20	20	7.8	7.8	7.9	8.39	8.41	8.42	4
	20	20	20	7.9	7.9	7.8	8.39	8.40	8.40	4
	20	21	20	7.8	7.8	7.8	8.43	8.40	8.37	4
	20	20	20	7.8	7.8	7.8	8.42	8.40	8.37	3
100	21	20	20	7.9	7.8	7.8	8.38	8.38	8.39	4
	20	20	20	7.8	7.8	7.8	8.44	8.42	8.40	4
	20	20	20	7.9	7.9	7.9	8.42	8.40	8.36	4
	20	20	20	7.7	7.8	7.9	8.35	8.32	8.30	3
	20	20	20	7.6	7.7	7.8	8.40	8.35	8.37	4
Control										
1	20	20	20	7.8	7.7	7.8	8.32	8.30	8.32	3
2	20	20	20	7.9	7.9	7.9	8.32	8.38	8.38	4
3	20	20	20	7.8	7.9	7.9	8.31	8.30	8.31	4
4	20	21	20	7.9	7.9	7.9	8.30	8.31	8.31	4
5	20	20	20	7.9	7.9	7.9	8.30	8.30	8.30	4

Table B6

Acute Site Water Bioassay - Water Quality Parameters and Survival in Filtered Site Water and Controls

Percent Elutriate	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
6	20	20	20	7.9	7.8	7.8	8.31	8.32	8.33	4
	20	20	20	7.9	7.8	7.8	8.38	8.36	8.36	4
	21	20	20	7.8	7.8	7.6	8.27	8.24	8.23	4
	21	20	20	7.8	7.7	7.5	8.31	8.30	8.26	4
	21	20	21	7.8	7.7	7.7	8.30	8.30	8.29	4
12	20	20	20	7.9	7.8	7.8	8.28	8.27	8.27	4
	20	20	20	7.8	7.8	7.8	8.28	8.28	8.29	3
	20	20	21	7.8	7.9	7.9	8.28	8.28	8.28	4
	20	20	20	7.9	7.9	7.7	8.31	8.28	8.28	4
	20	20	21	7.9	7.9	7.8	8.32	8.30	8.27	3
25	20	20	20	7.9	7.8	7.8	8.25	8.39	8.40	4
	20	20	20	7.8	7.9	8.0	8.29	8.33	8.42	4
	20	20	20	7.8	7.9	8.0	8.27	8.33	8.39	3
	20	20	20	7.9	7.9	7.8	8.30	8.38	8.41	3
	20	20	20	7.8	7.8	7.8	8.29	8.38	8.40	4
50	20	20	20	7.8	7.8	7.8	8.34	8.32	8.30	4
	20	20	20	7.9	7.9	7.9	8.38	8.35	8.33	3
	20	20	20	7.9	7.9	8.0	8.39	8.36	8.37	4
	20	20	20	7.8	7.8	7.9	8.41	8.40	8.38	3
	20	20	20	7.9	7.9	7.8	8.40	8.40	8.37	3
100	21	21	20	7.9	7.8	7.9	8.38	8.40	8.42	3
	20	20	20	7.8	7.9	8.0	8.40	8.41	8.41	3
	20	20	20	7.9	7.9	8.0	8.41	8.42	8.43	4
	20	20	20	7.7	7.8	7.8	8.40	8.44	8.46	4
	20	20	20	7.6	7.7	7.9	8.44	8.45	8.48	3
Control										
1	20	20	20	7.8	7.7	7.8	8.32	8.30	8.32	3
2	20	20	20	7.9	7.9	7.9	8.32	8.38	8.38	4
3	20	20	20	7.8	7.9	7.9	8.31	8.30	8.31	4
4	20	21	20	7.9	7.9	7.9	8.30	8.31	8.31	4
5	20	20	20	7.9	7.9	7.9	8.30	8.30	8.30	4

Table B7

Acute Elutriate Bioassay - Measured Ammonia (Total and Un-ionized) Levels in Composite Samples from Controls and Filtered (QIF) and Unfiltered (QIU) Quiver Island Elutriates

	Time = 0 hr			Time = 24 hr			Time = 48 hr		
Concentration	NH_3 mg/ℓ	F_u*	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
Control	0.01	0.0750	0.0011	0.03	0.0763	0.0021	0.02	0.0783	0.0016
QIU 6	0.72	0.0892	0.0642	0.74	0.0942	0.0697	0.68	0.0911	0.0619
QIU 12	1.3	0.0946	0.1230	1.3	0.1003	0.1303	1.4	0.0966	0.1352
QIU 25	2.5	0.0966	0.2145	2.6	0.1007	0.2618	2.3	0.0966	0.2221
QIU 50	5.0	0.1172	0.5859	4.8	0.1225	0.5881	4.7	0.1206	0.5666
QIU 100	10.0	0.1437	1.4375	9.4	0.1483	1.3944	9.6	0.1460	1.4019
QIF 6	0.68	0.0962	0.0654	0.64	0.0986	0.0631	0.42	0.0970	0.0407
QIF 12	0.24	0.0855	0.0205	0.22	0.0874	0.0192	0.14	0.0859	0.0120
QIF 25	0.36	0.1019	0.0367	0.26	0.1036	0.0269	0.20	0.1071	0.0214
QIF 50	0.50	0.1041	0.0520	0.44	0.1049	0.0462	0.38	1.1041	0.0395
QIF 100	0.92	0.1393	0.1281	0.63	0.1426	0.0898	0.66	0.1455	0.0960

Note: Five replicates per treatment.
* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table B8

Acute Elutriate Bioassay - Measured Ammonia (Total and Un-ionized) Levels in Composite Samples from Controls and Filtered (NSEF) and Unfiltered (NSEU) Nearshore Environs Elutriates

Concentration	Time = 0 hr			Time = 24 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
Control	0.01	0.0750	0.0011	0.03	0.0763	0.0021	0.02	0.0783	0.0016
NSEU 6	0.25	0.0824	0.0206	0.22	0.0838	0.0184	0.18	0.0841	0.0151
NSEU 12	0.27	0.0838	0.0226	0.25	0.0845	0.0211	0.28	0.0824	0.0231
NSEU 25	0.48	0.0770	0.0369	0.30	0.0773	0.0232	0.05	0.0796	0.0040
NSEU 50				0.76	0.0900	0.0684	0.66	0.0903	0.0596
NSEU 100	1.5	0.0900	0.1349	1.4	0.0877	0.1228	1.3	0.0885	0.1150
NSEF 6	0.09	0.0779	0.0066	0.09	0.0770	0.0069	0.08	0.0760	0.0061
NSEF 12	0.25	0.0855	0.0214	0.23	0.0817	0.0188	0.25	0.0831	0.0208
NSEF 25	0.30	0.0704	0.0211	0.28	0.0707	0.0198	0.30	0.0710	0.0213
NSEF 50	0.76	0.0966	0.0734	0.74	0.0877	0.0649	0.72	0.0888	0.0640
NSEF 100	1.9	0.0919	0.1773	1.7	0.0911	0.1549	1.8	0.0896	0.1630

Note: Five replicates per treatment.

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table B9

Acute Elutriate Bioassay - Measured Ammonia (Total and Un-ionized) Levels in Composite Samples from Controls and Filtered (SWF) and Unfiltered (SWU) Site Water

Concentration	Time = 0 hr			Time = 24 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
Control	0.01	0.0750	0.0011	0.03	0.0763	0.0021	0.02	0.0783	0.0016
SWU 6	0.01	0.0881	0.0012	0.02	0.0881	0.0018	0.02	0.0888	0.0020
SWU 12	0.05	0.0870	0.0047	0.04	0.0870	0.0035	0.02	0.0863	0.0021
SWU 25	0.06	0.0841	0.0047	0.04	0.0855	0.0034	0.02	0.0855	0.0017
SWU 50	0.13	0.0903	0.0117	0.08	0.0911	0.0073	0.02	0.0903	0.0022
SWU 100	0.30	0.0900	0.0270	0.16	0.0859	0.0137	0.03	0.0841	0.0021
SWF 6	0.02	0.0757	0.0015	0.02	0.0741	0.0015	0.02	0.0725	0.0014
SWF 12	0.04	0.0725	0.0028	0.04	0.0707	0.0028	0.03	0.0701	0.0020
SWF 25	0.02	0.0704	0.0012	0.02	0.0838	0.0017	0.03	0.0915	0.0023
SWF 50	0.06	0.0877	0.0053	0.04	0.0845	0.0034	0.03	0.0817	0.0020
SWF 100	0.08	0.0919	0.0075	0.03	0.0954	0.0029	0.04	0.0986	0.0035

Note: Five replicates per treatment.

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table B10

Acute Elutriate Bioassays - Total Suspended Solids in Unfiltered and Filtered Site Water

Concentration	Rep*	Total Suspended Solids mg/ℓ Time = 0 hr	Time = 48 hr
		Unfiltered	
0.1%	1	0.800	0.160
	2	0.821	0.140
	3	0.700	0.312
1.0%	1	1.89	0.520
	2	1.90	0.340
	3	1.92	0.700
10.0%	1	3.20	1.20
	2	3.12	1.24
	3	2.88	1.28
50.0%	1	3.82	1.40
	2	3.90	1.44
	3	4.00	1.48
100.0%	1	6.24	2.60
	2	7.22	2.66
	3	7.68	2.54
		Filtered	
100.0%	1	<0.01	<0.01
	2	<0.01	<0.01
	3	<0.01	<0.01
		Controls	
	1	<0.01	<0.01
	2	<0.01	<0.01
	3	<0.01	<0.01

* Composite samples.

Table B11

Acute Elutriate Bioassays - Hardness Measurements for Controls

Concentration	Rep*	Hardness** Time = 0 hr	Hardness** Time = 48 hr
Control	1	192	190
Control	2	192	189
Control	3	194	190

* Samples were collected as composites.
** Hardness expressed as milligrams equivalent $CaCO_3/\ell$.

Table B12

Ammonia Toxicity Test - Water Quality Parameters and Survival

Concentration	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
0.01-1	20	20	20	7.7	7.7	7.8	8.26	8.25	8.24	3
0.01-2	20	20	20	7.7	7.8	7.8	8.26	8.27	8.27	3
0.01-3	20	20	20	7.8	7.7	7.8	8.29	8.30	8.33	2
0.01-4	21	20	20	7.8	7.9	7.8	8.34	8.33	8.34	0
0.01-5	20	20	20	7.8	7.8	7.8	8.33	8.32	8.33	3
0.10-1	20	21	20	7.9	7.9	8.0	8.22	8.20	8.20	2
0.10-2	20	20	20	8.0	8.0	8.0	8.28	8.28	8.28	3
0.10-3	20	20	20	7.9	7.8	7.9	8.26	8.24	8.24	2
0.10-4	20	21	20	7.8	7.9	7.9	8.28	8.29	8.29	3
0.10-5	20	20	20	7.8	7.9	7.9	8.27	8.28	8.28	4
1.0-1	20	20	20	7.9	7.9	7.9	8.22	8.20	8.20	3
1.0-2	20	21	20	7.9	7.9	8.0	8.22	8.20	8.19	2
1.0-3	20	20	20	7.9	7.9	7.9	8.20	8.20	8.20	2
1.0-4	20	20	20	7.9	7.9	8.0	8.21	8.20	8.20	2
1.0-5	20	21	20	7.9	7.9	7.9	8.20	8.20	8.20	2
10.0-1	20	20	20	7.9	7.9	8.0	8.33	8.34	8.35	1
10.0-2	20	20	20	7.8	7.9	7.8	8.33	8.34	8.34	2
10.0-3	21	20	20	7.8	7.8	7.8	8.38	8.36	8.36	1
10.0-4	20	20	20	7.8	7.9	7.9	8.39	8.37	8.37	1
10.0-5	20	20	20	7.8	7.8	7.8	8.39	8.37	8.37	2
100.0-1	20			7.8			8.34			0
100.0-2	20			7.8			8.35			0
100.0-3	20			7.9			8.34			0
100.0-4	21			7.9			8.35			0
100.0-5	20			7.9			8.37			0

Table B13

Ammonia Toxicity Test - Measured Ammonia (Total and Un-ionized) Levels in Composite Samples

Concentration	Time = 0 hr			Time = 24 hr			Time = 48 hr		
	NH_3 mg/ℓ	F_u*	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
0.01	0.07	0.0728	0.0051	0.07	0.0725	0.0051	0.08	0.0737	0.0059
0.1	0.38	0.0677	0.0257	0.38	0.0671	0.0255	0.39	0.0671	0.0262
1.0	1.13	0.0605	0.0684	1.14	0.0592	0.0675	1.15	0.0590	0.0678
10.0	11.6	0.0841	0.9757	11.6	0.0827	0.9593	11.8	0.0831	0.9800
100.0	97.3	0.0817	7.9454	97.2	0.0817	7.9412	97.5	0.0817	7.9618

Note: Five replicates per treatment.

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

Table B14

Standard Reference Toxicant Test - Water Quality Parameters and Survival (CD++ in µg/ℓ)

Concentration	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, hr									
	0	24	48	0	24	48	0	24	48	48
37-1	20	20	20	7.9	7.7	7.3	8.19	8.20	8.21	0
37-2	20	20	20	7.9	7.6	7.2	8.19	8.17	8.19	0
37-3	21	20	20	7.7	7.7	7.3	8.28	8.26	8.21	0
37-4	20	20	20	7.7	7.6	7.5	8.21	8.20	8.19	2
37-5	20	21	20	7.8	7.7	7.7	8.17	8.17	8.14	2
75-1	20	20	20	7.7	7.8	7.7	8.21	8.20	8.20	2
75-2	20	20	20	7.8	7.7	7.8	8.21	8.20	8.20	3
75-3	20	20	20	7.7	7.5	7.5	8.19	8.19	8.14	2
75-4	20	21	20	7.6	7.5	7.6	8.20	8.21	8.20	2
75-5	20	20	20	7.5	7.6	7.5	8.20	8.19	8.17	2
150-1	20	20	21	7.8	7.8	7.7	8.20	8.19	8.13	2
150-2	20	20	20	7.9	7.9	8.0	8.10	8.19	8.14	0
150-3	20	21	20	7.9	7.9	8.0	8.19	8.20	8.20	4
150-4	20	20	20	7.9	7.9	7.9	8.22	8.19	8.19	2
150-5	20	20	20	7.5	7.6	7.5	8.23	8.19	8.14	1
300-1	20	20	20	7.7	7.8	7.7	8.18	8.16	8.14	0
300-2	20	20	20	7.5	7.4	7.7	8.17	8.14	8.10	0
300-3	20	20	21	7.4	7.4	7.3	8.19	8.15	8.11	0
300-4	20	20	20	7.5	7.3	7.3	8.18	8.16	8.16	1
300-5	20	20	20	7.8	7.7	7.7	8.16	8.13	8.13	0
600-1	20	20	21	7.9	7.8	7.8	8.24	8.20	8.20	0
600-2	20	20	20	8.0	7.9	8.0	8.20	8.23	8.20	0
600-3	20	20	20	7.7	7.7	7.6	8.30	8.26	8.26	0
600-4	20	20	20	7.9	7.8	7.9	8.19	8.22	8.20	0
600-5	20	20	20	7.8	7.8	7.7	8.24	8.24	8.21	0

Table B15

Cadmium Chloride Standard Reference Toxicant Test

Measured Levels in Composite Samples

Nominal Concentration	$CdCl_2$, $\mu g/\ell$ Time, hr 0	24	48
37	68	69	69
75	83	85	83
150	117	119	117
300	133	132	133
600	270	272	270

Note: Five replicates per treatment.

APPENDIX C: RAW DATA FOR CHRONIC BIOASSAYS WITH *DAPHNIA MAGNA*

Table C1

Chronic Elutriate Bioassay - Water Quality Parameters

in Quiver Island Unfiltered Elutriate (QI)

and Controls

Treatment	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, days									
	7	14	21	7	14	21	7	14	21	21
QI 1.0-1	20	20	20	6.7	8.5	6.0	8.09	8.33	8.12	1
QI 1.0-2	20	20	20	6.8	8.4	6.5	8.15	8.22	8.01	1
QI 1.0-3	20			6.8			8.03	8.14	8.24	1
QI 1.0-4	20	20	20	6.0	8.5	6.2	7.97	8.07	8.16	1
QI 1.0-5	20	20	20	6.5	8.3	6.4	8.00	8.00	8.04	0
QI 1.0-6	20	20	20	6.5	8.6	7.0	7.90	8.23	8.13	1
QI 1.0-7	20	20	20	6.2	8.6	6.5	7.84	8.29	8.23	1
QI 1.0-8	20	20	20	6.8	8.6	6.9	7.80	8.34	8.09	1
QI 1.0-9	20	20	20	6.5	8.5	7.2	7.90	8.22	8.23	1
QI 1.0-10	20	20	20	6.9	8.8	7.9	8.72	8.05	8.31	1
QI 10.0-1	20	20	20	6.4	8.0	6.8	7.40	8.00	8.34	1
QI 10.0-2	20	20	20	6.5	8.0	6.4	7.40	7.93	8.28	1
QI 10.0-3	20	20	20	6.6	8.3	6.0	7.48	8.00	8.24	1
QI 10.0-4	20	20	20	6.7	8.5	6.0	7.56	8.21	8.30	1
QI 10.0-5	20	20		6.8	8.0		7.64	8.06	8.02	0
QI 10.0-6	20	20	20	6.8	8.1	6.7	7.68		8.36	1
QI 10.0-7	20	20	20	6.0	7.9	7.3	7.61	8.24	8.40	1
QI 10.0-8	20	20	20	6.8	7.8	6.8	7.65	8.10	8.14	1
QI 10.0-9	20	20	20	6.8	8.2	7.1	7.68	8.13	8.38	1
QI 10.0-10	20	20	20	6.6	8.1	6.5	7.68	7.99	8.28	1
QI 50.0-1	20	20	20	6.3	8.5	7.0	7.69	8.24	8.30	1
QI 50.0-2	20	20	20	6.0	8.0	6.9	7.85	8.15	8.34	1
QI 50.0-3	20	20	20	6.1	8.4	7.2	7.88	7.96	8.26	1
QI 50.0-4	20	20		6.5	8.2		7.93			0
QI 50.0-5	20	20	20	6.5	8.5	7.3	7.85	7.66	8.15	1
QI 50.0-6	20	20	20	6.0	8.6	8.0	7.86	7.68	8.20	1
QI 50.0-7	20	20		6.5	8.0		8.16	7.90		0
QI 50.0-8	20	20	20	6.9	7.9	8.0	8.25		8.07	1
QI 50.0-9	20	20	20	6.7	7.9	7.6	8.20	8.08	8.31	1
QI 50.0-10	20	20	20	6.0	8.0	7.7	8.19	8.20	8.36	1
QI 100-1	20	20		6.2	8.0		7.80	8.00		0
QI 100-2	20	20	20	6.0	8.2	7.8	7.84	7.89	8.34	1
QI 100-3	20	20	20	6.2	8.4	8.0	7.82	8.10	8.26	1
QI 100-4	20	20	20	6.0	7.5	7.9	7.69	8.12		1
QI 100-5	20	20	20	6.4	8.0	8.0	7.79	8.23	8.15	1
QI 100-6	20	20	20	6.7	7.9	7.5	8.03	8.20	8.00	1
QI 100-7	20	20	20	6.3	7.5	7.3	8.00	8.16	8.17	1
QI 100-8	20	20	20	6.0	7.9	7.3	7.91	7.85	8.00	1

(Continued)

Table C1 (Concluded)

Treatment	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, days									
	7	14	21	7	14	21	7	14	21	21
QI 100-9	20	20		6.8	8.0		7.89	8.10		1
QI 100-10	20	20	20	6.6	7.8	7.6	7.85		7.97	0
Control 1	20	20		7.0	8.5		8.00	8.39	8.00	0
Control 2	20	20	20	7.0	8.5	6.7	8.14	8.23	8.17	1
Control 3	20	20	20	6.6	8.5	8.0	7.29	8.39	8.20	1
Control 4	20	20	20	6.8	8.6	6.1	8.15	8.33	8.15	1
Control 5	20	20	20	7.0	8.5	6.2	8.20	8.29	8.20	1
Control 6	20	20	20	6.5	8.6	6.5	8.16	8.26	8.08	1
Control 7	20	20	20	6.8	8.8	6.5	8.18	8.35	8.33	1
Control 8	20	20	20	6.8	8.8	6.7	8.08	8.39	8.24	1
Control 9	20	20	20	6.6	8.8	6.0	8.17	8.34	8.03	1
Control 10	20	20	20	6.5	8.8	6.2	8.23	8.39	8.30	1

Table C2

Chronic Elutriate Bioassay - Water Quality Parameters in Unfiltered Nearshore Environs Elutriate (NSE) and Controls

Treatment	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, days									
	7	14	21	7	14	21	7	14	21	21
NSE 1.0-1	20	20	20	6.0	7.9	7.0	7.93			1
NSE 1.0-2	20	20	20	5.8	8.5	6.1	7.87	8.22	8.28	1
NSE 1.0-3	20	20	20	6.7	7.2	7.0	8.01			1
NSE 1.0-4	20	20		5.9	7.0		7.92			0
NSE 1.0-5	20	20	20	6.0	7.1	7.0	7.83			1
NSE 1.0-6	20	20	20	5.2	8.7	7.0	7.77		8.14	1
NSE 1.0-7	20	20	20	5.0	7.1	7.0	7.84	8.08		1
NSE 1.0-8	20	20	20	6.6	7.0	6.9	7.86		8.33	1
NSE 1.0-9	20	20	20	5.5	7.1	7.0	7.90		8.44	1
NSE 1.0-10	20	20	20	5.0	7.2	7.0	7.79		8.41	1
NSE 10.0-1	20	20	20	6.4	8.0	6.7	7.28	7.93		0
NSE 10.0-2	20			6.8			7.33	7.81	8.25	1
NSE 10.0-3	20	20	20	6.8	7.7	7.0	7.33			1
NSE 10.0-4	20	20	20	6.5	7.9	7.4	7.35	7.99		1
NSE 10.0-5	20	20	20	6.9	8.2	6.5	7.39	7.93	8.12	1
NSE 10.0-6	20	20	20	6.5	8.1	6.7	7.38		8.34	1
NSE 10.0-7	20	20	20	6.7	8.2	6.9	7.35			0
NSE 10.0-8	20	20		6.5	8.0		7.37	7.84	8.44	1
NSE 10.0-9	20	20	20	6.6	7.2	6.8	7.42	7.89	8.21	1
NSE 10.0-10	20	20	20	7.0	7.4	6.5	7.44	8.00	8.33	1
NSE 50.0-1	20	20	20	6.3	8.2	7.1	7.46	7.94	8.45	1
NSE 50.0-2	20	20	20	6.5	8.1	7.0	7.54		8.41	1
NSE 50.0-3	20	20	20	7.0	8.5	6.0	7.56	8.00	8.30	1
NSE 50.0-4	20	20	20	7.0	8.0	6.4	7.51	7.99	8.35	1
NSE 50.0-5	20	20	20	6.9	8.5	6.9	7.62	7.79	8.23	1
NSE 50.0-6	20	20	20	3.5	8.4	6.5	7.46	7.73	7.98	1
NSE 50.0-7	20	20	20	6.6	8.5	6.1	7.64	8.06	8.18	1
NSE 50.0-8	20	20	20	6.5	8.0	6.8	7.56	8.20	8.32	1
NSE 50.0-9	20	20	20	4.5	8.7	6.0	7.51	7.83	8.00	1
NSE 50.0-10	20	20		6.5	8.5		7.42	7.91	8.16	0
NSE 100-1	20	20	20	6.1	7.9	6.5	7.77	8.15	8.13	1
NSE 100-2	20	20	20	6.5	8.5	6.0	7.73	7.99	8.33	1
NSE 100-3	20	20	20	6.2	8.1	6.7	7.70	8.00	8.19	1
NSE 100-4	20	20		6.0	8.4		7.65	8.33	8.23	1
NSE 100-5	20	20	20	6.6	8.0	6.3	7.80	8.28	8.00	0
NSE 100-6	20	20	20	6.1	7.9	6.9	7.74	8.08	8.19	1
NSE 100-7	20	20	20	6.9	8.4	7.1	7.85	8.10	8.47	1

(Continued)

Table C2 (Concluded)

Treatment	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive
	Time, days									
	7	14	21	7	14	21	7	14	21	21
NSE 100-8	20	20	20	6.9	8.7	6.8	7.64	7.99	8.24	1
NSE 100-9	20	20	20	6.4	8.4	6.3	7.84	8.00	8.15	1
NSE 100-10	20	20		6.5	8.8		7.87	8.20	8.23	0
Control 1	20	20		7.0	8.5		8.00	8.39	8.00	0
Control 2	20	20	20	7.0	8.5	6.7	8.14	8.23	8.17	1
Control 3	20	20	20	6.6	8.5	8.0	7.29	8.39	8.20	1
Control 4	20	20	20	6.8	8.6	6.1	8.15	8.33	8.15	1
Control 5	20	20	20	7.0	8.5	6.2	8.20	8.29	8.20	1
Control 6	20	20	20	6.5	8.6	6.5	8.16	8.26	8.08	1
Control 7	20	20	20	6.8	8.8	6.5	8.18	8.35	8.33	1
Control 8	20	20	20	6.8	8.8	6.7	8.08	8.39	8.24	1
Control 9	20	20	20	6.6	8.8	6.0	8.17	8.34	8.03	1
Control 10	20	20	20	6.5	8.8	6.2	8.23	8.39	8.30	1

Table C3

Chronic Elutriate Bioassay - Neonate Production During the 21-day Chronic Exposure of *Daphnia magna* to Unfiltered Elutriates of Quiver Island (QI) and Nearshore Environs (NSE) Sediment

Treatment	Replicate	Total Number of Neonates	Treatment	Replicate	Total Number of Neonates
QI-1	1	0	NSE-1	1	0
QI-1	2	12	NSE-1	2	18
QI-1	3	0	NSE-1	3	0
QI-1	4	6	NSE-1	4	0
QI-1	5	26	NSE-1	5	0
QI-1	6	30	NSE-1	6	27
QI-1	7	6	NSE-1	7	0
QI-1	8	42	NSE-1	8	0
QI-1	9	3	NSE-1	9	0
QI-1	10	18	NSE-1	10	0
QI-10	1	12	NSE-10	1	6
QI-10	2	24	NSE-10	2	0
QI-10	3	16	NSE-10	3	7
QI-10	4	19	NSE-10	4	6
QI-10	5	0	NSE-10	5	3
QI-10	6	39	NSE-10	6	0
QI-10	7	16	NSE-10	7	8
QI-10	8	31	NSE-10	8	0
QI-10	9	8	NSE-10	9	25
QI-10	10	28	NSE-10	10	26
QI-50	1	33	NSE-50	1	0
QI-50	2	23	NSE-50	2	0
QI-50	3	12	NSE-50	3	5
QI-50	4	0	NSE-50	4	0
QI-50	5	8	NSE-50	5	27
QI-50	6	41	NSE-50	6	26
QI-50	7	0	NSE-50	7	9
QI-50	8	0	NSE-50	8	19
QI-50	9	30	NSE-50	9	13
QI-50	10	15	NSE-50	10	11
QI-100	1	18	NSE-100	1	8
QI-100	2	27	NSE-100	2	25
QI-100	3	32	NSE-100	3	16
QI-100	4	1	NSE-100	4	9
QI-100	5	6	NSE-100	5	21
QI-100	6	27	NSE-100	6	15
QI-100	7	43	NSE-100	7	0
QI-100	8	4	NSE-100	8	1

(Continued)

Table C3 (Concluded)

Treatment	Replicate	Total Number of Neonates	Treatment	Replicate	Total Number of Neonates
QI-100	9	51	NSE-100	9	0
QI-100	10	0	NSE-100	10	13
Control	1	9			
Control	2	15			
Control	3	32			
Control	4	17			
Control	5	17			
Control	6	12			
Control	7	15			
Control	8	15			
Control	9	23			
Control	10	16			

Table C4

Chronic Elutriate Bioassay - Measured Ammonia (NH_3)

Levels in Unfiltered Quiver Island Elutriates

(QI) and Controls

Concentration	Time = 7 days			Time = 14 days			Time = 21 days		
	NH_3 mg/ℓ	F_u*	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
QI 1.0-1	1.20	0.0466	0.0559	0.02	0.0783	0.0014	0.03	0.0498	0.0015
QI 1.0-2	1.60	0.0531	0.0850	0.02	0.0618	0.0011	0.04	0.0390	0.0016
QI 1.0-3	1.50	0.0408	0.0612	0.02	0.0520	0.0010			
QI 1.0-4	1.50	0.0357	0.0536	0.02	**	**	0.07	0.0543	0.0036
QI 1.0-5	1.00	0.0382	0.0382	0.02	0.0382	0.0009	0.08	0.0417	0.0032
QI 1.0-6	1.50	0.0306	0.0459	0.03	0.0632	0.0017	0.03	0.0508	0.0013
QI 1.0-7	1.50	0.0267	0.0401	0.02	0.0719	0.0013	0.04	0.0632	0.0023
QI 1.0-8	1.10	0.0244	0.0269	0.06	0.0799	0.0046	0.02	0.0466	0.0009
QI 1.0-9	1.00	0.0306	0.0306	0.03	0.0618	0.0016	0.04	0.0632	0.0023
QI-1.0-10	1.40	0.0256	0.0358	0.03	**	**	0.03	**	**
QI 10.0-1	0.80	0.0099	0.0079	0.05	0.0382	0.0019	0.01	0.0799	0.0010
QI 10.0-2	0.80	0.0099	0.0079	0.07	0.0327	0.0022	0.02	0.0704	0.0013
QI 10.0-3	1.15	0.0118	0.0136	0.08	0.0382	0.0034	0.02	0.0646	0.0011
QI 10.0-4	0.40	0.0142	0.0057	0.08	0.0605	0.0048	0.02	0.0734	0.0012
QI 10.0-5	0.70	0.0170	0.0119	0.08	0.0436	0.0034	0.02	0.0399	0.0006
QI 10.0-6	0.80	0.0186	0.0149				0.05	0.0834	0.0042
QI 10.0-7	2.00	0.0159	0.0318				0.02	0.0907	0.0019
QI 10.0-8	0.86	0.0174	0.0150	0.08	0.0476	0.0038	0.02	0.0520	0.0011
QI 10.0-9	0.74	0.0186	0.0138	0.07	0.0509	0.0036	0.04	0.0870	0.0035
QI 10.0-10	0.90	0.0186	0.0168	0.02	0.0374	0.0009	0.03	0.0704	0.0021

(Continued)

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

** No pH value available for calculation of F_u.

Table C4 (Continued)

Concentration	Time - 7 days NH_3 mg/ℓ	Time - 7 days F_u	Time - 7 days UN-ionized NH_3 mg/ℓ	Time - 14 days NH_3 mg/ℓ	Time - 14 days F_u	Time - 14 days Un-ionized NH_3 mg/ℓ	Time - 21 days NH_3 mg/ℓ	Time - 21 days F_u	Time - 21 days Un-ionized NH_3 mg/ℓ
QI 50.0-1	0.16	0.0191	0.0031	0.01	0.0646	0.0007	0.03	0.0734	0.0025
QI 50.0-2	0.21	0.0273	0.0574	0.01	0.0531	0.0005	0.04	0.0799	0.0032
QI 50.0-3	0.10	0.0292	0.0029	0.01	0.0530	0.0003	0.03	0.0674	0.0018
QI 50.0-4	0.10	0.0327	0.0033	0.08	**	**			
QI 50.0-5				0.01	0.0178	0.0002	0.02	0.0531	0.0011
QI 50.0-6	0.04	0.0280	0.0010	0.04	0.0187	0.0007	0.03	0.0592	0.0018
QI 50.0-7				0.01	0.0306	0.0004			
QI 50.0-8	0.03	0.0660	0.0021	0.12	**	**	0.03	0.0446	0.0013
QI 50.0-9				0.02	0.0456	0.0007	0.04	0.0750	0.0030
QI 50.0-10	0.02	0.0580	0.0012	0.02	0.0592	0.0009	0.03	0.0834	0.0025
QI 100-1				0.60	0.0382	0.0229			
QI 100-2	1.60	0.0267	0.0428	0.30	0.0299	0.0090	0.04	0.0799	0.0032
QI 100-3	0.14	0.0256	0.0036	0.18	0.0476	0.0086	0.03	0.0674	0.0020
QI 100-4	1.20	0.0191	0.0029	0.11	0.0498	0.0055	0.04	**	**
QI 100-5	0.14	0.0239	0.0033	0.10	0.0632	0.0063	0.02	0.0531	0.0010
QI 100-6	0.10	0.0408	0.0041	0.10	0.0592	0.0059	0.01	0.0382	0.0005
QI 100-7	0.28	0.0382	0.0107	0.10	0.0543	0.0054	0.04	0.0555	0.0022
QI 100-8	0.26	0.0313	0.0081				0.04	0.0382	0.0015
QI 100-9	2.40	0.0299	0.0718						
QI 100-10	1.80	0.0273	0.0492				0.04	0.0357	0.0014
Control 1	0.10	0.0382	0.0038	0.11	0.0888	0.0098	0.02	0.0382	0.0009
Control 2	0.10	0.0520	0.0052	0.09	0.0632	0.0058	0.02	0.0555	0.0012
Control 3	0.10	0.0077	0.0008	0.07	0.0088	0.0062	0.02	0.0592	0.0012
Control 4	0.10	0.0531	0.0053	0.06	0.0783	0.0047	0.02	0.0531	0.0012
Control 5	0.10	0.0592	0.0059	0.09	0.0719	0.0063	0.04	0.0592	0.0025

(Continued)

** No pH value available for calculation of F_u.

Table C4 (Concluded)

Concentration	Time = 7 days			Time = 14 days			Time = 21 days		
	NH_3 mg/ℓ	F_v	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_v	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_v	Un-ionized NH_3 mg/ℓ
Control 6	0.10	0.0543	0.0054	0.01	0.0674	0.0008	0.02	0.0456	0.0007
Control 7	0.10	0.0567	0.0057	0.10	0.0817	0.0082	0.02	0.0783	0.0016
Control 8	0.10	0.0456	0.0046	0.03	0.0888	0.0027	0.01	0.0646	0.0009
Control 9	0.10	0.0555	0.0055	0.01	0.0799	0.0008	0.01	0.0408	0.0004
Control 10	0.10	0.0632	0.0063	0.02	0.0888	0.0018	0.02	0.0734	0.0015

Table C5

Chronic Elutriate Bioassay - Measured Ammonia (NH_3)

Levels in Unfiltered Nearshore Environs

Elutriate and Controls

Concentration	Time - 7 days			Time - 14 days			Time - 21 days		
	NH_3 mg/ℓ	F_u*	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
NSE 1.0-1	0.42	0.0327	0.0137				0.03	**	**
NSE 1.0-2	0.64	0.0286	0.0183	0.04	0.0618	0.0025	0.08	0.0704	0.0058
NSE 1.0-3	0.82	0.0391	0.0320				0.03	**	**
NSE 1.0-4	0.52	0.0320	0.0166	0.03	**	**			
NSE 1.0-5	0.48	0.0262	0.0126				0.01	**	**
NSE 1.0-6	0.46	0.0229	0.0105	0.02	0.0358	0.0456	0.01	0.0520	0.0005
NSE 1.0-7	0.74	0.0267	0.0198				0.02	**	**
NSE 1.0-8	0.30	0.0280	0.0084				0.01	0.0783	0.0008
NSE 1.0-9	0.42	0.0306	0.0128	0.02	**	**	0.03	0.0986	0.0030
NSE 1.0-10	0.37	0.0239	0.0088				0.03	0.0926	0.0028
NSE 10.0-1	0.15	0.0075	0.0011	0.09	0.0327	0.0029			
NSE 10.0-2	0.22	0.0084	0.0019	0.02	0.0250	0.0005			
NSE 10.0-3	0.76	0.0084	0.0064	0.02	**	**			
NSE 10.0-4	0.18	0.0088	0.0016	0.05	0.0374	0.0019			
NSE 10.0-5	0.34	0.0097	0.0033	0.03	0.0327	0.0009	0.02	0.0498	0.0008
NSE 10.0-6	0.22	0.0094	0.0021	0.04	**	**	0.01	0.0799	0.0010
NSE 10.0-7	0.37	0.0088	0.0033	0.03	**	**			
NSE 10.0-8	0.20	0.0092	0.0018	0.06	0.0267	0.0016	0.02	0.0986	0.0019
NSE 10.0-9	0.17	0.0103	0.0018	0.03	0.0299	0.0008	0.02	0.0605	0.0015
NSE 10.0-10	0.20	0.0108	0.0022	0.02	0.0382	0.0007	0.02	0.0783	0.0017

(Continued)

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

** No pH value available for calculation of F_u.

Table C5 (Continued)

Concentration	Time - 7 days NH_3 mg/ℓ	F_u	Time - 7 days Un-ionized NH_3 mg/ℓ	Time - 14 days NH_3 mg/ℓ	F_u	Time - 14 days Un-ionized NH_3 mg/ℓ	Time - 21 days NH_3 mg/ℓ	F_u	Time - 21 days Un-ionized NH_3 mg/ℓ
NSE 50.0-1	0.42	0.0113	0.0048	0.13	0.0334	0.0043	0.04	0.1007	0.0040
NSE 50.0-2	0.22	0.0136	0.0030	0.13	**	**	0.03	0.0926	0.0028
NSE 50.0-3	0.35	0.0142	0.0050	0.02	0.0382	0.0008	0.02	0.0734	0.0012
NSE 50.0-4	0.18	0.0127	0.0023	0.02	0.0374	0.0008	0.03	0.0817	0.0022
NSE 50.0-5	0.42	0.0163	0.0068	0.02	0.0239	0.0006	0.04	0.0632	0.0023
NSE 50.0-6	0.37	0.0113	0.0042	0.03	0.0209	0.0005	0.03	0.0365	0.0011
NSE 50.0-7	0.20	0.0170	0.0034	0.03	0.0436	0.0013	0.03	0.0567	0.0016
NSE 50.0-8	0.28	0.0142	0.0040	0.03	0.0592	0.0020	0.02	0.0766	0.0014
NSE 50.0-9	0.44	0.0127	0.0056	0.05	0.0262	0.0014	0.02	0.0382	0.0008
NSE 50.0-10	0.30	0.0103	0.0031	0.08	0.0313	0.0026	0.05	0.0543	0.0027
NSE 100.0-1	0.26	0.0229	0.0059	0.09	0.0531	0.0046	0.01	0.0508	0.0007
NSE 100.0-2	0.32	0.0209	0.0067	0.07	0.0374	0.0026	0.02	0.0783	0.0017
NSE 100.0-3	0.12	0.0195	0.0023	0.06	0.0382	0.0023	0.02	0.0580	0.0010
NSE 100.0-4	0.03	0.0174	0.0005	0.09	0.0783	0.0067	0.01	0.0632	0.0009
NSE 100.0-5	0.03	0.0244	0.0006	0.07	0.0704	0.0052	0.01	0.0382	0.0005
NSE 100.0-6	0.01	0.0214	0.0002	0.08	0.0456	0.0037	0.03	0.0580	0.0020
NSE 100.0-7	0.02	0.0273	0.0005	0.09	0.0476	0.0044	0.03	0.1049	0.0031
NSE 100.0-8	0.02	0.0170	0.0003	0.10	0.0374	0.0037	0.03	0.0646	0.0017
NSE 100.0-9	0.02	0.0267	0.0004	0.15	0.0382	0.0057	0.02	0.0382	0.0007
NSE 100.0-10	0.02	0.0286	0.0005	0.09	0.0592	0.0051	0.03	0.0382	0.0013
Control 1	0.10	0.0382	0.0038	0.11	0.0888	0.0098	0.02	0.0382	0.0009
Control 2	0.10	0.0520	0.0052	0.09	0.0632	0.0058	0.02	0.0555	0.0012
Control 3	0.10	0.0077	0.0008	0.07	0.0088	0.0062	0.02	0.0592	0.0012
Control 4	0.10	0.0531	0.0053	0.06	0.0783	0.0047	0.02	0.0531	0.0012
Control 5	0.10	0.0592	0.0059	0.09	0.0719	0.0063	0.04	0.0592	0.0025

(Continued)

** No pH value available for calculation of F_u.

Table C5 (Concluded)

Concentration	Time = 7 days NH3 mg/ℓ	Time = 7 days F_u	Time = 7 days UN-ionized NH3 mg/ℓ	Time = 14 days NH3 mg/ℓ	Time = 14 days F_u	Time = 14 days Un-ionized NH3 mg/ℓ	Time = 21 days NH3 mg/ℓ	Time = 21 days F_u	Time = 21 days Un-ionized NH3 mg/ℓ
Control 6	0.10	0.0543	0.0054	0.01	0.0674	0.0008	0.02	0.0456	0.0007
Control 7	0.10	0.0567	0.0057	0.10	0.0817	0.0082	0.02	0.0783	0.0016
Control 8	0.10	0.0456	0.0046	0.03	0.0888	0.0027	0.01	0.0646	0.0009
Control 9	0.10	0.0555	0.0055	0.01	0.0799	0.0008	0.01	0.0408	0.0004
Control 10	0.10	0.0632	0.0063	0.02	0.0888	0.0018	0.02	0.0734	0.0015

Table C6

Chronic Elutriate Bioassays - Hardness Measurements for Controls

Concentration	Sample Replicate*	Hardness**			
		Time = 0 days	Time = 7 days	Time = 14 days	Time = 21 days
Control	1	182	179	170	170
Control	2	181	179	172	176
Control	3	182	180	174	174

* Samples were collected as composites.

** Hardness expressed as milligrams equivalent $CaCO_3/\ell$.

Table C7

Chronic Ammonia Toxicity Test - Water Quality Parameters and Survival

Concentration	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive	
	Time, days										
	0	7	14	0	7	14	0	7	14	7	14
0.01-1	20	20	20	8.0	6.5	6.4	8.12	7.44	8.30	1	1
0.01-2	20	20	20	8.0	6.7	6.4	8.19	7.90	8.34	1	1
0.01-3	20	20	20	8.0	6.9	6.5	8.27	7.74	8.26	1	1
0.01-4		20	20		6.9			7.78		1	1
0.01-5		20	20		6.6	6.1		7.70	8.15	1	1
0.01-6		20	20		7.0	6.4		7.56	8.20	1	1
0.01-7		20	20		7.1			7.47		1	1
0.01-8		20	20		6.9			7.90		1	1
0.01-9		20	20		6.4	6.2		7.84	8.31	1	1
0.01-10		20	20		6.9	6.8		7.99	8.30	1	1
1.0-1		20	20		6.9	6.5		7.91	8.34	1	1
1.0-2		20	20		7.0	6.7		7.15	8.27	1	0
1.0-3		20	20		6.6	6.2		7.00	8.13	0	0
1.0-4		20	20		6.8	6.9		7.84	8.03	1	0
1.0-5		20	20		6.9	6.1		7.90	8.29	1	1
1.0-6		20	20		7.0	6.9		7.84	8.00	1	1
1.0-7		20	20		6.5	6.8		7.90	8.30	1	0
1.0-8		20	20		6.8	6.4		7.94	8.34	0	0
1.0-9		20	20		6.8	6.8		7.89	7.99	1	1
1.0-10		20	20		6.9			7.91		1	1
10-1	20	20		8.1	6.5		8.16	8.00		0	0
10-2	20	20		8.1	6.7		8.29	7.98		0	0
10-3	20	20		8.1	6.9		8.25	7.79		0	0
10-4		20			6.6			7.74		0	0
10-5		20			6.8			7.92		0	0
10-6		20			6.9			7.85		0	0
10-7		20			7.0			7.80		0	0
10-8		20			7.3			7.91		0	0
10-9		20			6.6			7.85		1	0
10-10		20			6.8			8.00		0	0
50-1	20	20		8.0	6.7		8.22	7.99		0	0
50-2	20	20		8.1	6.5		8.28	7.85		0	0
50-3	20	20		8.0	6.8		8.27	7.90		0	0
50-4		20			7.0			7.92		0	0
50-5		20			7.0			7.85		0	0
50-6		20			6.5			7.34		0	0
50-7		20			6.5			7.91		0	0
50-8		20			6.8			7.85		0	0
50-9		20			6.5			7.05		0	0
50-10		20			6.7			7.16		0	0

(Continued)

Table C7 (Concluded)

Concentration	Temperature °C			Dissolved Oxygen mg/ℓ			pH			Number Alive	
	Time, days										
	0	7	14	0	7	14	0	7	14	7	14
100-1	20	21		7.9	6.7		8.30	7.99		0	0
100-2	20	20		7.8	6.5		8.28	7.85		0	0
100-3	20	20		7.9	6.8		8.27	7.90		0	0
100-4		20			7.0			7.92		0	0
100-5		20			7.0			7.85		0	0
100-6		21			6.5			7.34		0	0
100-7		20			6.3			7.91		0	0
100-8		20			6.8			7.85		0	0
100-9		20			6.5			7.05		0	0
100-10		20			6.7			7.16		0	0

Table C8

Chronic Ammonia Toxicity Test - Measured Ammonia

(Total and Un-ionized)

Concentration	Time = 0 days			Time = 7 days			Time = 14 days		
	NH_3 mg/ℓ	F_u*	UN-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u*	Un-ionized NH_3 mg/ℓ
NH3 0.01-1	0.19	0.0498	0.0095	0.60	0.0108	0.0065	0.74	0.0734	0.0543
NH3 0.01-2	0.17	0.0580	0.0099	0.66	0.0306	0.0202	0.56	0.0799	0.0448
NH3 0.01-3	0.18	0.0689	0.0124	0.80	0.0214	0.0171	0.68	0.0674	0.0458
NH3 0.01-4				0.64	0.0234	0.0150			
NH3 0.01-5				0.82	0.0195	0.0160	0.80	0.0531	0.0425
NH3 0.01-6				0.74	0.0142	0.0105	0.76	0.0592	0.0450
NH3 0.01-7				0.80	0.0116	0.0093	0.68	**	**
NH3 0.01-8				0.88	0.0306	0.0269			
NH3 0.01-9				0.80	0.0267	0.0214	0.74	0.0750	0.0555
NH3 0.01-10				0.64	0.0374	0.0239	0.68	0.0734	0.0499
NH3 1.0-1				1.20	0.0313	0.0375	3.66	0.0799	0.2926
NH3 1.0-2				1.10	0.0056	0.0061	3.34	0.0689	0.2300
NH3 1.0-3				1.10	0.0040	0.0044	3.80	0.0509	0.1932
NH3 1.0-4				1.30	0.0267	0.0348	3.66	0.0408	0.1494
NH3 1.0-5				1.10	0.0306	0.0336	3.66	0.0719	0.2631
NH3 1.0-6				1.20	0.0267	0.0321	4.42	0.0382	0.1689
NH3 1.0-7				1.10	0.0306	0.0336	3.68	0.0734	0.2702
NH3 1.0-8				1.20	0.0334	0.0401	3.78	0.0799	0.3022
NH3 1.0-9				1.10	0.0299	0.0329	3.86	0.0374	0.1442
NH3 1.0-10				1.40	0.0313	0.0438			
NH3 10-1	10.2	0.0660	0.6729	9.80	0.0382	0.3744			
NH3 10-2	10.1	0.0618	0.6246	9.80	0.0365	0.3581			

(Continued)

* F_u = fraction of total ammonia in the un-ionized form (see materials and methods).

** No pH value available for calculation of F_u.

Table C8 (Concluded)

Concentration	Time = 0 days			Time = 7 days			Time = 14 days		
	NH_3 mg/ℓ	F_u	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u	Un-ionized NH_3 mg/ℓ	NH_3 mg/ℓ	F_u	Un-ionized NH_3 mg/ℓ
NH3 10-3	10.2	0.0674	0.6875	9.40	0.0239	0.2247			
NH3 10-4				9.60	0.0214	0.2051			
NH3 10-5				9.60	0.0320	0.3070			
NH3 10-6				9.60	0.0273	0.2626			
NH3 10-7				9.80	0.0244	0.2396			
NH3 10-8				9.40	0.0313	0.2940			
NH3 10-9				9.60	0.0273	0.2626			
NH3 10-10				9.80	0.0382	0.3744			
NH3 50-1	50.0	0.0618	3.0920	50.1	0.0374	1.8720			
NH3 50-2	50.0	0.0704	3.5179	50.2	0.0273	1.3730			
NH3 50-3	50.0	0.0689	3.4434	50.0	0.0306	1.5293			
NH3 50-4				50.0	0.0320	1.5990			
NH3 50-5				50.2	0.0273	1.3730			
NH3 50-6				50.0	0.0086	0.4307			
NH3 50-7				50.0	0.0313	1.5638			
NH3 50-8				50.0	0.0273	1.3675			
NH3 50-9				50.0	0.0044	0.2218			
NH3 50-10				50.2	0.0057	0.2866			
NH3 100-1	96.0	0.0734	7.0494	100.0	0.0374	3.7365			
NH3 100-2	96.0	0.0704	6.7544	99.8	0.0273	2.7295			
NH3 100-3	94.0	0.0689	6.4735	100.0	0.0306	3.0585			
NH3 100-4				98.0	0.0320	3.1341			
NH3 100-5				99.2	0.0273	2.7131			
NH3 100-6				99.6	0.0086	0.8580			
NH3 100-7				100.0	0.0313	3.1275			
NH3 100-8				100.0	0.0273	2.7350			
NH3 100-9				98.6	0.0044	0.4375			
NH3 100-10				99.4	0.0057	0.5674			

APPENDIX D: HYGIENIC LABORATORY DATA SHEETS

Corps of Engineers Sediment Procedures

Two 1-gal containers of sediment were received from the US Army Engineer Waterways Experiment Station (WES) on 29 November 1990. Sediments were stored at 4 °C until ready for testing.

SAMPLE PREPARATION

Day 1

Each sample (one at a time) was removed from refrigeration, container opened, and sediment thoroughly mixed. Three liters of sediment were placed in a 20-ℓ glass container. Before addition of the dilution water, a mark was placed on the outside of the glass mixing vessel 1 in. above the top of the sediment layer (mark to be used for decanting). Twelve liters of laboratory reconstituted hard water (EPA/600/4-85/013) were added to the missing vessel. The mixture was placed on a large magnetic stirrer and mixed vigorously for 30 min. After mixing, the material was allowed to settle for 30 min. At the end of 30 min, a glass tube and an unused, clean, food grade tube was used to decant the material down to the mark previously established on the mixing container. All decanting occurred at mid-level of the water column. The supernatant mixture was placed on a magnetic stirrer and, while mixing, was divided into two aliquots. One aliquot was identified as unfiltered and set aside. The remaining aliquot was gravity-filtered through a number 41 Whatman paper filter (each filter was prewashed with 100 ml of distilled water). The filtrate was then vacuum-filtered through a glass fiber filter (Gelman type A/E) followed by a 0.45-μm Mullipore filter type HA. The filtering process was continued until approximately 2 ℓ of filtered sample was available.

The filtered and unfiltered sample material was placed in large glass beakers, covered, and refrigerated overnight.

Day 2

The unfiltered samples were placed on a large magnetic stirrer, and while being thoroughly mixed, material was siphoned into five beakers representing the 100-percent concentration. Samples for total suspended solids analysis were also collected at this time. While the sample continued to mix, material was siphoned for the various dilutions (50, 10, 1, and 0.1 percent). Dilutions were made in 1-ℓ volumetric flasks, and samples for total suspended solids were obtained.

The filtered samples were well mixed and dilutions made in 1-ℓ volumetric flasks. Total suspended solids samples were obtained only on the 100-percent concentration.

For each concentration, five 250-ml plastic beakers were each filled with approximately 200 ml of test sample. Gentle aeration was begun on each beaker immediately while waiting for all beakers to reach ambient temperature.

Upon reaching ambient temperature, pH, dissolved oxygen, and temperature measurements were taken. In addition, samples were taken for ammonia nitrogen analysis, after which four 5-day-old fathead minnows were placed in each beaker. Temperature, dissolved oxygen, pH, and ammonia nitrogen were measured at 0, 24, and 48 hr, while total suspended solids were analyzed at 0 and 48 hr. Ammonia nitrogen samples were preserved by adding 80 μℓ of 1:1 sulfuric acid to 20 ml of sample.

A reference toxicant (cadmium chloride) test was also started at approximately the same time as the sediment tests. Cadmium concentrations used were calculated to be 0.7, 0.35, 0.175, 0.88, and 0.44 mg/ℓ. A laboratory analysis (University Hygienics Laboratory) indicated the 0.7-mg/ℓ cadmium concentration was actually 0.67 mg/ℓ. An aliquot of the 0.7-mg/ℓ cadmium was sent to WES for analysis.

Additional ammonia nitrogen samples were taken at the end of the test and divided into three sets. One set went to Applied Research and Development Laboratory for analysis, one set went to WES for analysis, and the UHL analyzed one set. UHL results are as follows:

	Ammonia Nitrogen
#9067219 - 100% Unfiltered	10.7 mg/ℓ
#9067219 - 100% Filtered	6.0 mg/ℓ

The difference observed between the 9067219 100-percent unfiltered (10.7 mg/ℓ) and the reported test value of 7.17 mg/ℓ (see results sheets) may be explained. The test sample was taken from the supernatant, while the three-way split was made up of all five beakers combined and the sediment resuspended. Mixing of the samples with the high solids content may have released additional ammonia nitrogen that was not available in the supernatant.

Rock Island Corps of Engineers
Sediment Study

Sample I.D. RAR Reference - Filtered

UHL Number 9067218

Conc.	Temperature (°C) 0	24 hr.	48 hr.	pH (Units) 0	24 hr.	48 hr.	Dissolved Oxygen (mg/L) 0	24 hr.	48 hr.
100%									
1	21.5	21.5	22.0	8.3	8.5	8.4	9.2	8.6	7.9
2	21.5	21.5	22.0	8.3	8.5	8.5	9.0	8.7	7.9
3	21.5	21.5	22.0	8.3	8.5	8.5	9.0	8.8	8.0
4	21.5	21.5	22.0	8.3	8.5	8.5	9.0	8.7	8.0
5	21.5	21.5	22.0	8.3	8.5	8.5	9.2	8.7	8.0
50%									
1	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.8	7.9
2	21.5	21.5	22.0	8.4	8.5	8.4	8.8	8.8	7.4
3	21.5	21.5	22.0	8.4	8.5	8.4	8.9	8.8	7.8
4	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.7	8.0
5	21.5	21.5	22.0	8.4	8.5	8.4	8.8	8.8	8.0
10%									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.8	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.7	8.0
3	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.7	8.1
4	21.5	21.5	22.0	8.4	8.4	8.4	9.0	8.7	7.9
5	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.7	7.9
1%									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.6	8.6	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.7	8.1
3	21.5	21.5	22.0	8.4	8.4	8.4	8.8	8.8	8.1
4	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.7	8.2
5	21.5	21.5	22.0	8.4	8.4	8.4	8.8	8.8	8.1
0.1%									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.4	8.8	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	8.6	8.8	7.9
3	21.5	21.5	22.0	8.4	8.4	8.4	8.4	8.6	8.0
4	21.5	21.5	22.0	8.4	8.4	8.4	8.6	8.7	8.0
5	21.5	21.5	22.0	8.4	8.4	8.4	8.6	8.7	8.1
Control (FILTERED)									
1	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.8	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.8	7.9
3	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.8	8.0
4	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.7	7.9
5	21.5	21.5	22.0	8.4	8.4	8.4	7.4	8.7	8.1

Analyst JGM/JOK/JS Date Reported [illegible] Verified

Rock Island Corps of Engineers
Sediment Study

Sample I.D. RAR Reference - Filtered

UHL Number 9067218

Conc.	Fish Mortality (No. Dead/No. Tested) 0	48 hr.	Ammonia Nitrogen (mg/L) 0	24 hr.	48 hr.	Total Suspended Solids (mg/L) 0	48 hr.
100%							
1	0/4	0/4		COMPOSITE 1 - 5		<1	<1
2	0/4	0/4				<1	<1
3	0/4	0/4	1.7	1.5	1.2	<1	<1
4	0/4	0/4				<1	<1
5	0/4	0/4				<1	<1
50%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	0.9	0.8	0.7		
4	0/4	0/4					
5	0/4	0/4					
10%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	1/4					
3	0/5	0/5	0.2	0.2	0.2		
4	0/4	0/4					
5	0/4	0/4					
1%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	<0.1	<0.1	0.1		
4	0/4	0/4					
5	0/4	0/4					
0.1%							
1	0/5	0/5		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	<0.1	<0.1	0.1		
4	0/4	0/4					
5	0/4	0/5					
Control (FILTERED)							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	<0.1	<0.1	<0.1		
4	0/4	0/4					
5	0/4	0/4					

Analyst JGM/JCK/JS Date Reported Verified

Rock Island Corps of Engineers
Sediment Study

Sample I.D. RAR Reference - Unfiltered

UHL Number 9067218

	Temperature (°C)			pH (Units)			Dissolved Oxygen (mg/L)		
Conc.	0	24 hr.	48 hr.	0	24 hr.	48 hr.	0	24 hr.	48 hr.
100%									
1	21.5	21.5	22.0	7.9	8.4	8.4	8.2	8.2	7.6
2	21.5	21.5	22.0	8.1	8.4	8.4	8.9	8.3	7.7
3	21.5	21.5	22.0	8.2	8.5	8.4	9.0	8.3	7.8
4	21.5	21.5	22.0	8.2	8.5	8.4	8.8	8.3	7.7
5	21.5	21.5	22.0	8.2	8.5	8.4	8.9	8.4	7.5
50%									
1	21.5	21.5	22.0	8.1	8.4	8.4	8.7	8.3	7.7
2	21.5	21.5	22.0	8.3	8.4	8.4	9.0	8.3	7.6
3	21.5	21.5	22.0	8.2	8.5	8.4	8.8	8.2	7.8
4	21.5	21.5	22.0	8.2	8.5	8.4	8.9	8.3	7.6
5	21.5	21.5	22.0	8.2	8.5	8.4	8.8	8.4	7.7
10%									
1	21.5	21.5	22.0	8.2	8.4	8.4	8.9	8.2	7.8
2	21.5	21.5	22.0	8.2	8.4	8.4	8.9	8.3	7.8
3	21.5	21.5	22.0	8.3	8.4	8.4	9.0	8.4	7.9
4	21.5	21.5	22.0	8.3	8.4	8.4	9.0	8.4	7.7
5	21.5	21.5	22.0	8.2	8.4	8.4	8.7	8.2	7.9
1%									
1	21.5	21.5	22.0	8.3	8.4	8.3	9.0	8.5	8.0
2	21.5	21.5	22.0	8.4	8.4	8.4	9.0	8.5	7.8
3	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.5	7.8
4	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.6	7.9
5	21.5	21.5	22.0	8.4	8.4	8.4	9.1	8.7	7.9
0.1%									
1	21.5	21.5	22.0	8.4	8.4	8.4	9.1	8.3	7.9
2	21.5	21.5	22.0	8.4	8.5	8.4	8.9	8.4	7.9
3	21.5	21.5	22.0	8.4	8.4	8.4	9.1	8.5	7.9
4	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.5	7.9
5	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.6	7.9
Control (UNFILTERED)									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.0
2	21.5	21.5	22.0	8.4	8.4	8.4	8.3	8.8	8.0
3	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.1
4	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.1
5	21.5	21.5	22.0	8.4	8.4	8.4	8.4	8.8	8.2

Analyst JGM/JOK/JS Date Reported Verified

Rock Island Corps of Engineers
Sediment Study

Sample I.D. RAR Reference - Unfiltered

UHL Number 9067218

Conc.	Fish Mortality (No. Dead/No. Tested) 0	48 hr.	Ammonia Nitrogen (mg/L) 0	24 hr.	48 hr.	Total Suspended Solids (mg/L) 0	48 hr.
100%							
1	0/4	1/4		COMPOSITE 1 - 5		90,000	111,600
2	0/4	0/4				91,500	108,000
3	0/4	0/4	2.0	1.6	1.3	96,900	106,600
4	0/4	0/4				90,700	100,100
5	0/4	0/4				95,300	102,500
50%							
1	0/4	0/4		COMPOSITE 1 - 5		44,500	51,000
2	0/4	0/4				45,450	52,700
3	0/4	0/4	1.4	1.2	0.9	45,800	52,500
4	0/4	0/4				44,700	45,900
5	0/4	0/4				44,250	54,200
10%							
1	0/4	0/4		COMPOSITE 1 - 5		8,720	10,190
2	0/4	0/4				9,000	10,080
3	0/4	0/4	0.5	0.3	<0.1	8,940	10,370
4	0/4	0/4				8,960	9,920
5	0/4	0/4				8,860	10,040
1%							
1	0/4	0/4		COMPOSITE 1 - 5		860	960
2	0/4	0/4				895	1,025
3	0/4	0/4	<0.1	<0.1	<0.1	900	970
4	0/4	0/4				900	980
5	0/4	0/4				910	995
0.1%							
1	0/4	0/4		COMPOSITE 1 - 5		74	90
2	0/4	0/4				81	91
3	0/4	0/4	<0.1	<0.1	<0.1	82	91
4	0/4	0/4				79	93
5	0/4	0/4				80	87
Control (UNFILTERED)							
1	0/4	0/4		COMPOSITE 1 - 5		<1	<1
2	0/4	0/4				<1	<1
3	0/4	1/4	<0.1	<0.1	0.1	<1	<1
4	0/4	0/4				<1	<1
5	0/4	0/4				<1	<1

Analyst JGM/JOK/JS Date Reported Verified

Rock Island Corps of Engineers
Sediment Study

Sample I.D. Quiver Island - Filtered

UHL Number 9067219

Conc.	Temperature (°C) 0	24 hr.	48 hr.	pH (Units) 0	24 hr.	48 hr.	Dissolved Oxygen (mg/L) 0	24 hr.	48 hr.
100%									
1	21.5	21.5	22.0	8.2	8.7	8.6	8.8	8.5	7.8
2	21.5	21.5	22.0	8.4	8.7	8.6	9.2	8.5	7.9
3	21.5	21.5	22.0	8.4	8.7	8.7	9.1	8.6	8.0
4	21.5	21.5	22.0	8.3	8.7	8.7	8.9	8.7	8.1
5	21.5	21.5	22.0	8.4	8.7	8.6	9.3	8.6	7.9
50%									
1	21.5	21.5	22.0	8.4	8.6	8.6	9.0	8.7	8.0
2	21.5	21.5	22.0	8.4	8.6	8.6	9.0	8.6	7.8
3	21.5	21.5	22.0	8.3	8.6	8.6	8.8	8.6	7.8
4	21.5	21.5	22.0	8.3	8.6	8.5	9.0	8.7	7.8
5	21.5	21.5	22.0	8.3	8.6	8.6	8.9	8.7	8.0
10%									
1	21.5	21.5	22.0	8.4	8.4	8.4	9.0	8.6	8.1
2	21.5	21.5	22.0	8.4	8.5	8.4	8.7	8.7	7.9
3	21.5	21.5	22.0	8.4	8.5	8.4	8.8	8.7	8.0
4	21.5	21.5	22.0	8.4	8.5	8.4	8.8	8.8	8.2
5	21.5	21.5	22.0	8.4	8.5	8.4	8.9	8.7	8.0
1%									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.7	7.9
2	21.5	21.5	22.0	8.4	8.4	8.4	8.6	8.8	8.1
3	21.5	21.5	22.0	8.4	8.4	8.4	8.8	8.7	7.8
4	21.5	21.5	22.0	8.4	8.4	8.4	9.0	8.8	8.0
5	21.5	21.5	22.0	8.4	8.4	8.4	8.8	8.8	8.1
0.1%									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.6	8.8	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	8.7	8.8	8.0
3	21.5	21.5	22.0	8.4	8.4	8.4	8.9	8.8	8.0
4	21.5	21.5	22.0	8.4	8.4	8.4	8.8	8.8	8.1
5	21.5	21.5	22.0	8.4	8.4	8.5	8.8	8.8	7.9
Control (FILTERED)									
1	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.8	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.8	7.9
3	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.8	8.0
4	21.5	21.5	22.0	8.4	8.4	8.4	7.3	8.7	7.9
5	21.5	21.5	22.0	8.4	8.4	8.4	7.4	8.7	8.1

Analyst JGM/JOK/JS Date Reported Verified JGM

Rock Island Corps of Engineers
Sediment Study

Sample I.D. Quiver Island - Filtered

UHL Number 9067219

Conc.	Fish Mortality (No. Dead/No. Tested) 0	48 hr.	Ammonia Nitrogen (mg/L) 0	24 hr.	48 hr.	Total Suspended Solids (mg/L) 0	48 hr.
100%							
1	0/4	4/4		COMPOSITE 1 - 5		<1	<1
2	0/4	4/4				<1	<1
3	0/4	4/4	10.1	7.9	6.3	<1	<1
4	0/4	4/4				<1	<1
5	0/4	4/4				<1	<1
50%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	5.0	4.1	3.3		
4	0/4	0/4					
5	0/3	0/3					
10%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	1.0	0.9	0.8		
4	0/4	0/4					
5	0/4	0/4					
1%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	0.1	0.1	0.1		
4	0/4	0/4					
5	0/4	0/4					
0.1%							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	<0.1	<0.1	<0.1		
4	0/4	0/4					
5	0/4	0/4					
Control (FILTERED)							
1	0/4	0/4		COMPOSITE 1 - 5		NO DATA	
2	0/4	0/4					
3	0/4	0/4	<0.1	<0.1	>0.1		
4	0/4	0/4					
5	0/4	0/4					

Analyst JGM/JCK/JS Date Reported Verified JCL

Rock Island Corps of Engineers
Sediment Study

Sample I.D. Quiver Island - Unfiltered

UHL Number 9067219

Conc.	Temperature (°C) 0	24 hr.	48 hr.	pH (Units) 0	24 hr.	48 hr.	Dissolved Oxygen (mg/L) 0	24 hr.	48 hr.
100%									
1	21.5	21.5	22.0	8.3	8.7	8.6	8.9	8.4	7.8
2	21.5	21.5	22.0	8.3	8.6	8.6	8.8	8.3	7.7
3	21.5	21.5	22.0	8.2	8.6	8.5	8.7	8.2	7.6
4	21.5	21.5	22.0	8.2	8.7	8.6	8.7	8.4	7.8
5	21.5	21.5	22.0	8.0	8.6	8.5	6.8	8.3	7.7
50%									
1	21.5	21.5	22.0	8.2	8.5	8.5	8.8	7.9	7.9
2	21.5	21.5	22.0	8.2	8.5	8.4	9.0	8.0	7.7
3	21.5	21.5	22.0	8.2	8.5	8.4	8.7	8.2	7.6
4	21.5	21.5	22.0	8.2	8.6	8.5	8.9	8.3	7.8
5	21.5	21.5	22.0	8.2	8.6	8.5	9.0	8.3	7.8
10%									
1	21.5	21.5	22.0	8.2	8.5	8.4	9.0	8.4	7.8
2	21.5	21.5	22.0	8.3	8.5	8.4	9.0	8.5	7.9
3	21.5	21.5	22.0	8.3	8.5	8.4	9.1	8.6	7.8
4	21.5	21.5	22.0	8.3	8.5	8.4	9.0	8.5	7.7
5	21.5	21.5	22.0	8.3	8.5	8.4	8.9	8.3	7.8
1%									
1	21.5	21.5	22.0	8.3	8.5	8.4	9.1	8.6	7.9
2	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.6	7.9
3	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.7	8.0
4	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.4	7.9
5	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.6	7.9
0.1%									
1	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.7	7.8
2	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.7	8.0
3	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.7	8.0
4	21.5	21.5	22.0	8.4	8.5	8.4	9.0	8.7	8.1
5	21.5	21.5	22.0	8.4	8.5	8.4	9.1	8.7	8.0
Control (UNFILTERED)									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.0
2	21.5	21.5	22.0	8.4	8.4	8.4	8.3	8.8	8.0
3	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.1
4	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.1
5	21.5	21.5	22.0	8.4	8.4	8.4	8.4	8.8	8.2

Analyst JGM/JOK/JS Date Reported Verified JGL

Rock Island Corps of Engineers
Sediment Study

Sample I.D. Quiver Island - Unfiltered

UHL Number 9067219

Conc.	Fish Mortality (No. Dead/No. Tested) 0	48 hr.	Ammonia Nitrogen (mg/L) 0	24 hr.	48 hr.	Total Suspended Solids (mg/L) 0	48 hr.
100%							
1	0/4	4/4		COMPOSITE 1 - 5		29,850	37,650
2	0/4	4/4				30,650	36,750
3	0/4	4/4	9.9	7.8	7.2	30,650	36,200
4	0/4	4/4				31,050	36,600
5	0/4	3/4				30,100	35,500
50%							
1	0/4	0/4		COMPOSITE 1 - 5		14,760	18,220
2	0/4	1/4				15,160	17,320
3	0/4	0/4	5.5	4.7	4.2	15,660	17,960
4	0/4	0/4				15,700	17,860
5	0/4	0/4				15,420	17,560
10%							
1	0/4	0/4		COMPOSITE 1 - 5		2,970	3,420
2	0/4	0/4				3,070	3,560
3	0/4	0/4	1.3	1.1	0.9	3,000	3,400
4	0/4	0/4				3,030	3,490
5	0/4	0/4				2,880	3,610
1%							
1	0/4	0/4		COMPOSITE 1 - 5		292	338
2	0/4	0/4				292	324
3	0/4	0/4	0.2	0.1	0.1	294	334
4	0/4	0/4				294	334
5	0/4	0/4				294	336
0.1%							
1	0/4	0/4		COMPOSITE 1 - 5		26	33
2	0/4	0/4				27	33
3	0/4	0/4	<0.1	<0.1	<0.1	28	34
4	0/4	0/4				30	36
5	0/4	0/4				29	32
Control (UNFILTERED)							
1	0/4	0/4		COMPOSITE 1 - 5		<1	<1
2	0/4	0/4				<1	<1
3	0/4	1/4	<0.1	<0.1	0.1	<1	<1
4	0/4	0/4				<1	<1
5	0/4	0/4				<1	<1

Analyst JGM/JCK/JS Date Reported Verified

Rock Island Corps of Engineers
Sediment Study

Sample I.D. Reference Toxicant - Cadmium Chloride - Unfiltered

UHL Number 9067854

	Temperature (°C)			pH (Units)			Dissolved Oxygen (mg/L)		
Conc.	0	24 hr.	48 hr.	0	24 hr.	48 hr.	0	24 hr.	48 hr.
0.7 mg/L									
1	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.8	8.1
2	21.5	21.5	22.0	8.5	8.4	8.4	8.8	8.8	8.1
3	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.7	8.1
4	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.8	8.2
5	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.7	8.2
0.350 mg/L									
1	21.5	21.5	22.0	8.5	8.4	8.4	8.8	8.8	8.2
2	21.5	21.5	22.0	8.5	8.4	8.4	8.8	8.8	8.2
3	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.8	8.2
4	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.7	8.0
5	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.8	7.9
0.175 mg/L									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.9	8.8	8.1
2	21.5	21.5	22.0	8.4	8.4	8.4	8.8	8.8	8.1
3	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.8	7.8
4	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.7	8.1
5	21.5	21.5	22.0	8.5	8.4	8.4	8.9	8.7	8.1
0.088 mg/L									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.9	8.7	8.2
2	21.5	21.5	22.0	8.5	8.5	8.4	8.9	8.7	8.1
3	21.5	21.5	22.0	8.5	8.5	8.4	8.9	8.8	8.2
4	21.5	21.5	22.0	8.5	8.5	8.4	8.9	8.8	7.9
5	21.5	21.5	22.0	8.5	8.5	8.4	8.8	8.8	8.1
0.044 mg/L									
1	21.5	21.5	22.0	8.5	8.5	8.4	8.8	8.6	8.2
2	21.5	21.5	22.0	8.5	8.5	8.4	8.8	8.7	8.1
3	21.5	21.5	22.0	8.5	8.5	8.4	8.8	8.7	8.0
4	21.5	21.5	22.0	8.5	8.5	8.4	8.8	8.8	7.9
5	21.5	21.5	22.0	8.5	8.5	8.4	8.8	8.8	8.1
Control (UNFILTERED)									
1	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.0
2	21.5	21.5	22.0	8.4	8.4	8.4	8.3	8.8	8.0
3	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.1
4	21.5	21.5	22.0	8.4	8.4	8.4	8.5	8.8	8.1
5	21.5	21.5	22.0	8.4	8.4	8.4	8.4	8.8	8.2

Analyst JGM/JCK/JS Date Reported Verified JCL

Rock Island Corps of Engineers
Sediment Study

Sample I.D. Reference Toxicant - Cadmium Chloride - Unfiltered

UHL Number 9067854

Conc.	Fish Mortality (No. Dead/No. Tested) 0	48 hr.	Ammonia Nitrogen (mg/L) 0	24 hr.	48 hr.	Total Suspended Solids (mg/L) 0	48 hr.
0.7 mg/L							
1	0/4	1/4		COMPOSITE 1 - 5			NO DATA
2	0/4	2/4					
3	0/4	2/4		<0.1			
4	0/4	1/4					
5	0/4	1/4					
0.350 mg/L							
1	0/4	0/4		COMPOSITE 1 - 5			NO DATA
2	0/4	0/4					
3	0/4	0/4		<0.1			
4	0/4	0/4					
5	0/4	1/4					
0.175 mg/L							
1	0/4	0/4		NOT ANALYZED			NO DATA
2	0/4	0/4					
3	0/4	0/4					
4	0/4	0/4					
5	0/4	1/4					
0.088 mg/L							
1	0/4	0/4		NOT ANALYZED			NO DATA
2	0/4	2/4					
3	0/4	0/4					
4	0/4	0/4					
5	0/5	0/5					
0.044 mg/L							
1	0/4	0/4		COMPOSITE 1 - 5			NO DATA
2	0/4	0/4					
3	0/4	0/4		0.4			
4	0/4	0/4					
5	0/4	0/4					
Control (UNFILTERED)							
1	0/4	0/4		COMPOSITE 1 - 5		<1	<1
2	0/4	0/4				<1	<1
3	0/4	1/4	<0.1	<0.1	<0.1	<1	<1
4	0/4	0/4				<1	<1
5	0/4	0/4				<1	<1

Analyst JGM/JCK/JS Date Reported Verified

Hygienic Laboratory

The University of Iowa

Oakdale Hall
Iowa City, IA 52242
Telephone: (319) 335-4500
FAX: (319) 335-4555

H.A. Wallace Building
900 East Grand, Des Moines, IA 50319
Telephone: (515) 281-5371
FAX: (515) 243-1349

Report Results To	Sample Identification: 9067854
UHL LIMNOLOGY OAKDALE CAMPUS IOWA CITY, IA 52240	Submitter Reference: Location: COE SEDIMENT STUDY Sample Type: WATER Date Collected: 12/11/90
Date Received: 12/11/90	Collected by: MILLER JOHN
Date Reported: 01/21/91	

Comments
REFERENCE TOXICANT FOR COE SEDIMENT STUDY
REPORT TO JACK KENNEDY

--- Results of Analyses ---

Description: INORGANIC CHEMISTRY

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
CADMIUM	0.67 MG/L	EPA 213.1	SR /SB	12/27/90

Coordinator of analytical services - Lynn Hudachek @ (319) 335-4500

PPM - Parts/Million
PPB - Parts/Billion
< - Less than
Quantitation Limit - Lowest concentration reliably measured

MG/L - Milligrams/Liter
uG/L - Micrograms/Liter
> - Greater than

MG/KG - Milligrams/Kilogram
uG/KG - Micrograms/Kilogram
pCi/L - Pico Curies/Liter