1 of 2

ECOLOGICAL EVALUATION OF PROPOSED
DREDGED MATERIAL FROM BULLS HEAD CHANNEL
(LOWER SUISUN BAY)

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SUMMARY

Bulls Head Channel is located in lower Suisun Bay, just upstream (east) of the Benicia Bridge. Recently, local sponsors requested the U. S. Army Corps of Engineers (USACE) to pursue deepening of Bulls Head Channel to give them access to nearby loading facilities. In August 1993, USACE headquarters reactivated the Bulls Head Channel project, also known as the Wickland Extension, allowing the San Francisco District to proceed with channel design and environmental evaluations.

This report describes the sampling and testing program conducted for USACE by Battelle/Marine Sciences Laboratory (MSL) to address 1) exclusion from further testing for ocean disposal, 2) suitability of open-water disposal within San Francisco Bay, and 3) beneficial uses, based on open-water and upland (leaching) disposal criteria, for the estimated 1.86 million cubic yards of sediment to be dredged from Bulls Head Channel and turning basin. To meet these objectives, core samples were collected from 28 locations to a depth of -47 ft mean lower low water (MLLW), which is -45 ft MLLW plus 2 ft overdepth. One to three samples per coring location were characterized physically and chemically; sediment from groups of locations and from various depth strata were combined into composite samples for biological toxicity characterization in addition to physical and chemical characterization. The chemical and biological tests were conducted following the guidance of USACE, the U. S. Environmental Protection Agency (EPA), and state regulatory agencies as described in two documents: *Testing Guidelines for Dredged Material Disposal at San Francisco Bay Sites* (Public Notice 93-2, USACE 1993), and *Evaluation of Dredged Material Proposed for Ocean Disposal--Testing Manual* (1991 Implementation Manual, EPA/USACE 1991).

Bulls Head Channel sediments could be physically characterized as either mostly sand or as silt and clay with varying amounts of sand. Chemical analyses showed that the Bulls Head Channel sediments were relatively uncontaminated. Metals concentrations were similar to or lower than concentrations found in the adjacent Carquinez Strait reach of the John F. Baldwin Ship Channel, although they often exceeded Alcatraz Environs reference values by up to three times. Organic contaminants were present in very low concentrations (polynuclear aromatic hydrocarbons [PAHs], butyltins, 4,4'-DDD) or undetected (phthalates, polychlorinated biphenyls [PCBs], and pesticides other than 4,4'-DDD) in Bulls Head Channel sediments. Approximately 50% of the sediment does not need to undergo further testing for ocean disposal; most of the material also meets in-bay disposal criteria as well, but the estimated 1.8 million cubic yards of material exceeds the volume limitations on in-bay disposal sites. Much of the material may also be acceptable for beneficial uses. The results of this project indicate that Bulls Head Channel sediment meets the criteria for a variety of disposal options without reason to believe that disposal will result in environmental damage.

CONTENTS

SUMMARY	iii
1.0 INTRODUCTION	1.1
2.0 MATERIALS AND METHODS	2.1
2.1 SEDIMENT SAMPLE COLLECTION	2.1
2.2 SEDIMENT SAMPLE PREPARATION	2.1
2.3 SEDIMENT CHEMISTRY	2.2
2.3.1 Conventional (Grain Size, TOC, TRPH, TVS, Total and Water Soluble Sulfides)	2.2
2.3.2 Metals	2.4
2.3.3 Organics (PAHs, Phthalates, Pesticides, PCBs, Butyltins)	2.4
2.3.4 Waste Extraction Test, STLC Metals, STLC Pesticides and PCBs	2.5
2.4 BIOLOGICAL TESTING	2.5
2.4.1 10-Day Solid Phase Test With the Amphipod, <i>Rhepoxynius abronius</i>	2.6
2.4.2 10-Day Solid Phase Test With the Amphipod, <i>Eohaustorius estuarius</i>	2.7
2.4.3 48-Hour Suspended-Particulate-Phase Test With the Bivalve, <i>Mytilus galloprovincialis</i>	2.8
2.5 DATA ANALYSIS	2.10
2.6 QUALITY ASSURANCE	2.10
3.0 RESULTS	3.1
3.1 SEDIMENT SAMPLE COLLECTION AND PREPARATION	3.1
3.1.1 Geology of Bulls Head Channel	3.1
3.1.2 Sediment and Composite Sample Preparation	3.7
3.2 SEDIMENT CHEMISTRY	3.7
3.2.1 Conventional Parameters	3.9
3.2.2 Metals	3.15
3.2.3 Organic Compounds	3.19
3.2.4 STLC Metals, Pesticides, and PCBs	3.20
3.3 BIOLOGICAL TESTING	3.20
3.3.1 10-Day Solid Phase Test With the Amphipod, <i>Rhepoxynius abronius</i>	3.26
3.3.2 10-Day Solid Phase Test With the Amphipod, <i>Eohaustorius estuarius</i>	3.26
3.3.3 48-Hour Suspended-Particulate-Phase Test With Larvae of the Bivalve, <i>Mytilus galloprovincialis</i>	3.28
4.0 DISCUSSION AND CONCLUSIONS	4.1
4.1 EXCLUSION FROM FURTHER TESTING FROM OCEAN DISPOSAL	4.1
4.2 SUITABILITY FOR OPEN-WATER DISPOSAL WITHIN SAN FRANCISCO BAY	4.2
4.3 BENEFICIAL USES	4.3

4.4 CONCLUSIONS	4.4
5.0 REFERENCES	5.1
APPENDIX A Geologic Core Data Logs	A.1
APPENDIX B Sediment Chemistry and Quality Control Data	B.1
APPENDIX C 10-Day Solid Phase Test With <i>Rhepoxynius abronius</i>	C.1
APPENDIX D 10-Day Solid Phase Test With <i>Eohaustorius estuarius</i>	D.1
APPENDIX E 48-Hour Suspended-Particulate-Phase Test With <i>Mytilus galloprovincialis</i> ..	E.1

FIGURES

1.1	Bulls Head Channel Study Area	1.2
• 3.1	Core Sampling Locations, Bulls Head Channel and Turning Basin	3.3
3.2	Geologic Cross-Sections Along Bulls Head Channel and Proposed Turning Basin	3.5
• 3.3	Geologic Cross-Sections Through the Proposed Turning Basin	3.6
3.4	Stations Contributing to Sand Composites	3.10
3.5	Stations Contributing to Silt/Clay Composites	3.11

TABLES

3.1	Reference Sediment Sampling Information	3.1
3.2	Core Sampling Results, Bulls Head Channel	3.2
3.3	Bulls Head Channel Sediment Sample Preparation and Testing Scheme	3.8
3.4	Conventional Parameters in Bulls Head Channel Sediment	3.12
3.5	Metals in Bulls Head Channel Sediment	3.16
3.6	Organic Parameters Detected in Bulls Head Channel Sediment	3.21
3.7	Soluble Threshold Limit Concentrations (STLC) for Metals in Bulls Head Channel Composites	3.24
3.8	Soluble Threshold Limit Concentrations (STLC) for Pesticides and PCBs in Bulls Head Channel Composites	3.25
3.9	Results of the 10-Day Solid-Phase Test With <i>R. abronius</i> , Based on Number Surviving	3.27
3.10	Results of the 10-Day Solid-Phase Test With <i>R. abronius</i> , Based on Number of Survivors Able to Rebury (Effective Survival)	3.27
3.11	Results of the 10-Day Solid-Phase Test With <i>E. estuarius</i>	3.29
3.12	Results of the 48-Hour Suspended-Particulate-Phase Test With Larval <i>M. galloprovincialis</i>	3.30
• 3.13	Normal Development of <i>M. galloprovincialis</i> Compared to Total Ammonia Levels in SPP Treatments	3.33
4.1	Concentrations of Metals in Bulls Head Channel Sediment Compared to Sediment Screening Levels for Beneficial Uses	4.5
4.2	Summary of Bulls Head Channel Test Results and Comparison to Applicable Criteria	4.7

1.0 INTRODUCTION

Bulls Head Channel is the westernmost 2 miles of the Suisun Bay Channel, located just upstream (east) of the main reaches of the John F. Baldwin Ship Channel and the Benicia Bridge (Figure 1.1). While the San Francisco District of the U.S. Army Corps of Engineers (USACE) has been actively pursuing the deepening of John F. Baldwin Ship Channel from San Francisco Bay to the Benicia-Martinez bridge, the Bulls Head Channel project was deferred for lack of sponsorship. Wickland Oil Company, a major private sponsor of that portion of the channel, had other offloading facilities. In March 1993, Wickland began using its pier in Suisun Bay above the Benicia-Martinez bridge and requested that USACE pursue deepening the Bulls Head Channel. In August 1993, USACE headquarters reactivated the Bulls Head Channel project, also known as the Wickland Extension, allowing the San Francisco District to proceed with channel design and environmental evaluations.

The new design dimensions for Bulls Head Channel are 9800 ft long by 520 ft wide to a depth of -45 ft mean lower low water (MLLW), with a turning basin approximately 1500 ft by 1500 ft that is also dredged to -45 ft MLLW. San Francisco bar pilots requested construction of the turning basin to allow safe maneuvering of ships near the Wickland and Avon piers. Together, deepening the existing channel and constructing the turning basin to -45 ft MLLW require dredging of approximately 1.86 million cubic yards (mcy) of material. Most of that volume (980,000 cy) will be removed during turning basin construction; 880,000 cy will be removed during channel deepening. Possible dredged material disposal options are open-water disposal at an ocean site or within San Francisco Bay, upland disposal, or beneficial uses, such as wetland construction.

This report describes the sampling and testing program conducted for USACE by Battelle/Marine Sciences Laboratory (MSL)^(a) to address 1) exclusion from further testing for ocean disposal, 2) suitability of open-water disposal within San Francisco Bay, and 3) beneficial uses, based on open-water and upland (leaching) disposal criteria, for sediment to be dredged from Bulls Head Channel and turning basin. To meet these objectives, core samples were collected from 28 locations to a depth of -47 ft MLLW (-45 ft MLLW plus 2 ft overdepth). One to three samples per coring location were characterized physically and chemically; sediment from groups of locations and from various depth strata were combined into composite samples for biological toxicity characterization in addition to physical and chemical characterization. The chemical and biological tests were conducted following the guidance of USACE, the U. S. Environmental Protection Agency (EPA), and state regulatory agencies as described in two

(a) The Battelle/Marine Sciences Laboratory is part of the Pacific Northwest Laboratory, which is operated for the U. S. Department of Energy by Battelle Memorial Institute.

FIGURE 1.1. Bulls Head Channel Study Area

documents: *Testing Guidelines for Dredged Material Disposal at San Francisco Bay Sites* (Public Notice 93-2, USACE 1993), and *Evaluation of Dredged Material Proposed for Ocean Disposal--Testing Manual* (1991 Implementation Manual, EPA/USACE 1991). Sampling, testing, data analysis, and quality assurance methods are contained in Section 2.0 of this report. Section 3.0 contains the results of sediment physical, chemical, and biological characterizations. These results are discussed in the context of the study objectives in Section 4.0. Supporting data for the results and conclusions are contained in Appendixes A through E.

2.0 MATERIALS AND METHODS

2.1 SEDIMENT SAMPLE COLLECTION

Sediment core samples were collected from Bulls Head Channel using a 4-in. vibratory-hammer corer. Navigation support was provided by Towill, Inc., of Concord, California. A laser-range system was used to locate the planned sampling sites, which were marked with weighted buoys. Towill provided corrected water depths at each station by measuring the actual depth with a recording fathometer (DE719-E), measuring the water surface elevation, and calculating the difference between the water surface elevation and 0 ft MLLW.

The 4-in. cores were collected and stored in noncontaminating Lexan polycarbonate tubes to maintain the stratigraphic integrity of the sediment for geological characterization from known depths at individual sites. The 4-in. core sampler was deployed from the derrick barge, *Hagar* (operated by Manson Construction of Richmond, California). Sampling procedures were the same as for previous sampling efforts in the John F. Baldwin Ship Channel (Kohn et al. 1991, Kohn et al. 1993). Core sampling records consisted of the station name, date, replicate number, uncorrected water depth, tide height, corrected depth, required core length, sampling time, total core collected, and comments. Sediment samples were stored at $\approx 4^{\circ}\text{C}$ in a freezer on board the derrick barge until all samples were collected.

Water from the lower Suisun Bay dredging site was collected using a peristaltic pump and 25 ft of noncontaminating C-flex tubing. Water was pumped from approximately 15 ft below the surface into solvent-rinsed 5-gal polypropylene carboys. Water and sediment core samples were transferred to a refrigerated ($\approx 4^{\circ}\text{C}$) truck the day after sampling was completed, and immediately transported to the MSL in Sequim, Washington.

In addition to sediment core samples, grab samples of reference sediment for biological testing were collected from the Alcatraz Environs (eight locations) and Bay Farm Borrow Pit (four locations) reference areas. Reference sediments were collected by Brezina & Associates of Dillon Beach, California. Sampling sites were located by vessel LORAN C. Reference sediment was shipped separately to the MSL.

2.2 SEDIMENT SAMPLE PREPARATION

The objectives of this task were to geologically describe the 4-in. cores from the individual Bulls Head Channel sampling stations, homogenize sediment from selected depth intervals (based on physical characteristics) for physical and chemical characterization, and create up to eight sediment composite samples for solid-phase toxicity testing. Geologic descriptions of each core were conducted following American Society for Testing and Materials (ASTM) Method D2488-84 (ASTM 1984). After the cores were geologically described and segmented based on

sediment type, sediment was scooped out of the liner with a stainless steel spatula, homogenized in a stainless steel bowl, and subsampled for chemical analysis. Care was taken not to sample sediment that had been in contact with the core liner or cap. Remaining sediment was contributed to the appropriate composite.

Alcatraz Environs reference, Bay Farm reference, and amphipod native control sediments were press-sieved (dry) through 0.5-mm mesh and homogenized. Reference sediments were also subsampled for chemical analysis; control sediments were subsampled but archived rather than analyzed.

2.3 SEDIMENT CHEMISTRY

Sediment samples from the John F. Baldwin Bulls Head Channel Project were analyzed for the series of inorganic and organic compounds listed in Public Notice 93-2. Samples were analyzed for metals, phthalates, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and chlorinated pesticides, as well as a number of conventional parameters including grain size, total organic carbon (TOC), total recoverable petroleum hydrocarbons (TRPH), total volatile solids (TVS), and total and water soluble sulfides.

2.3.1 Conventionals (Grain Size, TOC, TRPH, TVS, Total and Water Soluble Sulfides)

Grain size of sediment samples was determined by a combination of sieve and pipet techniques (Plumb 1981). Approximately 25 g of sediment was removed for analysis of total solids while another 10- to 100-g aliquot was weighed for grain size analysis. To separate the coarser sand and gravel fraction from the silt/clay fraction, sediment was washed with distilled water through a 63.5- μ m (4.0 phi) sieve into a 1-L graduated cylinder. The coarse fraction was dried, weighed, and shaken through a 2.0-mm sieve to separate the gravel and sand fractions. Any material still passing the 63.5- μ m sieve was added to the previous fines in the 1-L graduated cylinder. The silt/clay fraction was then subdivided by a pipet technique based on Stoke's Law of differential settling velocities for different sized particles. The silt/clay fraction was disassociated by mixing it with a dispersant in distilled water in a 1-L graduated cylinder. At a specified time interval and specified depth below the surface, a 20-mL aliquot of suspension was withdrawn from the graduated cylinder, delivered to a preweighed container, and dried to constant weight at 90°C $\pm$ 2°C. Grain-size data are corrected for dissolved solids (salt) concentrations. Grain-size distribution data are reported as percent gravel, sand, silt, and clay. Quality control measures consisted of duplicate analyses; spikes, standard reference materials (SRMs), and minimum detection limits do not apply to grain size.

TOC analysis was performed by Global Geochemistry of Canoga Park, California. The TOC measurement includes the amount of nonvolatile, partially volatile, volatile, and particulate organic compounds in a sample. The TOC in sediment was determined by measuring the carbon

dioxide released during combustion of the sample (PSEP 1986; SW846 Method 9060, EPA 1986). The sediment sample was dried and ground to a fine powder. Before combustion, inorganic carbonate was removed by acidification. The TOC in sediment was then determined by measuring the carbon dioxide released during combustion of the sample and reported as percent of dry weight. Quality control measures included analysis of a duplicate and the SRM MESS-I with each sample batch.

TRPH were measured by Analytical Resources, Inc. (ARI), of Seattle, Washington, using EPA Method 418.1 (EPA 1979). A 20-g aliquot of sample was dried with anhydrous sodium sulfate, then extracted with freon. Silica gel was added to the extract to remove the animal- and vegetable-based oils, which are generally more polar than the petroleum fraction. The extract was then shaken and allowed to settle, and an aliquot was removed and scanned using infra-red spectrophotometry (IR) from 4000 cm^{-1} to 600 cm^{-1} on an infrared spectrophotometer. The peak height was measured at 2930 cm^{-1} ; this wavelength represents the $-\text{CH}_2$ configuration of hydrocarbons and is the standard used to determine TRPH concentrations. The relationship of peak height to the oil concentration was determined by regression analysis of the peak height versus a known concentration of fuel oil. Concentrations are reported in mg/kg dry weight of sample. Quality control measures included analysis of a blank, duplicate, and matrix spike with each sample batch.

TVS was measured by ARI using EPA Method 160.4 (EPA 1979). TVS is operationally defined by the combustion temperature. TVS is a measure of the fraction of total solids that are lost on ignition at a higher temperature than that used to determine total solids. TVS can be used as an estimate of the amount of organic matter in the total solids, but it does not always represent the total organic content of a sample, because some organic material may be lost at the drying temperature and some inorganic material may be lost at the ignition temperature. To measure TVS, the sample is dried to a constant weight. The dried sample is then combusted at 550°C. The sample is cooled in a dessicator and then re-weighed. The amount of sample lost during ignition is defined as the volatile fraction and is reported as a percent of sample dry weight. Quality control measures included duplicate analyses; spikes and standard reference materials do not apply to TVS.

Total and water soluble sulfides were also analyzed by ARI. Total sulfides were measured using EPA method 376.1 (EPA 1979), which requires acidification and distillation to release sulfide from the sediment. Released sulfide is then trapped in zinc acetate, and this solution is then analyzed by the spectrophotometric methylene-blue procedure. Water soluble sulfides were analyzed by mixing an aliquot of sediment with N_2 purged water using a 1:1 ratio. The water is removed using centrifugation and analyzed by the spectrophotometric methylene-blue procedure. Quality control measures included analysis of blanks and duplicates.

2.3.2 Metals

Metals were analyzed at the MSL and at the Pacific Northwest Laboratory in Richland Washington. Ten metals were measured in JFB sediments: silver (Ag), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), selenium (Se), and zinc (Zn). Six metals (As, Cr, Cu, Ni, Pb and Zn) were measured by energy-diffusive x-ray fluorescence (XRF). Mercury was analyzed by cold-vapor atomic absorption spectroscopy (CVAA) (Bloom and Crecelius 1984), whereas Ag, Cd, and Se were analyzed by Zeeman graphite-furnace atomic absorption spectroscopy (GFAA) (EPA method 200.9, EPA 1991).

Samples were freeze-dried, then blended in a Spex mixer-mill as preparation for their analysis. Approximately 5 g of mixed sediment was ground in a ceramic ball mill. The XRF analysis was performed on a 0.5-g aliquot of dried, ground sediment pressed into a pellet of 2 cm diameter. For GFAA and CVAA analysis, 0.2-g aliquots of dried homogenate went through an acid digestion process to separate and isolate the metals from the sediment. Quality control measures for metals analysis included analysis of blanks (not applicable to XRF technique), analytical replicates, and two SRM samples: National Institute of Science and Technology (NIST) SRM 1646 and National Research Council of Canada (NRCC) SRM BEST-1 (for Hg only).

2.3.3 Organics (PAHs, Phthalates, Pesticides, PCBs, Butyltins)

The 16 priority pollutant PAHs and 5 phthalate compounds were analyzed by MSL. Sediment samples were extracted with methylene chloride using the roller technique at ambient temperatures. Four radio-labelled PAH compounds were added as surrogate internal standards prior to extraction to assess efficiency of extraction. Sample results are corrected for the recovery of these compounds. Interferences were removed from the extracts using high-pressure liquid chromatography (HPLC). Sample extracts were concentrated and analyzed using gas chromatography with mass spectrometry (GC/MS) in the selective ion monitoring mode, which is based on EPA method 8270 (EPA 1986). Quality control included a method blank, analytical duplicates, matrix spikes, and analyses of a standard reference material sediment obtained from NIST (SRM 1941a). NRCC SRM HS-4 was also analyzed for PAH compounds, although the levels of PAH compounds in this SRM are relatively high compared to the levels measured in the samples.

Pesticides and PCBs were also analyzed by MSL. Sediment samples were extracted for pesticides and PCBs simultaneously with the PAHs and phthalates. Two PCB congeners (PCB 103 and PCB 198) were added as surrogate internal standards prior to extraction to assess efficiency of extraction. Interferences were removed from the extracts using HPLC. Sample extracts were concentrated and analyzed using gas chromatography with electron capture detection (GC-ECD) following a modified version of EPA SW846 Method 8080 (EPA 1986).

Quality control included analysis of a method blank, duplicates, matrix spikes, and NIST SRM 1941a.

Butyltins were analyzed at the MSL using gas chromatography with flame photometric detection (GC-FPD) following the methods of Unger et al. (1986). Sediment samples were extracted with methylene chloride using a roller under ambient conditions. Triphenyltin was added as a surrogate internal standard prior to extraction to assess extraction efficiency. The mono-, di-, and tributyltin compounds extracted from the sediment were derivatized with n-hexyl magnesium bromide (Grignard reagent) to a less volatile, more thermally stable form (nonionic n-hexyl derivatives) compatible with gas chromatography. Sample extracts were passed through a florisil column for cleanup and analyzed using GC-FPD. Concentrations were reported in ug/kg dry weight of mono-, di- and tributyltin species as tin. NRCC SRM PACS-1, which is certified for mono-, di- and tributyltin, was also analyzed. Other quality control measures included analysis of a method blank, duplicate, and matrix spike with each batch.

2.3.4 Waste Extraction Test, STLC Metals, and STLC Pesticides and PCBs

California State Title 22 Waste Extraction Tests (WET) and subsequent analyses for soluble threshold limit concentrations (STLC) of metals, pesticides, and PCBs were conducted by Clayton Environmental Consultants of Pleasanton, California. WET extracts (membrane-filtered liquid portion of sediment sample) were measured for metals by either EPA Method 6010 (inductively-coupled plasma or ICP) or by atomic absorption. Extracts were prepared and measured for pesticides and PCBs following EPA Methods 3510 and 8080. Two surrogate internal standards were added prior to extraction: decachlorobiphenyl and tetrachloro-m-xylene. Quality control samples for both metals and organics analyses included a method blank, matrix spike, and matrix spike duplicate.

2.4 BIOLOGICAL TESTING

Biological tests to assess the ecological effects of in-bay disposal of dredged material from Bulls Head Channel were conducted on the solid and suspended phases of test sediment at the MSL in Sequim, Washington. Laboratory equipment necessary to provide the required conditions for static solid-phase and suspended-particulate-phase (SPP) tests was available at the MSL facilities, including a temperature-controlled environment, flow-through seawater supply, lighting control, and air supply.

The solid-phase tests were used to assess the acute toxicity of dredged material after settling at an aquatic disposal site. Ten-day acute solid-phase tests were conducted with two species of marine amphipod, *Rhepoxynius abronius* and *Eohaustorius estuarius*. The SPP test evaluates potential biological effects of dredged material being discharged through the water column during disposal operations; it allows assessment of effects caused by both the physical

presence of suspended particles in the water column and the toxicity of chemical contaminants associated with the particles and dissolved fractions. The larvae of the mussel, *Mytilus galloprovincialis*, were exposed to five concentrations of SPP.

Prior to any biological testing, a 250-mL aliquot of each sediment composite was centrifuged 45 min at 1750 rpm to extract porewater for preliminary salinity and total ammonia measurements. Preliminary porewater salinity was measured with a Reichert optical refractometer. Preliminary porewater ammonia was measured using a Fisher Accumet 1003 meter with an ammonia ion-specific electrode. Salinity and total ammonia measurements were used to predict potential solid-phase toxicity unrelated to chemical contamination. Precautions to avoid these effects are described in the following sections.

2.4.1 10-Day Solid Phase Test With the Amphipod, *Rhepoxynius abronius*

R. abronius amphipods were captured by the MSL off West Beach, Whidbey Island, Washington, using a specially designed anchor dredge deployed from a 17-ft Boston Whaler. The amphipods were held in a large tank containing their native sediment and flowing 15°C seawater. Organisms were not fed during the holding period, as food was available from the holding sediment. The amphipod holding period was 1.5 weeks before test initiation.

The 10-day test was conducted in 1-qt glass jars placed in random positions on a water table maintained at 15°C; 200 mL of test sediment was added to each jar, and the jars were slowly filled with 0.45- μ m-filtered seawater to the test volume of 750 mL. Exceptions to this procedure were three test treatments that had low salinity and high ammonia in the bulk sediment porewater. Comps TB-E Lower, BHC-A Lower, and BHC-B were manipulated as follows to minimize salinity and ammonia effects.

To avoid toxicity due to low salinity, the 200 mL sediment was thoroughly mixed with 200 mL filtered seawater before the jar was filled to 750 mL. Test containers were placed on the water table, allowed to settle for several hours, then aerated overnight. To avoid toxicity due to high porewater ammonia, procedures described in a recent EPA/USACE memorandum were followed: the overlying water was siphoned off (after overnight settling and aeration) and the jar refilled to 750 mL with clean filtered seawater and allowed to settle (with aeration) (EPA/USACE 1993). This process was repeated twice a day until porewater ammonia in the test chamber was below 30 mg/L. Porewater ammonia levels were ascertained by setting up two additional jars of sediment and water along with the five test replicates. After each day of settling, aeration, and overlying water replacement, one of the extra jars was sacrificed for the porewater ammonia measurement. The overlying water was siphoned off and the sediment was centrifuged for 45 min at 1750 rpm. Ammonia was measured in the supernatant.

Once initial water quality parameters were established to be in acceptable range in each container, the test was initiated by adding 20 *R. abronius* to each test container. Amphipods were gently sieved from the holding tank into clean seawater and counted into small transfer containers. The number of organisms was confirmed before they were transferred into the test container. Water temperature, salinity, pH, and DO were measured daily in one replicate of each treatment and in all containers at initiation and termination of the bioassay. Acceptable ranges for water quality parameters during the experiment were as follows:

temperature	15.0°C±2.0°C
dissolved oxygen	≥5.4 mg/L
pH	7.8±0.5 unit
salinity	30‰±2.0‰

At the end of the test (Day 10), the contents of each jar were sieved through a 0.5-mm Nytex screen to collect the *R. abronius*. The number of live and dead organisms in each dish was counted and recorded. If a *R. abronius* did not respond to gentle probing after several minutes of observation, the organism was considered dead. At least 10% of the mortality counts were confirmed by a second analyst. Immediately after the count, surviving *R. abronius* were transferred to clean native sediment (≈100 mL sediment plus ≈50 mL overlying seawater) and allowed 1 hour to rebury. The number of *R. abronius* that did not rebury was recorded. The proportion that was able to rebury is reported as effective survival in Section 3.3.1.

To assess the sensitivity of *R. abronius* response to a known contaminant, a reference toxicant test with cadmium was conducted. The reference toxicant test was a static 96-hour exposure to four concentrations of cadmium chloride (0.5, 1.0, 2.0, 4.0 mg/L as Cd) in the absence of sediment. Three 750-mL replicates of each concentration, including a seawater control, were placed randomly on the water table. The test was initiated, monitored, and terminated in a manner similar to that of the 10-day sediment test.

2.4.2 10-Day Solid Phase Test With the Amphipod, *Eohaustorius estuarius*

E. estuarius amphipods collected from Beaver Creek, Oregon, were obtained from Northwest Aquatic Sciences of Newport, Oregon. *E. estuarius* were acclimated to 27.5‰ salinity prior to shipping. When received at MSL, *E. estuarius* were held in a 10-gal aquarium containing their native sediment and flowing 15°C seawater. Organisms were not fed during the holding period, as food was available from the holding sediment. The amphipod holding period was 4 to 5 days before test initiation.

The procedure and test conditions for conducting the 10-day solid phase test with *E. estuarius* was the same as for *R. abronius* (ASTM 1990), with minor differences. The reburial test was not done for *E. estuarius*. Potential toxicity due to salinity and ammonia was avoided in

the same manner as for *R. abronius*, but only 1 day of aeration and overlying water replacement was necessary to reduce porewater ammonia to acceptable levels, based on the EPA/USACE memorandum. In the *E. estuarius* test, four surrogate replicates of each of the three problem sediments had been set up to monitor porewater ammonia (compared to two surrogates in the *R. abronius* test). As only two sets of surrogates were sacrificed before test initiation, the other two were treated exactly as the test replicates. One set of surrogates was sacrificed for porewater ammonia on Test Day 5, and the other set was sacrificed on Test Day 9 to determine porewater ammonia concentrations during the exposure. One other difference between the *R. abronius* and *E. estuarius* tests is that *E. estuarius* were exposed to much higher concentrations of Cd in the reference toxicant test (6, 12, 18, and 24 mg/L as Cd).

2.4.3 48-Hour Suspended-Particulate-Phase Test With the Bivalve, *Mytilus galloprovincialis*

SPP was prepared by creating a 4:1 (volume:volume) water to sediment slurry in 1-L glass jars with Teflon-lined lids. The jars were placed on a shaker table and agitated for 30 min at a rate of 120 to 150 cycles/min. After shaking, the slurry was poured into 500-mL Teflon containers, which were placed in a centrifuge and spun for 10 min to 15 min at approximately 1750 rpm. After centrifugation, the supernatant was poured into clean, labelled, 1-gal glass jars and used to prepare SPP dilutions as soon as possible. For the Bulls Head Channel Project, Sequim Bay seawater was used for both preparation and dilution of SPP.

Adult bay mussels (*M. galloprovincialis*) were obtained from Marinus, Inc. of Long Beach, California. Mussels were held in flowing, unfiltered Sequim Bay seawater at ambient temperatures for approximately 5 days. Chambers for the bivalve-larvae test were labelled 500-mL glass jars, with a test solution volume of 300 mL. Dilutions of SPP (0%, 1%, 10%, 50%, and 100%) were prepared with Sequim Bay seawater in a 2000-mL graduated cylinder, then 300 mL of test solution was poured directly into each of five replicate test chambers. After all chambers reached testing temperatures ($16^{\circ}\text{C} \pm 2^{\circ}\text{C}$), initial water quality parameters were measured in all replicates. Test chambers were placed in random positions on a water table and provided with gentle aeration.

Spawning was induced by placing adult *M. galloprovincialis* into 15°C , filtered Sequim Bay seawater and rapidly raising the holding water temperature to 20°C . Spawning generally occurred within 1 hour of temperature elevation. Spawning males and females were isolated in individual jars with filtered Sequim Bay seawater and allowed to shed gametes for approximately 45 min. Eggs from each female were then filtered into separate jars through a $75\text{-}\mu\text{m}$ Nytex screen to remove feces, detritus, and byssal fibers. Sperm from at least three males was pooled and 10 mL of sperm solution was then added to the egg stocks. Egg-sperm solutions were mixed every 10 min with a perforated plunger. Fertilization proceeded for 1 hour, then the fertilization rate (percent fertilized) was determined by removing a subsample and counting the number of multi-

cell stage embryos. Fertilization was considered successful if greater than 90% of the embryos reached the multi-cell stage. To prevent polyspermy, egg stocks with greater than 90% fertilization were rinsed on a 20- μ m Nytex screen to remove excess sperm. Embryo stock-solution density was estimated by removing a 0.1-mL subsample and counting all multi-cell embryos, then multiplying by 10 to yield embryo density (embryos/mL). Stock solution was diluted or concentrated to yield 7500-9000 embryos/mL. The test was initiated by introducing 1 mL of stock solution into each test chamber to produce embryo densities of 25-30 embryos/mL in each. Test initiation date and time were recorded on data sheets. Following initiation, 10 mL stocking density subsamples were removed from each container and preserved in 10% formaldehyde to determine actual stocking density.

Water quality parameters were measured in one replicate per treatment daily throughout the test. Acceptable ranges for water quality parameters were:

temperature	16°C $\pm$ 2°C
dissolved oxygen	$\geq$ 4.0 mg/L
pH	7.8 $\pm$ 0.5
salinity	30.0‰ $\pm$ 2.0‰

The bivalve test was terminated after 48 hours, when greater than 90% of the larvae in the controls had reached the D-cell stage (prodissoconch I). Final water quality parameters were recorded for all replicates. Each chamber was then homogenized using a perforated plunger, and a 10-mL subsample was removed and placed into 20-mL scintillation vial. The subsample was then fixed with 1 mL of 50% formaldehyde in seawater. In addition, ammonia concentrations were measured in one replicate of all 50% SPP and 100% SPP treatments. For the composites with high bulk sediment porewater ammonia levels (Comps TB-E Lower, BHC-A Lower, and BHC-B), ammonia concentrations were measured in one replicate of each SPP concentration.

Preserved samples were scored for the appearance of normal D-shaped larvae (prodissoconch I), abnormal prodissoconch I larvae, developmentally delayed/developmentally delayed-abnormal larvae (categorized as "other stages" in Appendix E), and total number of larvae. At least 10% of the counts were confirmed by a second observer.

A 48-hour reference toxicant test was conducted with each batch of test larvae to establish the health and expected response of the test organisms. *M. galloprovincialis* larvae were exposed to a filtered Sequim Bay seawater control plus copper sulfate concentrations of 1, 4, 16, and 64 μ g/L as Cu, with three replicates per concentration. Because only three or four SPP treatments could be tested concurrently, a reference toxicant test was performed on each of the three days that a set of SPP treatments was initiated. The reference toxicant tests were set up and conducted in the same manner as the SPP tests.

2.5 DATA ANALYSIS

Several statistical analyses were conducted to determine the magnitude and significance of toxicity in test treatments relative to reference treatments. Each statistical test is based on a completely random design that allows unbiased comparison between treatments. In the laboratory, this means that organisms were randomly allocated to treatments, and treatments were randomly positioned on water tables. Prior to statistical analysis, all bioassay data (solid-phase and SPP) was transformed to the arcsine square root of the proportion of organisms surviving.

Solid-phase treatments were compared by analysis of variance (ANOVA) followed by the multiple comparison Dunnett's Test with $\alpha = 0.05$. Dunnett's Test compared solid-phase toxicity of Bulls Head Channel composites first to the Alcatraz Environs reference, then to the Bay Farm reference. Technically, Dunnett's Test is an inappropriate analysis for comparing the same test treatments to two different but concurrently tested reference treatments; such testing of non-independent data sets increases the chance of statistical errors in both sets of comparisons. These errors are usually the identification of differences as statistically significant when they are not, therefore the approach is more environmentally conservative (more treatments are identified as significantly different from reference). It is possible to avoid statistical errors by comparing the data to all reference treatments at once, maintaining the experiment-wise error rate, with a test such as Tukey's Honestly Significant Difference (HSD) Test or Dunn's Test.

Statistical analysis of the SPP test with *M. galloprovincialis* was conducted as described in the Implementation Manual (Green Book) for ocean disposal evaluations of dredged material (EPA/USACE 1991). If survival in the 100% SPP was less than control (0% SPP) survival and when control survival was greater than 90% (indicating test validity), survival in the 0% and 100% SPP was compared in a one-sided t-test. Normal larval development (as opposed to survival) in the 0% and 100% SPP was also compared by a one-sided t-test. If survival decreased with increasing SPP concentration, and fell below 50% relative to controls, the median lethal concentration (LC50) was estimated using the Trimmed Spearman-Kärber method (Hamilton et al. 1977). If 50% mortality did not occur in the 100% SPP, the LC50 value was reported as >100% SPP. The same method was used to calculate median effective (EC50) values for the normal development endpoint in the *M. galloprovincialis* SPP test, and LC50 values for all reference toxicant tests.

2.6 QUALITY ASSURANCE

Work on the Bulls Head Channel Project was conducted under the quality assurance (QA) plan developed for previous John F. Baldwin Ship Channel Program work, described in detail in the Tier III report (Kohn et al. 1993). This plan ensured compliance with the quality control (QC) and QA requirements of the Implementation Manual (EPA/USACE 1991), and required only minor modification to accommodate the requirements of PN 93-2. All project staff

were required to be familiar with the QA plan prior to working on any part of the project. The plan included QA/QC goals and procedures for sample handling, toxicity testing, analytical chemistry, record-keeping, and data handling.

3.0 RESULTS

3.1 SEDIMENT SAMPLE COLLECTION AND PREPARATION

Grab samples of surface sediment were collected from the Alcatraz Environs and Bay Farm Borrow Pit reference areas by Brezina and Associates for biological testing (Table 3.1). Sediment core samples from 24 stations in Bulls Head Channel and proposed turning basin, plus 4 stations outside the proposed turning basin, were collected to the project depth of -45 ft MLLW plus 2 ft overdepth (Table 3.2, Figure 3.1). At stations TB-21 and TB-22 in the proposed turning basin, cores did not reach full project depth of -47 ft MLLW, but sediment was collected beyond -45 ft MLLW. All core samples were shipped to MSL for geologic description and preparation of individual and composite sediment samples, as described in the following sections.

3.1.1 Geology of Bulls Head Channel

In this section, the distribution and physical characteristics of sediments in the Bulls Head Channel are described. Geologic cross-sections were constructed using the core data logs prepared for each 4-in. core sample. The 28 coring locations are shown in Figure 3.1 and core data logs are provided in Appendix A.

Unconsolidated sedimentary deposits in San Francisco Bay are divided into three distinct units: the "older bay mud" (OBM), sand deposits, and "younger bay mud" (YBM), in order of decreasing age and higher stratigraphic position (Goldman 1969). Only the YBM was penetrated during core sampling in the Bulls Head Channel. The YBM is typically composed of

TABLE 3.1. Reference Sediment Sampling Information

Reference Area	Station	Date Collected	Station Location		Depth (ft)	Volume Collected
			Latitude (N)	Longitude (W)		
Alcatraz Environs	R-AM-A	01-07-94	37°49.75'	122°25.90'	66	1 gal
	R-AM-B	01-07-94	37°49.73'	122°25.57'	64	1 gal
	R-AM-C	01-07-94	37°49.77'	122°24.90'	64.5	1 gal
	R-AM-D	01-07-94	37°49.27'	122°25.88'	72	1 gal
	R-AM-F	01-07-94	37°49.28'	122°24.90'	82	0.5 gal
	R-AM-F	01-07-94	37°49.27'	122°24.90'	80	0.5 gal
	R-AM-G	01-07-94	37°48.80'	122°25.88'	59	1 gal
	R-AM-H	01-07-94	37°48.83'	122°25.57'	47.5	1 gal
	R-AM-I	01-07-94	37°48.82'	122°24.89'	52.5	1 gal
Bay Farm (R-BF)	R-BF 2	01-07-94	37°44.50'	122°17.14'	32	1 gal
	R-BF 3	01-07-94	37°44.44'	122°16.77'	33	1 gal
	R-BF 4	01-07-94	37°44.71'	122°16.81'	28	1 gal
	R-BF 5	01-07-94	37°44.61'	122°16.36'	29.5	1 gal

TABLE 3.2. Core Sampling Results, Bulls Head Channel (all cores collected with 4-in. vibratory-hammer core sampler)

Station ID	Date Collected	California State Plane Coordinates (Zone III)		Mudline Elevation (-ft MLLW)	Project Depth (-ft MLLW)	Core Required (ft)	Core Collected (ft)
		North	East				
BHC-1	01-15-94	564,382	1,534,127	40.8	47.0	6.2	6.2
BHC-2	01-15-94	565,099	1,534,940	36.9	47.0	10.1	11.0
BHC-3	01-13-94	564,855	1,535,045	39.3	47.0	7.7	8.5
BHC-4	01-15-94	565,413	1,535,773	36.6	47.0	10.4	11.1
BHC-5	01-16-94	565,806	1,536,450	38.5	47.0	8.5	9.0
BHC-6	01-16-94	566,179	1,537,159	43.2	47.0	3.8	3.2
BHC-7	01-16-94	567,301	1,538,869	36.6	47.0	10.4	10.5
BHC-8	01-16-94	567,095	1,539,014	41.8	47.0	5.2	5.5
BHC-9	01-16-94	567,662	1,539,857	42.0	47.0	5.0	4.2
TB-10	01-16-94	567,579	1,539,037	30.4	47.0	16.6	17.0
TB-11	01-13-94	568,007	1,539,118	39.7	47.0	7.3	6.9
TB-12	01-16-94	568,092	1,539,793	39.8	47.0	7.2	7.2
TB-13	01-16-94	568,232	1,540,260	43.0	47.0	4.0	4.5
TB-14	01-16-94	568,369	1,539,613	37.1	47.0	9.9	9.7
TB-15	01-13-94	568,686	1,539,453	29.7	47.0	17.3	19.4
TB-16	01-15-94	568,989	1,540,135	28.3	47.0	18.7	19.6
TB-17	01-15-94	569,198	1,540,664	28.3	47.0	18.7	19.0
TB-18	01-15-94	568,637	1,540,282	37.1	47.0	9.9	9.8
TB-19	01-15-94	568,808	1,540,735	31.9	47.0	15.1	15.1
TB-20	01-15-94	568,981	1,541,263	29.2	47.0	17.8	18.0
TB-21	01-15-94	568,447	1,540,825	38.0	47.0	9.0	6.9(a)
TB-22	01-15-94	568,593	1,541,293	33.0	47.0	14.0	11.7(a)
TB-23	01-15-94	568,811	1,541,786	29.0	47.0	18.0	18.9
TB-24	01-15-94	568,676	1,542,535	37.4	47.0	9.6	10.0
TB-25	01-13-94	567,745	1,538,612	38.1	47.0	8.9	10.0
TB-26	01-15-94	568,414	1,538,932	28.6	47.0	18.4	20.0
TB-27	01-15-94	569,402	1,541,356	26.8	47.0	20.2	20.0
TB-28	01-15-94	569,103	1,542,116	29.0	47.0	18.0	19.4

(a) Approximately 0.8 ft additional firm clay material was collected at location but not contained in core liner.

FIGURE 3.1. Core Sampling Locations, Bulls Head Channel and Turning Basin

very soft to soft, gray to black silty clay with minor fine-grained sand, decayed organic material, and shell fragments. It was deposited in an estuarine environment during and after the melting of the Wisconsin continental glaciers, from approximately 10,000 years ago to the present. In addition, hydraulic mining in Sierra Nevada gold districts from about 1853 to 1884 resulted in the shoaling of the upper bay by a few meters (Hedgpeth 1979).

Core samples from the Bulls Head Channel ranged from 3.2 ft to 20.0 ft thick. Sediments were divided into the following three units based on lithology: homogeneous dark gray clay, dark gray to black interbedded fine sand and clay, and poorly-graded gray to brown medium sand. The distribution of these units throughout the study area is shown in Figures 3.2 and 3.3. Each unit is described below.

The homogeneous clay and interbedded sand and clay occur throughout the proposed channel and turning basin. These units are not laterally continuous, and vertical and lateral changes from one to the other are common. Contacts between the two units are sharp or gradational. The clay is very soft to soft, and dark gray to olive gray. The clay unit contains numerous partially decayed, yellowish-brown, grooved and jointed plant stalks. The stalks are hollow and round, and typically oriented in an upright position. The plants appear to be *Equisetum* species (horsetail ferns), which often grow in low-energy, shallow freshwater environments. The clay also has many thin (<1 in.) layers of partially decayed organic material, and few fine sand laminae and shell fragments. A hard, dry, light gray layer less than 1 ft thick was observed in two cores (BHC-4 and TB-16). The clay appears to have been deposited in a freshwater environment, probably on the floodplain of a stream discharging to the bay.

The interbedded sand and clay unit is dark gray or black. Sediment layers range in thickness from several inches to several feet. Sediment types include poorly-graded fine black sand, fine-grained sand with clay, clay with sand laminae, and minor silt. Grain size changes are commonly gradational. The sand layers are of firm consistency, and the clay and silt are very soft to soft. The sediments contain few shell fragments and little plant material. The numerous vertical changes in grain size reflect deposition in an environment with a fluctuating current speed. The interfingering of this unit with the freshwater clay described above indicates that the area was characterized by a dynamic shoreline.

A poorly-graded sand unit overlies the clay and interbedded sand and clay in portions of the Bulls Head Channel and most of the proposed turning circle (Figures 3.2 and 3.3). The sand is discontinuous and has a maximum thickness of 9.7 ft at Station TB-14. It is predominantly medium-grained, although grain sizes range from medium to very coarse. It is dark olive gray or dark grayish brown, and soft to firm in consistency. Sand grains are subangular and composed of quartz, muscovite, feldspar, and dark-colored minerals. Many grains are coated with iron oxide. The sand unit also contains few shell fragments and thin layers (less than 2 in.) of woody debris

FIGURE 3.2. Geologic Cross-Sections Along Bulls Head Channel and Proposed Turning Basin

FIGURE 3.3. Geologic Cross-Sections Through the Proposed Turning Basin

and chunks of wood. These sands probably represent recent channel deposits. The San Joaquin and Sacramento rivers supply 85% by weight of the sediment to San Francisco Bay (Schlocker 1974); most of the sand is deposited in the delta and in tidal channels in Suisun Bay, while the finer-grained sediment is carried farther into the bay.

3.1.2 Sediment and Composite Sample Preparation

Immediately following geologic description, sediment from discrete vertical segments within a single 4-in. core were subsampled based on sediment type (sand, clay, or interbedded sand/clay) as determined by the geologist (Table 3.3). Sediment from the 4-in. cores was removed immediately after the geological description was finished, using clean stainless steel implements and labelled bowls, and avoiding material that had been in contact with the Lexan core liner. The sediment was mixed until color and consistency appeared homogeneous, then aliquots for the various chemical analyses were removed to the appropriate clean, labelled jars. The remaining sediment was then combined with sediment from other stations to form a composite sample. Rather than following the proposed compositing scheme, which was based on the assumption that the sediment would be homogeneous throughout the study area, samples of similar sediment type from geographically contiguous stations were combined (Table 3.3, Figures 3.4 and 3.5). This revised compositing scheme was developed with EPA and USACE at the time of sample processing. The sediment composites were also mixed in a stainless steel bowl until homogeneous, and were subsampled for chemical analysis. The composites were stored in sealed containers at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ until used in toxicity tests.

Reference and control sediments were sieved through 0.5-mm to 1.0-mm mesh to remove organisms that might affect the outcome of biological tests. Sieved sediment was mixed in a stainless steel bowl until homogeneous. Homogenized reference and control sediments were stored at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ until biological testing.

3.2 SEDIMENT CHEMISTRY

Eight composites, 46 individual samples (38 from cores within the proposed dredging area, 8 from cores outside the proposed dredging area), and 2 reference sediments were analyzed for a variety of physical and chemical parameters. The results of these analyses are summarized in the following section; complete sediment chemistry and quality control data are contained in Appendix B.

TABLE 3.3. Bulls Head Channel Sediment Sample Preparation and Testing Scheme

Sample ID	Mudline Elevation (-ft MLLW)	Vertical Segment (Incremental ft)	Vertical Segment (-ft MLLW)	PN 93-2 Sediment Chemistry	CA Title 22 WET Test, STLC	Solid Phase Amphipod Bioassays	SPP Bivalve Bioassay
Comp BHC-A Upper (sand from following stations)				Yes	Yes	Yes	Yes
BHC-2	36.9	0-7.0	36.9-43.9	Yes	No	No	No
BHC-4	36.6	0-1.5	36.6-38.1	Yes	No	No	No
BHC-5	38.5	0-1.4	38.5-39.9	Yes	No	No	No
BHC-6	43.2	0-1.5	43.2-44.7	Yes	No	No	No
Comp BHC-A Lower (clay, silt from following stations)				Yes	Yes	Yes	Yes
BHC-1	40.8	0-6.2	40.8-47.0	Yes	No	No	No
BHC-2	36.9	7.0-10.1	43.9-47.0	Yes	No	No	No
BHC-3	39.3	0.6-7.7	39.3-46.4	Yes	No	No	No
BHC-4	36.6	1.5-10.4	38.1-47.0	Yes	No	No	No
BHC-5	38.5	1.4-8.5	39.9-47.0	Yes	No	No	No
BHC-6	43.2	1.5-3.2	44.7-46.4	Yes	No	No	No
Comp BHC-B (clay, silt from following stations)				Yes	Yes	Yes	Yes
BHC-7	36.6	0-10.4	36.6-47.0	Yes	No	No	No
BHC-8	41.8	0-5.2	41.8-47.0	Yes	No	No	No
BHC-9	42.0	3.2-4.2	45.2-46.2	Yes	No	No	No
TB-10	30.4	0-9.8	30.4-40.2	Yes	No	No	No
TB-12	39.8	0-7.2	39.8-47.0	Yes	No	No	No
Comp TB-C (brown sand from following stations)				Yes	Yes	Yes	Yes
BHC-9	42.0	0-3.2	42.0-45.2	Yes	No	No	No
TB-11	39.7	0-6.9	39.7-46.6	Yes	No	No	No
TB-13	43.0	0-4.0	43.0-47.0	Yes	No	No	No
TB-14	37.1	0-9.7	37.1-46.8	Yes	No	No	No
TB-18	37.1	0-3.1	37.1-40.2	Yes	No	No	No
TB-19	31.9	0-1.5	31.9-33.4	Yes	No	No	No
TB-20	29.2	0-6.0	29.2-35.2	Yes	No	No	No
TB-21	38.0	0-3.8	38.0-41.8	Yes	No	No	No
TB-22	33.0	0-2.0	33.0-35.0	Yes	No	No	No
TB-23	29.0	0-0.7	29.0-29.7	No	No	No	No
TB-24	37.4	0-2.7	37.4-40.1	Yes	No	No	No
Comp TB-D Upper (fine gray sand from following stations)				Yes	Yes	Yes	Yes
TB-15	29.7	0-17.3	29.7-47.0	Yes	No	No	No
TB-16	28.3	0-2.3	28.3-30.6	Yes	No	No	No
TB-17	28.3	0-4.2	28.3-32.5	Yes	No	No	No
Comp TB-D Lower (fine gray sand from following stations)				Yes	No	Yes	Yes
TB-10	30.4	9.8-16.4	40.2-46.8	Yes	No	No	No
Comp TB-E Upper (gray sand from following stations)				Yes	Yes	Yes	Yes
TB-21	38.0	3.8-6.3	41.8-44.3	Yes	No	No	No
TB-22	33.0	2.0-11.7	35.0-44.7	Yes	No	No	No

TABLE 3.3. (contd)

Sample ID	Mudline Elevation (-ft MLLW)	Vertical Segment (Incremental ft)	Vertical Segment (-ft MLLW)	PN 93-2 Sediment Chemistry	CA Title 22 WET Test, STLC	Solid Phase Amphipod Bioassays	SPP Bivalve Bioassay
Comp TB-E Lower (clay, silt from following stations)				Yes	Yes	Yes	Yes
TB-16	28.3	2.3-18.7	30.6-47.0	Yes	No	No	No
TB-17	28.3	4.2-18.7	32.5-47.0	Yes	No	No	No
TB-18	37.1	3.1-9.8	40.2-46.9	Yes	No	No	No
TB-19	31.9	1.5-13.6	33.4-47.0	Yes	No	No	No
TB-20	29.2	6.0-18.0	35.2-47.2	Yes	No	No	No
TB-21	38.0	6.3-6.9	44.3-44.9	Yes	No	No	No
TB-23	29.0	0.7-18.0	29.7-47.0	Yes	No	No	No
TB-24	37.4	2.7-9.6	40.1-47.0	Yes	No	No	No
<u>Cores Outside Proposed Project Boundary (not composited)</u>							
TB-25	38.1	0-0.5	38.1-38.4	No	No	No	No
TB-25	38.1	0.5-8.9	38.4-46.8	Yes	No	No	No
TB-26	28.6	0-7.4	28.6-36.0	Yes	No	No	No
TB-26	28.6	7.4-18.4	28.6-39.6	Yes	No	No	No
TB-27	26.8	0-12.7	26.8-39.5	Yes	No	No	No
TB-27	26.8	12.7-14.3	39.5-41.1	Yes	No	No	No
TB-27	26.8	14.3-20.0	41.1-46.8	Yes	No	No	No
TB-28	29.0	0-3.9	29.0-32.9	Yes	No	No	No
TB-28	29.0	3.9-18.0	32.9-47.0	Yes	No	No	No
<u>Reference and Control Sediments</u>							
R-AM	NA(a)	NA	NA	Yes	No	Yes	Yes
R-BF	NA	NA	NA	Yes	No	Yes	Yes
C-WB	NA	NA	NA	No	No	Yes	No
C-EO	NA	NA	NA	No	No	Yes	No
(a) NA Not applicable.							

3.2.1 Conventional Parameters

Conventional sediment parameters include grain size, TOC, TRPH, TVS, and total and water soluble sulfides. Complete sediment chemistry and quality control data for these parameters are contained in Appendix B, Tables B.1 through B.3. The quality control data show that all conventionals data are of acceptable accuracy and precision. Conventional parameters in Bulls Head Channel sediments are summarized in Table 3.4. The sand composites (BHC-A Upper, TB-C, TB-D Upper and Lower, and TB-E Lower) can be clearly differentiated from the silt/clay composites (BHC-A Lower, BHC-B, TB-E Lower) by their grain size distributions; in addition, the composites are quite representative of the contributing stations. The stations and composites with high (>80%) sand generally had low concentrations of TOC, TVS, TRPH, and

FIGURE 3.4. Stations Contributing to Sand Composites

FIGURE 3.5. Stations Contributing to Silt/Clay Composites

TABLE 3.4. Conventional Parameters in Bulls Head Channel Sediment

Sediment Treatment	Vertical Segment (-ft MLLW)	Percent Dry Weight				mg/kg Dry Weight				
		Gravel >2000 µm	Sand 62.5- 2000 µm	Silt 3.9- 62.5 µm	Clay <3.9 µm	TOC	TVS	TPH	Total Sulfide	Water Soluble Sulfide
R-AM	NA(a)	0	97	1	2	0.04	0.690	20	1.31 U ^(b)	0.15 U
R-BF	NA	0	7	39	54	1.28	2.11	54	91.9	0.39 U
Comp BHC-A Upper		1	97	0	2	0.17	1.40	12 U	1.41 U	0.16 U
BHC-2	36.9-43.9	1	98	0	1	0.73	1.31	12 U	1.26 U	0.12 U
BHC-4	36.6-38.1	0	99	0	1	0.03	0.957	13 U	1.53 U	0.14 U
BHC-5	38.5-39.9	0	97	2	1	0.10	1.09	13 U	1.46 U	0.17 U
BHC-6	43.2-44.7	1	95	1	3	0.12	1.31	13 U	1.53 U	0.16 U
Comp BHC-A Lower		0	46	31	23	0.76	3.18	22	1.81 U	0.20 U
BHC-1	40.8-47.0	1	14	42	43	1.22	3.37	34	23.5	0.17 U
BHC-2	43.9-47.0	0	60	18	22	0.70	2.72	40	152	1.25 U
BHC-3	39.3-46.4	0	33	31	36	0.68	3.77	16 U	26.5	0.20 U
BHC-4	38.1-47.0	0	5	60	35	1.29	3.20	19	1.96 U	0.34
BHC-5	39.9-47.0	0	55	33	12	0.51	2.42	14 U	24.3	0.19
BHC-6	44.7-46.4	0	81	14	5	0.24	2.26	13 U	1.54 U	0.16 U
Comp BHC-B		0	21	48	31	2.02	3.97	20	1.96 U	0.20 U
BHC-7	36.6-47.0	0	35	42	23	1.80	3.76	20	1.74 U	0.20
BHC-8	41.8-47.0	0	3	64	33	1.73	3.71	32	6.01	0.20 U
BHC-9	45.2-46.2	0	38	43	19	0.82	3.01	14 U	16.1 U	1.43 U
TB-10	30.4-40.2	0	9	52	39	2.68	4.77	18 U	88.7	0.25 U
TB-12	39.8-47.0	0	5	61	34	1.97	3.97	16 U	1.69 U	0.23 U
Comp TB-C		0	97	1	2	0.18	1.30	14	1.36 U	0.14 U
BHC-9	42.0-45.2	0	98	1	1	0.12	1.26	12 U	1.43 U	0.16 U
TB-11	39.7-46.6	0	97	1	2	0.04	1.17	12 U	1.40 U	0.16 U
TB-13	43.0-47.0	0	97	2	1	0.05	1.13	11 U	1.37 U	0.15 U
TB-14	37.1-46.8	0	93	4	3	0.17	1.33	13	1.45 U	0.15 U

TABLE 3.4. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Percent Dry Weight				mg/kg Dry Weight				
		Gravel	Sand	Silt	Clay	TOC	TVS	TPH	Total Sulfide	Water Soluble Sulfide
		>2000 μm	62.5-2000 μm	3.9-62.5 μm	<3.9 μm					
Comp TB-C (continued)										
TB-18	37.1-40.2	1	98	0	1	0.02	0.973	12 U	1.48 U	0.16 U
TB-19	31.9-33.4	0	94	3	3	0.11	1.35	13 U	1.48 U	0.15 U
TB-20	29.2-35.2	0	99	0	1	0.07	0.961	12	1.46 U	0.14 U
TB-21	38.0-41.8	0	95	3	2	0.09	1.04	12 U	1.42 U	0.16 U
TB-22	33.0-35.0	0	96	2	2	0.17	1.19	38	16.2 U	0.13 U
TB-24	37.4-40.1	0	98	1	1	0.06	0.809	12 U	1.49 U	0.16 U
Comp TB-D Upper										
TB-15	29.7-47.0	0	85	9	6	0.32	1.49	13 U	1.55 U	0.15 U
TB-16	28.3-30.6	0	81	11	8	0.53	2.28	14	17.1	0.13 U
TB-17	28.3-32.5	0	89	7	4	0.53	2.52	14	1.55 U	0.16 U
Comp TB-D Lower										
TB-10	40.2-46.8	0	80	15	5	0.23	1.85	13 U	1.63 U	0.14 U
Comp TB-E Upper										
TB-21	41.8-44.3	0	87	8	5	0.30	1.53	14	1.49 U	0.17 U
TB-22	35.0-44.7	0	90	6	4	0.12	1.37	13 U	1.62 U	0.17 U
Comp TB-E Lower										
TB-16	30.6-47.0	0	5	51	44	2.38	4.59	24	23.7 U	0.20 U
TB-17	32.5-47.0	0	12	65	23	0.97	3.39	14 U	214	0.16 U
TB-18	40.2-46.9	0	49	37	14	0.61	2.47	451	2.81	0.12 U
TB-19	33.4-47.0	0	6	60	34	1.87	4.54	17 U	15.7	0.23 U
TB-20	35.2-47.2	0	5	68	27	1.28	3.43	15 U	1.86 U	0.18 U
TB-23	29.0-46.3	0	16	55	29	1.74	3.95	19	17.8 U	0.21 U
TB-24	40.1-47.0	0	37	43	20	1.51	3.91	15 U	10.4	0.18 U

TABLE 3.4. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Percent Dry Weight						mg/kg Dry Weight		
		Gravel	Sand	Silt	Clay	TOC	TVS	TPH	Total Sulfide	Water Soluble Sulfide
		> 2000 µm	62.5-2000 µm	3.9-62.5 µm	<3.9 µm					
<u>Cores Outside Proposed Dredging Area</u>										
TB-25	38.4-46.8	0	50	37	13	0.57	2.56	18	28.4	0.15 U
TB-26	28.6-36.0	0	53	23	24	0.78	2.80	20	29.3	0.20 U
TB-26	36.0-47.0	0	94	3	3	0.52	1.73	13 U	1.45 U	0.15 U
TB-27	26.8-39.5	0	75	14	11	0.64	2.41	18	27.2	0.15 U
TB-27	39.5-41.1	0	75	12	13	5.43	6.62	33	202	0.25 U
TB-27	41.1-46.8	0	10	59	31	1.48	3.98	15 U	53.2	0.18 U
TB-28	29.0-32.9	0	99	0	1	0.05	0.861	16	1.39 U	0.14 U
TB-28	32.9-47.0	0	29	45	26	1.96	3.62	20	1.83 U	0.21 U

(a) NA Not applicable.

(b) U Analyte undetected above given concentration.

sulfides. The stations with more fine material had higher concentrations of the other conventional parameters, but these concentrations were, with few exceptions, generally low. The high TRPH value for TB-18 40.2-46.9 ft MLLW has no obvious explanation: there were no apparent analytical errors or sample contamination, and the TRPH level is not supported by the PAH or other organics data. Total sulfides exceeded 100 mg/kg in some samples, generally where decaying plant material or woody debris was present in the sediment (see core data logs, Appendix A).

3.2.2 Metals

Ten metals were measured in the Bulls Head Channel sediment samples and reference sediments (Table 3.5). Complete results and quality control data for metals are contained in Appendix B, Tables B.4 and B.5. Quality control results were excellent for all metals; the data are of very good accuracy and precision. However, the achieved detection limits (DLs) were higher than the target detection limits listed in PN 93-2 for a number of metals (Appendix B, Table B.4). This does not pose a problem with the data because the metals for which target DLs were not met are present in Bulls Head Channel samples at levels higher than achieved DLs and at levels much higher than the PN 93-2 target DLs.

Silver concentrations ranged from 0.024 mg/kg to 0.059 mg/kg in sandy sediments and from 0.048 mg/kg to 0.132 mg/kg in finer-grained sediments. These concentrations were generally lower than in other reaches of the channel and central bay (Kohn et al. 1993, Bienert et al. 1994). Concentrations of silver in the silt/clay composites and contributing stations exceeded the silver concentration in the sandy Alcatraz Environs reference by a factor of two to three. None of the Bulls Head Channel silver concentrations exceeded the Bay Farm reference, which had the highest silver concentration of any sediment tested.

The range of copper values (11.7 mg/kg to 68.4 mg/kg) was also similar to those in the lower John F. Baldwin Ship Channel. In Bulls Head Channel, copper was much lower in the sandy samples than in the silt/clay samples, yet even the sandiest samples had higher copper concentrations than in the sandy Alcatraz Environs, which had only 11.0 mg/kg. Only the silt/clay samples of Comps BHC-B and TB-E Lower exceeded the Bay Farm reference in copper concentration.

Arsenic, cadmium, chromium, nickel, lead, and zinc concentrations in Bulls Head Channel sediments were all similar to or lower than in the lower John F. Baldwin Ship Channel and central bay (Kohn et al. 1993, Bienert et al. 1994). Concentrations of these metals, especially in the silt/clay samples, often exceeded both Alcatraz and Bay Farm reference sediment concentrations, but never by more than a factor of two to three.

TABLE 3.5. Metals in Bulls Head Channel Sediments

Sediment Treatment	Vertical Segment (-ft MLLW)	Metals (mg/kg dry weight)									
		Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
R-AM	NA(a)	0.048	8.0	0.084 U ^(b)	386	11.0	0.026	42.8	14.3	0.10 U	43.7
R-BF	NA	0.423	10.8	0.146	164	56.0	0.368	103	34.1	0.29	146
Comp BHC-A Upper		0.035	7.6	0.084 U	258	17.0	0.031	83.3	12.1	0.10 U	74.1
BHC-2	36.9-43.9	0.034	8.7	0.084 U	211	14.4	0.025	77.3	12.3	0.10 U	65.5
BHC-4	36.6-38.1	0.048	5.8	0.115	352	13.2	0.022	75.4	10.8	0.29	74.1
BHC-5	38.5-39.9	0.039	7.9	0.084 U	271	14.4	0.024	82.0	15.2	0.18	80.2
BHC-6	43.2-44.7	0.039	8.2	0.084 U	272	18.3	0.031	73.6	7.9	0.24	72.8
Comp BHC-A Lower		0.079	11.0	0.167	204	46.3	0.138	106	11.9	0.18	91.1
BHC-1	40.8-47.0	0.116	10.7	0.173	184	45.7	0.090	104	11.8	0.36	94.5
BHC-2	43.9-47.0	0.098	13.6	0.131	240	40.3	0.195	95.1	16.8	0.29	87.7
BHC-3	39.3-46.4	0.100	16.3	0.129	225	52.6	0.416	93.9	11.9	0.30	87.6
BHC-4	38.1-47.0	0.124	10.5	0.242	145	55.4	0.050	111	9.1	0.29	101
BHC-5	39.9-47.0	0.090	8.4	0.137	187	43.5	0.042	113	8.7	0.12	89.2
BHC-6	44.7-46.4	0.048	10.2	0.084	204	25.7	0.023	91.5	10.7	0.23	76.0
Comp BHC-B Rep 1		0.099	10.1	0.171	171	64.3	0.051	122	12.3	0.24	102
BHC-7	36.6-47.0	0.092	7.8	0.189	185	51.7	0.050	113	13.6	0.41	101
BHC-8	41.8-47.0	0.124	10.6	0.188	173	57.6	0.069	112	9.3	0.46	102
BHC-9	45.2-46.2	0.106	8.5	0.174	215	52.7	0.043	115	8.2	0.24	96.2
TB-10	30.4-40.2	0.132	13.0	0.175	150	59.1	0.071	117	6.4	0.30	104
TB-12	39.8-47.0	0.122	7.7	0.198	158	63.8	0.059	120	12.7	0.30	112
Comp TB-C		0.027	8.8	0.084 U	230	19.2	0.015	83.5	9.1	0.10 U	71.7
BHC-9	42.0-45.2	0.024	10.4	0.058	218	11.7	0.014	78.8	21.9	0.29	83.3
TB-11	39.7-46.6	0.042	5.5	0.087	245	15.6	0.022	86.9	9.8	0.10 U	72.5
TB-13	43.0-47.0	0.027	8.1	0.084 U	216	14.2	0.016	89.1	11.7	0.10 U	73.9
TB-14	37.1-46.8	0.045	6.7	0.084 U	366	17.0	0.016	84.9	9.5	0.10 U	71.2

TABLE 3.5. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Metals (mg/kg dry weight)									
		Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
Comp TB-C (continued)											
TB-18	37.1-40.2	0.027	5.9	0.084 U	286	14.4	0.016	85.4	11.5	0.10 U	66.9
TB-19	31.9-33.4	0.042	9.4	0.088	233	20.0	0.017	81.9	11.4	0.10 U	70.6
TB-20	29.2-35.2	0.031	10.8	0.087 U	260	16.2	0.019	84.0	9.1	0.10 U	71.9
TB-21	38.0-41.8	0.031	9.1	0.084 U	168	16.6	0.026	82.2	10.6	0.10 U	68.7
TB-22	33.0-35.0	0.034	11.9	0.084 U	188	14.8	0.022	82.2	11.2	0.10 U	71.5
TB-24	37.4-40.1	0.035	9.4	0.086	211	15.3	0.022	89.7	10.9	0.10 U	71.4
Comp TB-D Upper											
TB-15	29.7-47.0	0.048	5.2	0.084 U	486	26.6	0.022	104	7.4	0.10 U	83.5
TB-16	28.3-30.6	0.049	6.6	0.084 U	227	29.2	0.025	93.9	8.2	0.10 U	83.7
TB-17	28.3-32.5	0.031	7.8	0.084 U	204	18.0	0.016	88.4	7.5	0.10 U	66.3
Comp TB-D Lower											
TB-10	40.2-46.8	0.059	5.8	0.113	219	30.9	0.024	100	9.1	0.10 U	78.2
Comp TB-E Upper											
TB-21	41.8-44.3	0.031	13.7	0.084 U	264	25.4	0.018	94.1	6.7	0.10 U	73.1
TB-22	35.0-44.7	0.038	6.0	0.084 U	320	24.7	0.019	97.8	7.6	0.10 U	76.5
Comp TB-E Lower											
TB-16	30.6-47.0	0.125	12.1	0.192	160	68.4	0.066	126	9.6	0.35	116
TB-17	32.5-47.0	0.103	8.9	0.181	180	55.2	0.054	112	11.5	0.17	98.3
TB-18	40.2-46.9 Rep 1	0.089	5.9	0.161	241	50.6	0.045	110	10.6	0.10 U	94.2
TB-19	33.4-47.0	0.112	9.7	0.214	174	61.3	0.050	120	12.8	0.24	103
TB-20	35.2-47.2	0.100	10.9	0.084 U	203	66.0	0.057	125	9.6	0.30	106
TB-23	29.0-46.3	0.093	12.1	0.177	178	58.8	0.063	119	9.4	0.30	107
TB-24	40.1-47.0	0.068	8.5	0.141	182	44.4	0.045	114	10.6	0.18	87.7

TABLE 3.5. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Metals (mg/kg dry weight)									
		Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
<u>Cores Outside Proposed Dredging Area</u>											
TB-25	38.4-46.8	0.072	9.7	0.162	222	40.8	0.032	108	7.0	0.12	88.0
TB-26	28.6-36.0	0.078	10.5	0.148	200	33.7	0.045	103	9.1	0.12	89.1
TB-26	36.0-47.0	0.038	7.3	0.084 U	192	21.1	0.016	95.0	6.2	0.10 U	64.3
TB-27	26.8-39.5	0.045	10.5	0.127	213	25.9	0.018	95.2	5.7	0.10 U	76.7
TB-27	39.5-41.1	0.048	18.4	0.151	138	29.8	0.021	99.0	6.5	0.12	76.3
TB-27	41.1-46.8	0.120	14.2	0.226	167	59.2	0.077	117	8.6	0.23	102
TB-28	29.0-32.9	0.024	10.2	0.084 U	223	14.6	0.017	84.6	10.0	0.10 U	71.3
TB-28	32.9-47.0	0.093	11.3	0.176	192	53.0	0.045	112	7.9	0.23	91.8

(a) NA Not applicable.

(b) U Analyte undetected above given concentration.

Mercury concentrations were generally low, except for locally high concentrations (0.090 mg/kg to 0.416 mg/kg in Comp BHC-A Lower and contributing stations closest to the Benicia-Martinez bridge). Mercury was strongly associated with the fine-grained sediments; mercury in all of the silt/clay composites and samples exceeded Alcatraz Environs by up to two times, while mercury concentrations in the sandy samples were similar to Alcatraz Environs. Only the single high mercury value at BHC-3 exceeded the Bay Farm reference value of 0.368 mg/kg.

Selenium concentrations were similar to or lower than in the lower John F. Baldwin Ship Channel and central bay. Selenium was also associated with fine-grained sediments. Selenium concentrations in most samples did not exceed either reference sediment concentration by more than three times. However, because selenium was undetected in the Alcatraz Environs, any sample with detectable selenium exceeded this reference value.

3.2.3 Organic Compounds

Organic compounds measured in Bulls Head Channel sediments included PAHs, phthalates, chlorinated pesticides, PCBs, and butyltins. Complete results and quality control data for these parameters are contained in Appendix B, Tables B.6 through B.21. PAHs, pesticides, PCBs, and butyltins were measured in all channel and reference sediments; phthalates were measured in only one batch of samples, which consisted of the composites, reference, and several individual samples. Organics results are generally of acceptable quality; target detection limits, accuracy, and precision criteria were met for all analyses except PAHs and phthalates (Appendix B, Tables B.6 and B.10 through B.12). Phthalate target DLs were not achieved, probably because of the way the DLs were calculated. Usually, achieved DLs are based on the standard deviation of a number of spiked samples, but in this case, achieved DLs were based on the sample concentration that corresponded to the lowest phthalate standard.

Achieved DLs for PAHs were 0.48 µg/kg to 8.06 µg/kg, far below the target DL of 20 µg/kg. Five PAHs (naphthalene, acenaphthylene, phenanthrene, benzo[a]anthracene, and fluoranthene) were detected in several method blanks above achieved DLs but still far below target DLs. Sample values less than five times the associated blank value were flagged with a "B" in Appendix B, Tables B.8 through B.11. Sample values for which the ratio of confirmation ion to parent ion were outside of QC range are also flagged. The analysts believe that the likelihood of error in measuring the confirmation ion concentration is increased when sample values are extremely low, which was the case with the Bulls Head Channel samples. As the compounds are quantified from the parent ion concentration only, the out-of-range ion ratios should not affect data quality. Matrix spike recoveries for some PAHs were above the upper control limit of 120% in Batch 3, the batch that was also analyzed for phthalates. The high recoveries were most likely a result of interferences that were not removed because a silica

cleanup step was eliminated in order to recover and quantify the phthalates. Accuracy and precision measurements in other batches, and spike recoveries for other PAHs in Batch 3, show that the data are of acceptable quality. The QC issues discussed above do not influence the utility of the data, which show that PAH concentrations are extremely low in nearly all the Bulls Head Channel sediments.

Table 3.6, a summary of detected organic parameters in the Bulls Head Channel sediments, shows that these sediments are relatively uncontaminated with organic pollutants. Phthalates were not detected in any of the Bulls Head Channel samples (Appendix B, Table B.6). The concentrations of PAHs are very low (most are below the target DL of 20 µg/kg), and are in all cases lower than both the Alcatraz Environs and Bay Farm reference sediments (Appendix B, Tables B.7 through B.12). The pesticide, 4,4'-DDD, was detected in a few samples, including both reference sediments, at very low concentrations (less than the target DL of 2 µg/kg) (Appendix B, Tables B.16 through B.19). Its parent compound, 4,4'-DDT, was detected only in reference sediments. PCBs were not detected in Bulls Head Channel or in reference sediments (Appendix B, Tables B.13 and B.14).

3.2.4 STLC Metals, Pesticides, and PCBs

The STLC concentrations of metals, pesticides, and PCBs in the Bulls Head Channel composite samples (except Comp TB-D Lower) were measured following the California WET test for each analyte group. Quality control data for these analyses were acceptable; no analytes were detected in method blanks, matrix spike/spike duplicate recoveries were within acceptable ranges, and there was excellent agreement between MS and MSD results. Most metals were undetected, but low concentrations of barium, chromium, cobalt, lead, nickel, vanadium, and zinc were detected in WET extracts (Table 3.7). All pesticides and PCBs were undetected in WET extracts (Table 3.8).

3.3 BIOLOGICAL TESTING

Prior to biological testing, salinity and total ammonia were measured in porewater extracted from each of the test sediments. Many of the sand composites did not have sufficient water content to yield porewater; porewater was extracted from only the four fine-grained samples: Comp BHC-A Lower, Comp BHC-B, Comp TB-E Lower, and Bay Farm reference. The Bay Farm reference sediment porewater had high salinity (28.0‰) and low ammonia (<1 mg/L), whereas porewater from the three Bulls Head Channel fine-grained composites had low salinities and relatively high ammonia levels. Comps BHC-A Lower, BHC-B, and TB-E Lower had porewater salinities of 15.0‰, 16.0‰, and 18.0‰, and porewater ammonia concentrations of 70, 100, and 110 mg/L, respectively. The potential effects of low salinity and high ammonia in solid phase tests were minimized before initiation by following the procedures in the EPA/USACE memorandum of December 1993 (EPA/USACE 1993).

TABLE 3.6. Organic Parameters Detected in Bulls Head Channel Sediment (no phthalates or PCBs detected in Bulls Head Channel sediments)

Sediment Treatment	Vertical Segment (-ft MLLW)	Concentration (µg/kg dry weight)						
		Total Detected Low Molecular Weight PAHs	Total Detected High Molecular Weight PAHs	Total Detected PAHs	4,4-DDD	Tributyltin	Dibutyltin	Mono-butyltin
R-AM	NA(a)	574	1039	1613	0.53	0.25 U(b)	0.41 U	0.71
R-BF	NA	217	1444	1661	1.63	3.63	11.5	3.00
Comp BHC-A Upper		20	27	47	0.13 U	0.25 U	0.41 U	0.43 U
BHC-2	36.9-43.9	31	33	64	0.14 U	0.25 U	1.96	1.41
BHC-4	36.6-38.1	167	275	442	0.75	0.25 U	0.41 U	0.43 U
BHC-5	38.5-39.9	20	27	47	0.13 U	0.25 U	0.41 U	1.43
BHC-6	43.2-44.7	28	42	70	0.75	0.25 U	0.41 U	0.43 U
Comp BHC-A Lower		26	79	105	0.14 U	0.25 U	0.41 U	0.43 U
BHC-1	40.8-47.0	27	17	44	0.17 U	0.25 U	0.41 U	0.43 U
BHC-2	43.9-47.0	93	400	493	0.16 U	0.25 U	0.41 U	0.43 U
BHC-3	39.3-46.4	9	15	24	0.16 U	0.25 U	0.41 U	0.43 U
BHC-4	38.1-47.0	27	21	48	0.17 U	0.25 U	3.14	1.67
BHC-5	39.9-47.0	7	11	18	0.14 U	0.25 U	0.41 U	0.43 U
BHC-6	44.7-46.4	4	6	10	0.13 U	0.25 U	0.41 U	0.43 U
Comp BHC-B		18	12	30	0.16 U	0.25 U	1.96	1.88
BHC-7	36.6-47.0	18	11	29	0.16 U	0.25 U	0.41 U	2.48
BHC-8	41.8-47.0	25	17	42	0.17 U	0.25 U	0.41 U	0.43 U
BHC-9	45.2-46.2	5	6	11	0.14 U	0.25 U	0.41 U	0.43 U
TB-10	30.4-40.2	37	21	58	0.16 U	0.25 U	0.41 U	0.43 U
TB-12	39.8-47.0	27	21	48	0.17 U	0.25 U	0.41 U	0.43 U
Comp TB-C		10	9	19	0.12 U	0.25 U	0.41 U	0.43 U
BHC-9	42.0-45.2	19	38	57	0.13 U	1.42	0.41 U	0.43 U
TB-11	39.7-46.6	9	7	16	0.55	0.25 U	2.95	0.43 U
TB-13	43.0-47.0	9	7	16	0.11 U	0.25 U	0.41 U	0.43 U
TB-14	37.1-46.8	10	14	24	0.52	0.25 U	0.41 U	0.43 U

TABLE 3.6. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Concentration (µg/kg dry weight)						
		Total Detected Low Molecular Weight PAHs	Total Detected High Molecular Weight PAHs	Total Detected PAHs	4,4-DDD	Tributyltin	Dibutyltin	Mono-butyltin
Comp TB-C (continued)								
TB-18	37.1-40.2	5	5	10	0.13 U	0.25 U	0.41 U	0.43 U
TB-19	31.9-33.4	6	9	15	0.13 U	0.25 U	0.41 U	0.43 U
TB-20	29.2-35.2	9	12	21	0.60	0.25 U	0.41 U	0.43 U
TB-21	38.0-41.8	8	14	22	0.38	0.25 U	0.41 U	0.43 U
TB-22	33.0-35.0	5	9	14	0.32	0.25 U	0.41 U	0.43 U
TB-24	37.4-40.1	5	8	13	0.12 U	0.25 U	0.41 U	0.43 U
Comp TB-D Upper								
TB-15	29.7-47.0	12	8	20	0.13 U	0.25 U	0.41 U	0.43 U
TB-16	28.3-30.6	6	11	17	0.14 U	0.25 U	0.41 U	0.43 U
TB-17	28.3-32.5	7	9	16	0.14 U	0.25 U	0.41 U	0.43 U
Comp TB-D Lower								
TB-10	40.2-46.8	11	10	21	0.13 U	0.25 U	0.41 U	0.43 U
Comp TB-E Upper								
TB-21	41.8-44.3	8	6	14	0.13 U	0.25 U	0.41 U	0.43 U
TB-22	35.0-44.7	6	6	12	0.13 U	0.25 U	0.41 U	0.43 U
Comp TB-E Lower								
TB-16	30.6-47.0	30	21	51	0.18 U	0.25 U	0.41 U	0.43 U
TB-17	32.5-47.0	22	25	47	0.14 U	0.25 U	0.41 U	0.43 U
TB-18	40.2-46.9	12	11	23	0.14 U	0.25 U	0.41 U	0.43 U
TB-19	33.4-47.0	25	22	47	0.17 U	0.25 U	0.41 U	0.43 U
TB-20	35.2-47.2	21	21	42	0.15 U	0.25 U	0.41 U	0.43 U
TB-23	29.0-46.3	27	26	53	0.15 U	0.25 U	0.41 U	0.43 U
TB-24	40.1-47.0	19	15	34	0.12 U	0.25 U	0.41 U	0.43 U

TABLE 3.6. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Total Detected Low Molecular Weight PAHs	Total Detected High Molecular Weight PAHs	Concentration (µg/kg dry weight)				
				Total Detected PAHs	4,4-DDD	Tributyltin	Dibutyltin	Mono-butyltin
Cores Outside Proposed Dredging Area								
TB-25	38.4-46.8	8	7	15	0.14 U	0.39	0.41 U	1.36
TB-26	28.6-36.0	21	11	32	0.14 U	0.25 U	0.41 U	0.43 U
TB-26	36.0-47.0	2	5	7	0.12 U	0.25 U	0.41 U	0.43 U
TB-27	26.8-39.5	9	3	12	0.15 U	0.25 U	0.41 U	0.43 U
TB-27	39.5-41.1	20	11	31	0.14 U	0.25 U	0.41 U	0.43 U
TB-27	41.1-46.8	10	11	21	0.15 U	0.25 U	0.41 U	0.43 U
TB-28	29.0-32.9	1	6	7	0.14 U	0.25 U	0.41 U	0.43 U
TB-28	32.9-47.0	13	11	24	0.15 U	0.25 U	0.41 U	0.43 U

(a) NA Not applicable.

(b) U Analyte undetected above given concentration.

TABLE 3.7. Soluble Threshold Limit Concentrations (STLC) for Metals in Bulls Head Channel Composites

Analyte	Concentration in Extract from Composite (mg/L)						
	Comp BHC-A Upper	Comp BHC-A Lower	Comp BHC-B	Comp TB-C	Comp TB-D Upper	Comp TB-E Upper	Comp TB-E Lower
Antimony	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Arsenic	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Barium	0.8	1.3	1.8	1.3	1.6	2.4	2.7
Beryllium	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Cadmium	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Chromium	0.1 U	0.2	0.1	0.1	0.2	0.2	0.2
Cobalt	0.4	0.2	0.2	0.4	0.3	0.3	0.2
Copper	0.1 U	0.1 U	0.1	0.1 U	0.1 U	0.1 U	0.1 U
Lead	0.3	0.1	0.1 U	0.1	0.1 U	0.1	0.1
Mercury	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Molybdenum	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	0.7	0.7	0.9	0.9	1.0	1.0	0.9
Selenium	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Silver	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Thallium	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Vanadium	0.5	0.8	1.3	0.5	0.7	0.6	1.1
Zinc	1.0	0.2	0.2	1.0	0.2	0.2	0.1

(a) U Undetected above given concentration.

TABLE 3.8. Soluble Threshold Limit Concentrations (STLC) for Pesticides and PCBs in Bulls Head Channel Composites

Analyte	Concentration in Extract from Composite (ug/L)						
	Comp BHC-A Upper	Comp BHC-A Lower	Comp BHC-B	Comp TB-C	Comp TB-D Upper	Comp TB-E Upper	Comp TB-E Lower
Aldrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
alpha-BHC	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
beta-BHC	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Chlordane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
4,4'-DDT	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDD	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
delta-BHC	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Dieldrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan I	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan II	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan Sulfate	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endrin aldehyde	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
gamma-BHC (Lindane)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Heptachlor	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Heptachlor epoxide	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Methoxychlor	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toxaphene	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1016	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor 1221	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor 1232	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor 1242	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor 1248	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor 1254	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Aroclor 1260	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Surrogate Recoveries (%)							
Decachlorobiphenyl	88	83	82	103	43	93	88
Tetrachloro-m-xylene	88	91	86	99	46	95	88

(a) U Undetected above given concentration.

3.3.1 10-Day Solid Phase Test With the Amphipod *Rhepoxynius abronius*

The 10-day solid-phase test with *R. abronius* was conducted with the eight Bulls Head Channel composites, two reference sediments, and native control sediment. Twenty *R. abronius* were exposed in each of five replicates of each sediment treatment. Survival and effective survival (proportion of survivors that reburied) were the test endpoints. Survival data for all replicates are reported in Appendix C, Table C.1. The test was validated by 98% survival in the native control. All water quality parameters were within acceptable ranges throughout the test (Appendix C, Table C.2). The reference toxicant test showed that this test population of *R. abronius* was of acceptable sensitivity: the cadmium LC50 of 0.93 mg/L is very close to the 0.92 mg/L value cited for cadmium toxicity to *R. abronius* in ASTM 1990, and within MSL's control range of 0.53 mg/L to 1.75 mg/L.

Three sediment treatments, Comps BHC-A Lower, BHC-B, and TB-E Lower, had relatively high preliminary porewater ammonia levels (70 mg/L, 100 mg/L, and 110 mg/L total ammonia, respectively). Two days of aeration and overlying water replacement were necessary to reduce porewater ammonia to acceptable levels (<30 mg/L) for test initiation. To test the efficacy of the ammonia reduction procedures, Comp TB-E Lower was also tested without reducing porewater ammonia.

R. abronius survival ranged from 81% to 97% in Bulls Head Channel test composites, except for the low (12%) survival in the unmanipulated Comp TB-E Lower (Table 3.9). In this case, reduction of porewater ammonia significantly improved *R. abronius* survival (by 71%). Comps TB-E Lower and BHC-B both had statistically significantly reduced survival relative to the Alcatraz Environs reference, but survival was not more than 20% lower than in Alcatraz Environs. None of the Bulls Head Channel composites was statistically significantly different or more than 20% lower than the Bay Farm reference.

The effective survival of *R. abronius*, assessed by counting the number of survivors that were able to rebury in clean sediment following the 10-day exposure, is presented in Table 3.10. The reburial test can be used as a sublethal endpoint of the solid-phase test. Most *R. abronius* that survived exposure to Bulls Head Channel composites were able to rebury in clean control sediment. Statistical analysis of the effective survival endpoint did not change the outcome or significance of the solid-phase *R. abronius* test as indicated by the standard survival endpoint.

3.3.2 10-Day Solid Phase Test With the Amphipod *Eohaustorius estuarius*

The 10-day solid-phase test with *E. estuarius* was also conducted with the eight Bulls Head Channel composites, two reference sediments, and native control sediment. Twenty *E. estuarius* were exposed in each of five replicates of each sediment treatment. Survival data for all replicates are reported in Appendix D, Table D.1. The test was validated by 99% survival

TABLE 3.9. Results of the 10-Day Solid-Phase Test With *R. abronius*, Based on Number Surviving

Sediment Treatment	Mean Proportion Survival	s.d.	Survival Significantly Lower Than Alcatraz Environs	Survival >20 % Lower Than Alcatraz Environs	Survival Significantly Lower Than Bay Farm	Survival >20 % Lower Than Bay Farm
<i>R. abronius</i> Control	0.98	0.04	NA(a)	NA	NA	NA
Alcatraz Environs	0.96	0.07	NA	NA	NA	NA
Bay Farm	0.85	0.12	NA	NA	NA	NA
Comp BHC-A Upper	0.94	0.05	NO	NO	NO	NO
Comp BHC-A Lower(b)	0.94	0.04	NO	NO	NO	NO
Comp BHC-B(b)	0.81	0.09	YES	NO	NO	NO
Comp TB-C	0.97	0.04	NO	NO	NO	NO
Comp TB-D Upper	0.97	0.03	NO	NO	NO	NO
Comp TB-D Lower	0.91	0.05	NO	NO	NO	NO
Comp TB-E Upper	0.94	0.04	NO	NO	NO	NO
Comp TB-E Lower(b)	0.83	0.08	YES	NO	NO	NO
Comp TB-E Lower	0.12	0.09	YES	YES	YES	YES

(a) NA Not applicable.

(b) Samples were manipulated to reduce porewater ammonia before adding animals.

TABLE 3.10. Results of the 10-Day Solid-Phase Test With *R. abronius*, Based on Number of Survivors Able to Rebury (Effective Survival)

Sediment Treatment	Mean Proportion Effective Survival	s.d.	Effective Survival Significantly Lower Than Alcatraz Environs	Effective Survival >20 % Lower Than Alcatraz Environs	Effective Survival Significantly Lower Than Bay Farm	Effective Survival >20 % Lower Than Bay Farm
<i>R. abronius</i> Control	0.98	0.04	NA(a)	NA	NA	NA
Alcatraz Environs	0.94	0.09	NA	NA	NA	NA
Bay Farm	0.85	0.12	NA	NA	NA	NA
Comp BHC-A Upper	0.94	0.05	NO	NO	NO	NO
Comp BHC-A Lower(b)	0.94	0.04	NO	NO	NO	NO
Comp BHC-B(b)	0.77	0.12	YES	NO	NO	NO
Comp TB-C	0.97	0.04	NO	NO	NO	NO
Comp TB-D Upper	0.92	0.06	NO	NO	NO	NO
Comp TB-D Lower	0.88	0.10	NO	NO	NO	NO
Comp TB-E Upper	0.91	0.07	NO	NO	NO	NO
Comp TB-E Lower(b)	0.77	0.10	YES	NO	NO	NO
Comp TB-E Lower	0.11	0.08	YES	YES	YES	YES

(a) NA Not applicable.

(b) Samples were manipulated to reduce porewater ammonia before adding animals.

in the native control (Table 3.11). All water quality parameters were within acceptable ranges throughout the test (Appendix D, Table D.2). The reference toxicant test showed that this test population of *E. estuarius* was of acceptable sensitivity: the cadmium LC50 of 14.3 mg/L is within the range of previous tests at MSL (cadmium LC50s of 10.6, 18.3, 18.5 mg/L), although it is higher than the 9.33 mg/L value cited in ASTM 1990.

Three sediment treatments, Comps BHC-A Lower, BHC-B, and TB-E Lower, had relatively high preliminary porewater ammonia levels (70 mg/L to 110 mg/L). One day of aeration and overlying water replacement were necessary to reduce porewater ammonia to acceptable levels for test initiation. The USACE/EPA (1993) memorandum states that 60 mg/L ammonia is acceptable for initiating *E. estuarius*, but in this test, porewater ammonia was reduced to levels similar to the *R. abronius* test (~30 mg/L) for greater comparability between species. As in the *R. abronius* test, five replicates of Comp TB-E Lower were tested without reducing porewater ammonia.

E. estuarius survival ranged from 74% to 98% in Bulls Head Channel composites, and was lower (68%) in unmanipulated replicates of Comp TB-E Lower. With *E. estuarius*, the difference between the unmanipulated replicates and the reduced porewater ammonia replicates was 9%, not as great as was observed with *R. abronius*. In Comps BHC-B and TB-E Lower with reduced porewater ammonia, *E. estuarius* survival was statistically significant and more than 20% lower when compared to the Alcatraz Environs reference (Table 3.11). This indicates that perhaps *E. estuarius* are sensitive to something other than or in addition to ammonia (e.g., grain size) in those composites. Another possibility is that the ammonia level wasn't really reduced--the difference between manipulated and unmanipulated ammonia levels may not have been significant.

3.3.3 48-Hour Suspended-Particulate-Phase Test With Larvae of the Bivalve, *Mytilus galloprovincialis*

The 48-hour larval bivalve test was conducted following the procedures described in section 2.4.3. Dredging site water collected from Suisun Bay was not used for preparation of SPP because of its low salinity (15.5‰). Instead, Sequim Bay seawater (~31‰) was used for both preparation and dilution of SPP. Larvae of the bivalve, *Mytilus galloprovincialis*, were exposed to five concentrations of 10 treatments (eight composites, two reference). Larval data for all replicates, reference toxicant test data, and water quality data are presented in Appendix E. Table 3.12 shows that the tests with *M. galloprovincialis* were validated by >90% survival in the controls (0% SPP) of all treatments. Water quality parameters were within acceptable ranges for all test chambers throughout the test (Appendix E, Table E.2).

TABLE 3.11. Results of the 10-Day Solid-Phase Test With *E. estuarius*

Sediment Treatment	Mean Proportion Survival	s.d.	Survival Significantly Lower Than Alcatraz Environs	Survival >20 % Lower Than Alcatraz Environs	Survival Significantly Lower Than Bay Farm	Survival >20 % Lower Than Bay Farm
<i>E. estuarius</i> Control	0.99	0.02	NA ^(a)	NA	NA	NA
Alcatraz Environs	0.98	0.03	NA	NA	NA	NA
Bay Farm	0.74	0.13	NA	NA	NA	NA
Comp BHC-A Upper	0.94	0.04	NO	NO	NO	NO
Comp BHC-A Lower ^(b)	0.81/0.96 ^(c)	0.34 /0.03 ^(c)	NO	NO	NO	NO
Comp BHC-B ^(b)	0.74	0.07	YES	YES	NO	NO
Comp TB-C	0.98	0.03	NO	NO	NO	NO
Comp TB-D Upper	0.95	0.04	NO	NO	NO	NO
Comp TB-D Lower	0.94	0.05	NO	NO	NO	NO
Comp TB-E Upper	0.97	0.04	NO	NO	NO	NO
Comp TB-E Lower ^(b)	0.77	0.18	YES	YES	NO	NO
Comp TB-E Lower	0.68	0.09	YES	YES	NO	NO

(a) NA Not applicable.

(b) Samples were manipulated to reduce porewater ammonia before adding animals.

(c) Mean proportion surviving and s.d. calculated without anomalous rep 2 result (see Appendix D, Table D.1).

Reference toxicant tests indicated that the *M. galloprovincialis* larvae used in these tests were sensitive to copper, with median lethal concentrations (LC50s) ranging from 10.3 µg/L to 14.4 µg/L copper and median effective concentrations (EC50s) ranging from 6.6 µg/L to 8.3 µg/L copper. These values are within the range of responses (LC50s 5.8 µg/L to 35.0 µg/L copper; EC50s 5.7 µg/L to 21.0 µg/L copper) previously reported both by the MSL and other scientists (Dinnel et al. 1983; EPA 1985). The tight range of LC50s and EC50s demonstrates that all batches of larvae used in these tests produced a similar and therefore comparable response.

Table 3.12 summarizes the survival and normal development data for Bulls Head Channel SPP tests with bivalve larvae. A statistically significant difference in survival between the 0% and 100% SPP was seen only in Comp TB-E Lower. The LC50 for Comp TB-E Lower was estimated to be 85.3% SPP. All other treatments had LC50s greater than 100% SPP. EC50s are based on the proportion normal prodissoconch I in each treatment and are considered a more sensitive indicator of water column toxicity. A statistically significant difference in the mean proportion normal between the 0% and 100% SPP was calculated for six of the eight Bulls Head Channel composites. The other four treatments (Comp TB-C, Comp BHC-A Upper, Alcatraz Environs and Bay Farm references) showed no significant difference in normal development between the 0% and 100% SPP, and EC50s are reported as >100%.

TABLE 3.12. Results of the 48-Hour Suspended-Particulate-Phase Test With Larval *M. galloprovincialis*

Sediment Treatment	Concentration (Percent SPP)	Mean	Development in 100% SPP	EC50	Mean	Survival in 100% SPP	LC50
		Proportion Normal(a)	Significantly Lower Than Development in 0% SPP	(Percent SPP)	Proportion Survival(a)	Significantly Lower Than Survival in 0% SPP	(Percent SPP)
3.30	R-AM	0	0.99		0.99		
	R-AM	1	0.95		0.96		
	R-AM	10	0.99		0.99		
	R-AM	50	0.99		0.99		
	R-AM	100	0.96	No	0.98	No	>100
	R-BF	0	0.92		0.95		
	R-BF	1	0.96		0.98		
	R-BF	10	0.88		0.93		
	R-BF	50	0.88		0.94		
	R-BF	100	0.95	No	0.97	No	>100
	Comp BHC-A Upper	0	0.91		0.94		
	Comp BHC-A Upper	1	0.85		0.92		
	Comp BHC-A Upper	10	0.94		0.98		
	Comp BHC-A Upper	50	0.89		0.94		
	Comp BHC-A Upper	100	0.00	No	0.97	No	>100
	Comp BHC-A Lower	0	1.00		1.00		
	Comp BHC-A Lower	1	0.97		0.98		
	Comp BHC-A Lower	10	1.00		1.00		
	Comp BHC-A Lower	50	0.00		0.90		
	Comp BHC-A Lower	100	0.00	Yes	0.94	No	>100
	Comp BHC-B	0	1.00		1.00		
	Comp BHC-B	1	1.00		1.00		
	Comp BHC-B	10	1.00		1.00		
	Comp BHC-B	50	0.00		1.00		
	Comp BHC-B	100	0.00	Yes	0.63	Yes	>100
	Comp TB-C	0	0.96		0.97		
	Comp TB-C	1	0.93		0.94		
	Comp TB-C	10	0.97		0.98		
	Comp TB-C	50	0.98		0.99		
	Comp TB-C	100	1.00	No	1.00	No	>100

TABLE 3.12. (contd)

Sediment Treatment	Concentration (Percent SPP)	Mean Proportion Normal(a)	Development in 100% SPP Significantly Lower Than Development in 0% SPP	EC50 (Percent SPP)	Mean Proportion Survival(a)	Survival in 100% SPP Significantly Lower Than Survival in 0% SPP	LC50 (Percent SPP)
Comp TB-D Upper	0	0.92			0.96		
Comp TB-D Upper	1	0.96			0.99		
Comp TB-D Upper	10	0.90			0.95		
Comp TB-D Upper	50	0.03			0.97		
Comp TB-D Upper	100	0.00	Yes	22.3	0.96	No	>100
Comp TB-D Lower	0	0.97			0.97		
Comp TB-D Lower	1	0.97			0.98		
Comp TB-D Lower	10	0.92			0.93		
Comp TB-D Lower	50	0.00			0.94		
Comp TB-D Lower	100	0.00	Yes	20.0	0.86	No	>100
Comp TB-E Upper	0	0.97			0.98		
Comp TB-E Upper	1	0.98			0.98		
Comp TB-E Upper	10	0.99			1.00		
Comp TB-E Upper	50	0.50			0.91		
Comp TB-E Upper	100	0.00	Yes	40.7	0.85 ^(b)	No	>100
Comp TB-E Lower	0	0.98			0.99		
Comp TB-E Lower	1	0.97			0.98		
Comp TB-E Lower	10	0.89			0.97		
Comp TB-E Lower	50	0.00			0.92		
Comp TB-E Lower	100	0.00	Yes	18.8	0.37	Yes	85.3

(a) A proportion normal or proportion survival of 1.00 was used for any replicate with a number normal or number surviving greater than the stocking density (embryos per 10 mL; Appendix E, Table E.1).

(b) Mean survival in Comp TB-E Upper 100% SPP is based on four replicates (anomalous rep 5 value not included in calculations or statistical analyses).

EC50s for Comps TB-D Upper, TB-D Lower, TB-E Lower, BHC-A Lower, and BHC-B ranged between 18.8% and 22.4% SPP. Comp TB-E Upper had an intermediate EC50 response of 40.7% SPP.

The level of response for both survival and normal development corresponded quite well with the ammonia levels measured in the SPP treatments (Table 3.13). The highest ammonia concentration (23.7 mg/L total ammonia) was measured in 100% SPP prepared from Comp TB-E Lower, the treatment to which the larvae were most sensitive. Normal development, but not survival, was affected to a similar degree in treatments with total ammonia concentrations between 9.82 mg/L and 22.1 mg/L in the 100% SPP: Comps BHC-A Lower, BHC-B, TB-D Upper, and TB-D Lower. Larvae exposed to Comp TB-E Upper SPP were less affected (ammonia 7.06 mg/L in the 100% SPP), while the treatments with unaffected larval development all had total ammonia less than 1.6 mg/L in the 100% SPP.

To make further conclusions about ammonia toxicity vs. SPP or sediment contaminant toxicity, we need to be able to compare test organism response to ammonia independently from their response to SPP prepared from sediment. Some data exist about bivalve larvae response to ammonia, but little to no testing has been done specifically with *M. galloprovincialis*. This data gap was recently addressed by MSL in studies conducted on Richmond Harbor sediment for USACE. The Richmond Harbor study incorporated ammonia exposures to nearly all test species, including *M. galloprovincialis*. In six independent ammonia tests, *M. galloprovincialis* larval development was affected by relatively low concentrations of ammonia: EC50s ranged from 2.53 mg/L to 9.46 mg/L total ammonia. *M. galloprovincialis* survival was not affected until ammonia concentrations were relatively high (LC50s 43.2 mg/L to >80 mg/L). Bulls Head Channel sediment had very low contaminant concentrations, but ammonia concentrations in SPP treatments (7.06 mg/L to 22.1 mg/L) were in or above the median effective concentration range of ammonia (2.5 mg/L to 9.5 mg/L). The recent ammonia-larval development data support the hypothesis that the Bulls Head Channel SPP toxicity was due to ammonia rather than suspended sediment contaminants.

TABLE 3.13. Normal Development of *M. galloprovincialis* Compared to Total Ammonia Levels in SPP Treatments

Sediment Treatment	Concentration (Percent SPP)	Mean Proportion Normal	SPP EC50 (Percent SPP)	Total Ammonia (mg/L)	Ammonia EC50 (mg/L)
R-AM	50	0.99		0.229	
R-AM	100	0.96	>100	0.301	NC(a)
R-BF	50	0.88		0.57	
R-BF	100	0.95	>100	0.97 ^e	NC
Comp BHC-A Upper	50	0.89		0.147	
Comp BHC-A Upper	100	0.00	>100	0.183	NC
Comp BHC-A Lower	0	1.00		0.302	
Comp BHC-A Lower	1	0.97		0.207	
Comp BHC-A Lower	10	1.00		1.66	
Comp BHC-A Lower	50	0.00		9.51	
Comp BHC-A Lower	100	0.00	22.3	17.6	3.97
Comp BHC-B	0	1.00		0.086	
Comp BHC-B	1	1.00		0.486	
Comp BHC-B	10	1.00		2.24	
Comp BHC-B	50	0.00		12.1	
Comp BHC-B	100	0.00	22.4	22.1	5.25
Comp TB-C	50	0.98		0.904	
Comp TB-C	100	1.00	>100	1.6	NC
Comp TB-D Upper	0	0.92		--- (b)	
Comp TB-D Upper	1	0.96		---	
Comp TB-D Upper	10	0.90		---	
Comp TB-D Upper	50	0.03		4.61	
Comp TB-D Upper	100	0.00	22.3	9.82	NC(c)
Comp TB-D Lower	0	0.97		---	
Comp TB-D Lower	1	0.97		---	
Comp TB-D Lower	10	0.92		---	
Comp TB-D Lower	50	0.00		8.27	
Comp TB-D Lower	100	0.00	20.0	16.2	NC(c)
Comp TB-E Upper	50	0.50		3.61	
Comp TB-E Upper	100	0.00	40.7	7.06	NC(c)
Comp TB-E Lower	0	0.98		0.196	
Comp TB-E Lower	1	0.97		0.441	
Comp TB-E Lower	10	0.89		3.48	
Comp TB-E Lower	50	0.00		13.1	
Comp TB-E Lower	100	0.00	18.8	23.7	5.92

(a) NC Ammonia EC50 not calculated because ammonia was not measured in lower SPP concentrations.

(b) --- Ammonia not measured.

(c) Ammonia EC50s not calculated but appear to be in 3 mg/L to 5 mg/L range.

4.0 DISCUSSION AND CONCLUSIONS

In this section, proposed dredged material from Bulls Head Channel and turning basin is discussed in the context of the stated objectives of the Bulls Head Channel project: exclusion of the material from further testing for ocean disposal, suitability for in-bay disposal, and beneficial uses.

4.1 EXCLUSION FROM FURTHER TESTING FROM OCEAN DISPOSAL

Ocean disposal is regulated under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA), which requires that dredged material be evaluated using EPA criteria in Title 40 of the Code of Federal Regulations, Parts 220-228 (CFR 40, 220-228). According to CFR 40, Part 227.13(b), dredged material is environmentally acceptable for ocean dumping without further testing if "it is composed predominantly of sand, gravel, rock, or other naturally occurring bottom material with particle sizes larger than silt, and the material is found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and currents." Approximately half the Bulls Head Channel sediment, represented by Comps BHC-A Upper, TB-C, TB-D Upper and Lower, and TB-E Upper, meets these criteria and should be acceptable for ocean dumping without further testing. These composites are ≥80% sand, the solid phase is not acutely toxic to *R. abronius* and *E. estuarius*, and the suspended-particulate phase is not acutely toxic to *M. galloprovincialis* larvae.

The other three composites, Comps BHC-A Lower, BHC-B, and TB-E Lower are predominantly silt and clay. Even though they are removed from known existing and historical sources of pollution by distance, depth, or both, these composites must be shown to be "substantially the same as the substrate of the proposed disposal site," or, to be in compliance with ocean dumping criteria following further testing of liquid, suspended-particulate, and solid phases. The fine-grained Bulls Head Channel sediments contain less sand and more silt than the ocean reference sediment to which all other sediment from the John F. Baldwin Ship Channel was compared when evaluated for ocean disposal in 1992 (Kohn et al. 1993). Contaminant levels in fine-grained Bulls Head Channel sediment are similar to or slightly higher (some metals) than the previously tested ocean reference, but were similar to or lower than in proposed dredged material from the lower reaches of John F. Baldwin Ship Channel.

Biological responses to Bulls Head Channel sediment cannot be statistically compared to the ocean reference, because this reference was not evaluated during the project. In previous ocean testing programs, survival of the amphipod, *R. abronius*, in the ocean reference ranged from 63% to 97%, with a mean of 80% (Kohn et al. 1993; Pinza et al. 1992, 1993a, 1993b). *R. abronius* would not cause Bulls Head Channel sediments to fail solid-phase criteria, because no treatments had less than 80% survival (none would be more than 20% different from 100% survival in a reference). The amphipod, *E. estuarius*, has never been tested against the ocean

reference sediment at the MSL, so no survival data are available for comparison. In a worst-case scenario, Comp BHC-B would fail solid-phase criteria if *E. estuarius* survival in ocean reference were greater than 94%; if *E. estuarius* survival in ocean reference sediment were greater than 97%, Comp TB-E Lower would fail also. Bulls Head Channel sediments appear to have a low potential for bioaccumulation because of their low sediment metals and low to undetected organics concentrations. In previous ocean testing programs, metals have been shown not to bioaccumulate substantially (most no more than 2X to 3X reference); this was the case for lower John F. Baldwin Ship Channel sediments.

The limiting permissible concentration (LPC) of Bulls Head Channel sediments is 0.8-1% SPP based on survival of bivalve (*M. galloprovincialis*) larvae. However, all but the sandiest composites did affect normal development of bivalve larvae. Using this endpoint, and assuming the sediment is causing the effect (as opposed to release of nonpersistent ammonia from the sediment), the LPCs range from lows of 0.2% SPP to 1% SPP. It is probable that ammonia is contributing to larval abnormalities: approximate EC50s as ammonia measured in SPP treatments ranged from 3.97 mg/L to 5.92 mg/L total ammonia. In recent experiments isolating the effects of ammonia in seawater on *M. galloprovincialis* development, EC50s ranged from about 2 mg/L to 7 mg/L ammonia (unpublished data, MSL). The ammonia-effects levels in the SPP tests are very similar to the effects levels of ammonia alone in seawater. The effects on larval development in the SPP tests are most likely due to ammonia, which is not a persistent contaminant, and therefore are not considered to represent a significant environmental risk. To determine whether LPCs and water quality criteria (WQC) will be exceeded, a mixing model with input parameters for the ocean disposal site must be used. Effects from release of contaminants from sediment into the water column should be minimal given that levels of persistent sediment contaminants are relatively low.

4.2 SUITABILITY FOR OPEN-WATER DISPOSAL WITHIN SAN FRANCISCO BAY

Open-water disposal within San Francisco Bay is regulated under Section 404 of the Clean Water Act, and requires testing under the guidelines in Public Notice 93-2 (USACE 1993). Bulls Head Channel was tested for all Public Notice 93-2 physical, chemical, and biological parameters. Because of the large volume of dredged material in Bulls Head Channel and turning basin (>500,000 cy), an appropriate sampling and compositing scheme was developed and presented to regulatory agencies prior to sampling, and reviewed by those agencies. Although the actual compositing scheme departed from the plan, the composite samples that were created are very representative of the material, which was easily categorized into a few distinct sediment types (described in Section 3.1.1 and Appendix A).

All Bulls Head Channel composites passed 10-day solid-phase bioassays conducted with *R. abronius* when compared to the Alcatraz Environs and Bay Farm reference sites.

However, two of the composites, Comps BHC-B and TB-E Lower, did not pass in-bay aquatic disposal criteria when conducted with *E. estuarius* and compared to the Alcatraz Environs reference (all composites passed with *E. estuarius* when compared to Bay Farm reference). These two composites were relatively fine-grained and had higher porewater ammonia concentrations than the other composites. It is possible that further reduction of porewater ammonia would have improved *E. estuarius* survival.

The LPCs for Bulls Head Channel sediments are 0.2% to 1% SPP, using the most sensitive endpoint, bivalve larvae development. Water column contaminant levels can be estimated from sediment chemistry data and suspended sediment concentration, and then compared to state and federal WQC. Although site-specific compliance with LPCs needs to be determined, Bulls Head Channel sediments are relatively uncontaminated and of low toxicity. The primary obstacle to in-bay disposal is probably the extremely large volume of dredged material created by the project. The in-bay aquatic disposal testing requirements are also applied to use of dredged material in wetland creation and enhancement.

4.3 BENEFICIAL USES

Beneficial uses such as wetlands creation or cover, levee restoration, or landfill cover, is regulated under Section 404 of the Clean Water Act (use of dredged material in wetlands) or California Code of Regulations Title 23, Chapter 15 (nonaquatic use or disposal of dredged material). The California Environmental Protection Agency and Regional Water Quality Control Board have developed interim sediment screening criteria and testing requirements for wetland creation and upland beneficial use (Wolfenden & Carlin 1992). Sediment chemical characterization of PN 92-7 (superseded by PN 93-2) is the minimum requirement for wetlands creation or uplands disposal. A 10-day solid-phase bioassay is also required for wetlands creation cover material, as is the WET test. Sediment chemical characterization, 10-day solid-phase bioassays, and the WET test were conducted on Bulls Head Channel composites.

Upland testing requirements tend to be specific to the certain disposal option (i.e., class of landfill). However, the interim screening criteria state that:

"Inert waste does not have to be disposed of at a classified waste management unit. . . . Dredged material will be considered inert waste if the following criteria are met:

1. It has concentrations less than those listed for wetlands creation cover material and it passes the 10-d solid-phase bioassay test; or
2. It is within the concentrations for the wetlands noncover material and it passes the leach test."

Two Bulls Head Channel composites, Comps BHC-B and TB-D Lower, meet all interim sediment screening criteria for wetlands creation noncover material, wetlands creation cover material, levee restoration, and daily landfill cover (Table 4.1). Comp TB-E Lower also met all criteria, except that one contributing sample exceeded the wetlands cover criterion for chromium. The other composites met most of the screening criteria except for chromium in the sandier samples and one mercury value in Comp BHC-A Lower.

Ten-day solid-phase testing resulted in no significant toxicity to *R. abronius* and some toxicity to *E. estuarius* when compared to two in-bay disposal reference sediments. As there is no wetland proposed to accept Bulls Head Channel sediment, solid-phase test results could not be compared directly to a "wetlands reference sediment." However, if the in-bay solid-phase criteria (reduction in survival statistically significant and >20% from reference) are applied, only Comps BHC-B and TB-E Lower have any potential for failure. As stated above, these two composites essentially pass all screening criteria for wetlands creation and other beneficial uses. The comparisons to both in-bay reference sediments give a good idea of the range of responses.

4.4 CONCLUSIONS

The sediments in the Bulls Head Channel reach of the John F. Baldwin Ship Channel are relatively uncontaminated by priority pollutants. Metals concentrations overall are similar to those found in the lower reaches of the John F. Baldwin Ship Channel (Kohn et al. 1993). PAH and butyltin concentrations are extremely low; phthalates, pesticides, and PCBs were undetected. The silts and clays at depth had higher contaminant concentrations, but such concentrations are commonly associated with fine particles and higher organic content. Metals levels in the finer-grained samples often exceeded the levels in the Alcatraz Environs reference, usually by less than a factor of three. Fewer metals levels exceeded the Bay Farm reference, which is also a finer-grained sediment. Chromium concentrations were higher in the coarser sediments than in fine-grained material. The chromium in both coarse and fine sediment is probably part of the mineral matrix of the sediment, as very little chromium was extracted by the WET procedure (see STLC results, Table 3.7). In all cases, concentrations of organic contaminants in Bulls Head Channel samples were lower than concentrations in the Alcatraz Environs and Bay Farm reference sediments.

Bulls Head Channel sediments were not acutely toxic to the amphipod, *Rhepoxynius abronius*; only two composites were acutely toxic to the amphipod, *Eohaustorius estuarius* when compared to the Alcatraz Environs reference sediment. These two sediments were relatively fine-grained and had higher porewater ammonia concentrations than the other composites. Ammonia also appeared to affect the outcome of the SPP toxicity tests with bivalve larvae. Larval development was abnormal in half the organisms at 3 mg/L to 5 mg/L ammonia, regardless of the suspended sediment concentration.

TABLE 4.1. Concentrations of Metals and Organics in Bulls Head Channel Sediment Compared to the Sediment Screening Levels for Beneficial Uses

Parameter	Screening Criteria Value (mg/kg dry wt)		Composite Value in mg/kg dry weight (range of values, number exceeding minimum criteria in contributing samples)							
	Wetlands Creation Noncover(a)	Wetlands Creation Cover, Levee Restoration, Daily Landfill Cover(a)	Comp BHC-A		Comp BHC-B	Comp TB-C	Comp TB-D		Comp TB-E	Comp TB-E
			Upper	Lower			Upper	Lower		
Cadmium	5-9	<5	ND(b) (ND-0.11, 0)	0.17 (0.08-0.24, 0)	0.17 (0.17-0.20, 0)	ND (ND-0.09, 0)	0.09 (ND, 0)	0.09 (0.11, 0)	0.09 (ND, 0)	0.18 (ND-0.21, 0)
Chromium	220-300	<220	258(c) (211-352, 3)	204 (145-240, 2)(c)	171 (150-215, 0)	230(c) (168-366, 5)	304(c) (204-486, 2)	210 (219, 0)	334(c) (264-320, 2)	181 (160-241, 1)(c)
Copper	90-390	<90	17 (13.2-18.3, 0)	46.3 (25.7-55.4, 0)	64.3 (51.7-63.8, 0)	19.2 (11.7-20.0, 0)	23.7 (18.0-29.2, 0)	30.6 (30.9, 0)	29.4 (24.7-25.4, 0)	60.2 (44.4-68.4, 0)
Lead	50-110	<50	12.1 (7.9-15.2, 0)	11.9 (8.7-16.8, 0)	12.3 (6.4-13.6, 0)	9.1 (9.1-21.9, 0)	7.8 (7.4-8.2, 0)	8.3 (9.1, 0)	7.3 (6.7-7.6, 0)	8.4 (9.4-12.8, 0)
Mercury	0.35-1.3	<0.35	0.03 (0.02-0.03, 0)	0.14 (0.02-0.42, 1)(d)	0.05 (0.04-0.07, 0)	0.02 (0.01-0.03, 0)	0.02 (0.02-0.03, 0)	0.02 (0.02, 0)	0.02 (0.02, 0)	0.05 (0.05-0.07, 0)
Nickel	140-200	<140	83 (74-82, 0)	106 (92-113, 0)	122 (112-120, 0)	84 (78-90, 0)	95 (88-104, 0)	101 (100, 0)	106 (94-98, 0)	116 (110-126, 0)
Silver	1.0-2.2	<1.0	0.04 (0.03-0.05, 0)	0.08 (0.05-0.12, 0)	0.10 (0.09-0.13, 0)	0.03 (0.02-0.05, 0)	0.05 (0.03-0.05, 0)	0.05 (0.06, 0)	0.04 (0.03-0.04, 0)	0.1 (0.07-0.13, 0)
Selenium	0.7-1.4	<0.7	ND (ND-0.29, 0)	0.18 (0.12-0.36, 0)	0.24 (0.24-0.46, 0)	ND (ND-0.29, 0)	0.18 (ND, 0)	ND (ND, 0)	ND (ND, 0)	0.24 (ND-0.35, 0)
Zinc	160-270	<160	74 (66-80, 0)	91 (76-101, 0)	102 (96-112, 0)	72 (67-83, 0)	74 (66-84, 0)	78 (78, 0)	77 (73-77, 0)	102 (88-116, 0)
Arsenic	33-85	<33	7.6 (5.8-8.7, 0)	11.0 (8.4-16.3, 0)	10.1 (7.7-13.0, 0)	8.8 (5.5-11.9, 0)	7.3 (5.2-7.8, 0)	6.5 (5.8, 0)	6.2 (6.0-13.7, 0)	11.6 (5.9-12.1, 0)
PCBs	0.05-0.4	<0.05	ND	ND	ND	ND	ND	ND	ND	ND
Total DDT	0.003-0.1	<0.003	ND (ND-0.0008, 0)	ND (ND, 0)	ND (ND, 0)	ND (ND-0.0006, 0)	ND (ND, 0)	ND (ND, 0)	ND (ND, 0)	ND (ND, 0)
Total PAH	4-35	<4	0.04 (0.05-0.44, 0)	0.11 (0.01-0.49, 0)	0.03 (0.01-0.06, 0)	0.02 (0.01-0.05, 0)	0.01 (0.02-0.02, 0)	0.01 (0.02, 0)	0.01 (0.01-0.02, 0)	0.04 (0.02-0.06, 0)

(a) Screening criteria values taken from *Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse*, San Francisco Bay Regional Water Quality Control Board (Wolfenden and Carlin 1992).

(b) ND None Detected.

(c) STLC chromium values were ≤ 0.2 mg/L (200 μ g/L) for all composites (see Table 3.7, page 3.24).

(d) STLC mercury was undetected in all composites (<0.01 mg/L or <10 μ g/L).

The suitability of Bulls Head Channel dredged material for several disposal options may be evaluated by the testing performed during this project (Table 4.2). Approximately 50% of the sediment does not need to undergo further testing for ocean disposal; current and previous testing indicate that further testing may not be necessary for the other 50% as well, since the material is similar to other John F. Baldwin Ship Channel sediments that were acceptable for ocean disposal. Most of the material also meets in-bay disposal criteria as well, but the estimated 1.8 mcy of material exceeds the volume limitations on in-bay disposal sites. The in-bay option could probably apply only to partial volumes. Much of the material is acceptable for beneficial uses, based on a combination of in-bay disposal criteria and upland testing criteria. The results of this project indicate a reason to believe that Bulls Head Channel sediments pose low levels of risk for environmental damage.

TABLE 4.2. Summary of Bulls Head Channel Test Results and Comparison to Applicable Criteria

	Comp BHC-A Upper	Comp BHC-A Lower	Comp BHC-B	Comp TB-C	Comp TB-D Upper	Comp TB-D Lower	Comp TB-E Upper	Comp TB-E Lower
Approximate Percentage of Dredged Material Total Volume ^(a)	5%	14%	13%	17%	9%	3%	5%	34%
>80% Sand	Yes	No	No	Yes	Yes	Yes	Yes	No
Passes 10-d <i>R. abronius</i> vs. Alcatraz	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Passes 10-d <i>R. abronius</i> vs. Bay Farm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Passes 10-d <i>E. estuarius</i> vs. Alcatraz	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Passes 10-d <i>E. estuarius</i> vs. Bay Farm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bivalve LC50 >100% SPP (LC50 as %SPP)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No (85%)
Bivalve EC50 >100% SPP (EC50 as %SPP)	Yes	No (22%)	No (22%)	Yes	No (22%)	No (20%)	No (41%)	No (19%)
Meets Wetland Creation Noncover Criteria	Yes	Yes	Yes	Yes	No ^(b)	Yes	No ^(b)	Yes
Meets Wetland Creation Cover, Other Beneficial Uses Criteria	No ^(b)	No ^(c)	Yes	No ^(b)	No ^(b)	Yes	No ^(b)	Yes ^(b)
Meets Inert Solid Waste Criteria (assumes in-bay reference is ok for wetland comparison)	Maybe ^(b)	Maybe	Maybe	Maybe ^(b)	Maybe	Yes	Maybe	Maybe

(a) Percentage of volume based on thickness of sediment from each station contributing to a composite, and assumes each foot of thickness represents the same volume. These volumes are rough estimates: each vertical foot does not represent the same volume because of the variable sampling density. For example, each vertical foot in the turning basin represents less volume than a vertical foot from a channel (BHC-) station, because the TB-stations are closer together. Actual volumes will be calculated by USACE.

(b) Composite or contributing sample(s) meets all criteria except for Cr (see Table 4.1). All Bulls Head Channel Cr values are in same range as Cr in sediment from lower John F. Baldwin Ship Channel.

(c) Composite meets all criteria, but Cr criteria exceeded in 2 contributing samples and Hg exceeded in 1 contributing sample.

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APPENDIX A

GEOLOGIC CORE DATA LOGS

Lithology:

Clay
Silty clay to clayey silt
Silt
Sandy silt to silty sand
Sand
Pebbles
Mollusk shells
Concentrated organic matter
Iron-oxide concentrations
Root traces

Silt/Clay Characteristics

Dilatancy:

N = none
S = slow
R = rapid

Toughness:

L = low
M = medium
H = high

Plasticity:

N = none
L = low
M = medium
H = High

Type:

See soil group classification in
ASTM D2488-84

Color (wet):

Selected from Munsell Soil
Color Chart

Consistency:

H = hard = <0.25 cm
F = firm = 0.25-2.0 cm
S = soft = 2.0-4.0 cm
VS = very soft = >4.0 cm

Cementation:

N = not cemented
W = weakly cemented
M = moderately cemented
S = strongly cemented

Structure:

S = stratified
L = laminated
F = fissured
SL = slickensided
Ln = lensed
Bl = blocky
M = mottled
H = homogeneous

HCl Reaction:

N = none
W = weak
S = strong

Maximum Particle Size:

CP = coarse pebble
CS = coarse sand
MS = medium sand
FS = fine sand
VFS = very fine sand

Odor:

N = none
S = sulfide
P = petroleum
O = other
w/HCl = odor apparent after HCl application

Comments:

YBM = Younger Bay Mud unit
OBM = Older Bay Mud unit

Core Data Log

Project: JFB Bulls Head Channel

Core #: BHC-1

Logger: P. White

Date: 1/21/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
40.8	0	NA	NA	NA	SC CL ↓ SC ↓ SP ↓ CL ↓ SP ↓ CL	5 1/2 S/1 black	VS ↓ F ↓ S ↓ F ↓ S	N	S	NA	FS ↓ FS	N	✓		upper 6" oxidized plant material plates of muscovite in fine sand 1 mm laminae of FS in CL plant material twig
-47	6.2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	

Core Data Log

Project: JFB Bulls Head Channel

Core #: BHC-2

Logger: P White

Date: 1/21/74

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-3.9	0	MA	NA	NA	SP	SY3/2 dark olive gray	S	N	H	NA	MS	N	✓		Sand has same lithology as other BHC stations (subang., qtz., muscovite, fsp w. Fe ₂ , Fe Mg mins.) chunk of wood at 1.2' occasional shell frag + woody debris.
							F				CS MS				
	5								(S)		VCS	decomp. org. N			2" layer of woody material
-43.9	7				✓	SY2.5/1 SY4/1 dark gray	F	N	H	NA	FS Z	N	X		clast of clay in sand 4" layer of black FS few shell fragments
							S								
-47	10.1														

Project: JTB Bulls Head Channel

Core #: BHC-3

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Page 7 of 7

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
0	0		NA	NA	NA	SP	SP	H	H	NA	NA	MS	N	X	
0.6	0.6		NA	NA	NA	SP	SP	H	H	NA	NA	MS	N	X	Class of clay in fine block sand in FS
29.3	29.3		NA	NA	NA	SP	SP	H	H	NA	NA	MS	N	X	Zone of mixed silt + cl
3.7	3.7		NA	NA	NA	CL	SP/2 olive gray	F	S	SP/2 olive gray	SP/2 olive gray	MS	N	X	Flow laminae of MS
5	5		NA	NA	NA	CL	SP/2 olive gray	F	S	SP/2 olive gray	SP/2 olive gray	MS	N	X	Flow laminae of MS
7.7	7.7		NA	NA	NA	CL	SP/2 olive gray	F	S	SP/2 olive gray	SP/2 olive gray	MS	N	X	Flow laminae of MS
47.7	47.7		NA	NA	NA	CL	SP/2 olive gray	F	S	SP/2 olive gray	SP/2 olive gray	MS	N	X	Flow laminae of MS

Core Data Log

Project: JFB Bulls Head Channel

Core #: BHC-4

Logger: P. White

Date: 1/21/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-36.6	0	NA	NA	NA	SP	5 3/2 dk. olive gray	S F	N	H	NA	MS	N			Sand similar to other BHC stations. Few granules + pebbles; shell fragments
-36.1	1.5	NA	NA	NA	CL	5 4 1/1 dark gray	V S	N	H	NA	Z	N		X	Homogeneous clay w/ few shell fragments
	5										(MS in sandy layer) Z				thin sandy layer quartz pebbles, plant material, shell frags in clay plant material beginning at 6' Vertical segmented stalks (partially decayed) in clay from 6 - 11' (NPK photo 18) stalks are yellowish brown, black where decayed
-47	10.4					5 6 7/1 gray	H		L						Sed is light gray & hard from 10.2 to 11'; gas holes

Core Data Log

Project: JFB Bulls Head Channel

Core #: BHC-5

Logger: P. White

Date: 1/21/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
38.5	0	NA	NA	NA	SP	SY3/2 dk. olive gray	S	N	H	NA	MS	N			Sand similar to other BHC stations shell fragments in sand
-39.9	1.4	NA	NA	NA	CL (sw)	SY4/1 dark gray	VS	N	H	NA	E (a)	Faint sweet		X	0.5' layer of sw shell fragments clay grades to clayey sand. Sand has flecks of muscovite.
					SC		S				VFS				
					SC/SP		π				FS	N			Percentage of clay in fine sand varies; changes are gradual.
															wood fragments
-47	8.5														

Project: JFB Bulls Head Channel

Page 1 of 1

A.8

Core Data Log

Project: JFB Bulls Head Channel

Core #: BKC-7

Logger: pwhite

Date: 1/21/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
36.6	0	NA	NA	NA	CL	SY3/1 v. dk. gray	S	N	H	NA	Z	S			Plant material dispersed throughout clay; woody debris, segmented stalks, leaf material? some organics in thin layers. Some black (decomposed). Similar to BKC-8. Photo 17 - NVR camera
					ML						VFS	Faint Sweet smell			Clayey silt; flakes of muscovite
5					CL	SY2.5/1 black					Z				Plant material less abundant
					ML						FS				grades from clayey silt to clay, then back to clayey silt
															Flecks of muscovite in clayey silt
10															0.5" layer of peat
10.4															
47															

Project: JFB Bulls Head Channel

Logger: P White

Date: 1/21/94

Page 1 of 1

A.10

Project: JFB Bulls Head Channel

Page 1 of 1

A.11

Project: JFB Bulls Head Channel

Page 1 of 2

A.12

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-10

Logger: Pwhite

Date: 1/28/94

Page 2 of 2

[illegible]

Project: JFB Bulls Head Channel

Page 1 of 1

A.14

Project: JFB Bulls Head Channel

Page 1 of 4

A.15

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-13

Logger: PnWhite

Date: 1/22/94

Page 1 of 1

[illegible]

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-14

Logger: P. White

Date: 1/22/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-37.1	0	NA	NA	NA	SP	2.5/4/2 dk. grayish brown	S F	N	H	NA	MS	N	✓		Sand has same lith. as other BHC/TB stations
						5/12/2 dk. olive gray			(L)						Average grain size 5 to 10, mostly smaller; several thin CL laminae
	5								(L)						1" layer of decayed woody material
									(L)						CL laminae, woody debris
						5/12.5/1 black					CS				Few CL laminae, layers of woody debris. Shell frags.
-45.1															gradational change to black
-46.8	9.7														
	10														

Core Data Log

Project: JFB Bulls Head Channel

Core #: T8-15

Logger: P.W. M. L.

Date: 1/22/95

Page Lot 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
0														
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														

Mostly FS, blocks of muscovite in sand
Changes between lithologies are gradational
CL in SP
Thin (1-2mm) laminae of CL in SP
Mostly FS
1mm layer wavy material
few lam clay

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-15

Logger: Pwhite

Date: 1/22/94

Page 2 of 2

[illegible]

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-16

Logger: P. White

Date: 1/23/94

Page 1 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
22.3	0	NA	NA	NA	SP/CL	SP	5/2.5/1 black	S	N	L	NA	FS	N	+	Laminae of CL in black FS wood chip
23.4	2.3				CL	CL	5/4/1 dark gray	F		I		Z	Faint sweet	X	dark yellowish brown plant material dispersed throughout CL, some decayed to black
5															segmented stalks visible
16															Some layers of black, decayed plant material
15															

Project: JFB Bulls Head Channel

Logger: fwhite

Date: 1/23/94

Page 2 of 2

A.21

Project: JFB Bulls Head Channel

Page 1 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
0	0	NA	NA	NA	SP	SY2.5/1 black	S	N	H/L	NA	MS	N	N	1	Laminar & CL in black sand. Many muscovite flakes in sand.
4.2	4.2	NA	NA	NA	CL	SY4/1 dk. gray	S	N	H	NA	Z	S	X		Shell debris & plant material in clay
5	5	NA	NA	NA	CL	SY4/1 dk. gray	S	N	H	NA	Z	S	X		Some dark yellowish brown + black plant material in clay; not as abundant as other cores
16	16	NA	NA	NA	CL	SY3/1 V. dk. gray	S	N	H	NA	Z	S	X		little plant material 8-10
15	15	NA	NA	NA	CL	SY3/1 V. dk. gray	S	N	H	NA	Z	S	X		Flocks of muscovite in clay. Few roots

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-17

Logger: Pwhite

Date: 1/23/96

Page 2 of 2

[illegible]

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-10

Logger: P White

Date: 1/21/44

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-37.1	0	NA	NA	NA	SP	SY3/2 dk olive gray	S F	N	H	NA	CS	N	✓		Sand same lith. as other JFB stations. few shell frags & weed chunks
-40.2	3.1				CL/SP	SY4/1 dark gray	S	N	L	NA	MS	N	X		~1 mm laminae of FS + MS in CL
-46.9	9.8				SC				H						grades to clay w/ yellowish brown, partly decayed plant material
	10				CL										

Page 1 of 1

	Depth Below Water Surface (m)	Depth Below Mudline (m)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-31.9	0		NA	NA	NA	SP	SY3/2 dark olive gray	S	N	H	NA	CS	N		1	Sand is gtz, muscovite, fsp of FeO ₃ , Fe-Mg mms., few shell frags.
-33.4	1.5		NA	NA	NA	CL	SY3/1 v. dk. gray	S	N	H	NA	E	S	X		Plant material mostly decayed to black
	5						SY4/1 dark gray						Faint S			color change gradational
	10						SY3/1 v. dk. gray					VFS	N			much of decayed plant matter in black layers color change gradational
-47	15.1															less plant material flocks of muscovite small gas holes - "spongy" texture

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-20

Logger: P. White

Date: 1/23/94

Page 1 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-29.2	0	NA	NA	NA	SP	SY3/2	S	N	H	NA	MS	N	✓		Sand has same lith. as other JFB stations
						dark olive gray	F								
						512-5/1 black						S			0.5' black layer in sand smells strongly of sulfur.
						513/2 dk. olive gray						N			
-35.2	6.0				CL	514/1	S	N	H	NA	Z	Faint S	X		Dark yellowish-brown to black plant material dispersed in clay.
						dark gray									
						513/1 v. dk. gray									color change gradational
															segmented stuff visible.

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-20

Logger: Pwhite

Date: 1/23/94

Page 2 of 2

[illegible]

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-21

Logger: P. White

Date: 1/22/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-38	0	NA	NA	NA	SP	SY3/2	dark olive gray	S	N	H	NA	MS	N	✓	Sand same lith. as other JFB stations
-41.0	3.8	NA	NA	NA	SP	SY2.5/1	black	S	N	H	NA	CS	N	✓	Some clay in sand wood chunks
-41.2	6.3	NA	NA	NA	CL	SY4/1	dark gray	S	N	H	NA	FS	N	✓	Few thin (1 mm) clay layers in SP
-41.9	6.9	NA	NA	NA	CL	SY4/1	dark gray	S	N	H	NA	FS	N	✓	clay
															Sediment from cutter head + stored in bag is also dark gray clay.

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-22

Logger: pwhite

Date: 1/23/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-33	0	NA	NA	NA	SP	SY 3/2	dark olive gray	SF	N	H	NA	CS	N	✓	Same "brown" sand as at other JFB stations. Pine cone at top of core wood chunks.
2	2	NA	NA	NA	SP	SY 3/1	dark gray	F	N	H	NA	FS	N	✓	very few cl laminae
5	5										MS				
10	10														
-44.7	11.7				SC						FS				grades from SP to SC
															Material from -44.7 to -45.5 saved from cutterhead into bag. SC similar to material in bottom of core liner.

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-23

Logger: p white

Date: 1/23/94

Page 1 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-29	0	NA	NA	NA	SP	SP	5/3/2 dk. ol. gray	S	N	H	NA	MS	N	X	
0.7					CL		5/3/1 v dk. gray	S		H		Z	Faint S		Dark yellowish brown to black plant matter dispersed throughout clay
5															Plant material more decayed
10													N		little plant material small gas holes; spongy texture
13.5						SC						FS			
15															

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-23

Logger: pwhite

Date: 1/23/94

Page 2 of 2

[illegible]

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-24

Logger: P. White

Date: 1/23/94

Page 1 of 1

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-37.4	0	NA	NA	NA	SP	SY 3/2 dk olive gray	S	N	H	NA	MS	N	T		Sand has same lith as other JFB station
-40.1	2.7				CL	SY 1/1 v. dk. gray	S		H		Z	Faint S	X		woody debris
					SC				S		FS	N			Partially decayed plant matter in CL
	5				CL						Z				little plant material
					SP						FS				
					SC										
					CL										
-47	9.6														

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-25

Logger: *Private*

Date: 1/24/94

Page 1 of 1

Depth Below Water Surface (m)	Depth Below Mudline (m)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-38.1	0.5	NA ↓ NA	NA ↓ NA	NA ↓ NA	SP ↓ SC CL	SY3/2 dk. dk. gray SY3/1 v. dk. gray	S ↓ F	N ↓ N	H ↓ H/L	NA ↓ NA	MS ↓ FS	N ↓ N	no X		upper 0.20 of core missing ↑ 0.5 of sand has same lith. as other JFB stations CL laminae in SC
-47	8.0					SC		S ↓ S							few laminae of SP & CL in SC

Project: JFB Bulls Head Channel

Page 1 of 2

A.34

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Core Data Log

Project: JFB Bu11s Head Channel

Core #: TB-24

Logger: *pubuk*

Date: 1/27/94

Page 2 of 2

		Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
				NK	NK	NK	SP	SY3/1 dk gray	F	N	H	NA	MS	N			layers of woody material few laminae of CL
										</								

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-27

Logger: pwhite

Date: 1/24/94

Page 1 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
-26.8	0	NA	NA	NA	SP/CL	SY3/1 v. dk. gray	S	N	S	NA	MS	N		✓	Layers of CL in SP
															few shell frag.
															2" layers of decayed woody material
	5						F								Fewer CL laminae between 5-8'
							S								0.5" of woody material
	10						F								Few CL laminae btw 10-12'
	12.7													X	
	14.3													X	
41.1	15						S	H			Z	N			

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-27

Logger: P White

Date: 1/24/94

Page 2 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
15		NA	NA	NA	CL	SV4/1	dark gray	S	N	H	NA	Z	N		Few pieces of dark yellowish brown plant material in clay
20															
-47															

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-28

Logger: P. White

Date: 1/24/94

Page 1 of 2

Depth Below Water Surface (ft)	Depth Below Mudline (ft)	Lithology	Dilatancy	Toughness	Plasticity	Type	Color	Consistency	Cementation	Structure	HCl Reaction	Maximum Particle Size	Odor	Samples	Comments
0	0	NA	NA	NA	SP	SY 3/2	dk. olive gray	S ↓ F	N	H	NA	CS	N		
3.9	3.9				CL	SY 3/1	v. dk. gray	S ↓	H	NA	Z	N	X		
5	5														Some partly decayed plant material - dark yellowish brown to black.
10	10														
14.8	14.8				SC						FS				Sand & clay
15	15														

Core Data Log

Project: JFB Bulls Head Channel

Core #: TB-28

Logger: pnwhite

Date: 1/24/94

Page 2 of 2

[illegible]

APPENDIX B

SEDIMENT CHEMISTRY AND QUALITY CONTROL DATA

TABLE B.1. Summary of Sediment Grain Size, Including Quality Control Data

Sediment Treatment	Vertical Segment (-ft MLLW)	Percent Dry Weight			
		Gravel >2000 μm	Sand 62.4- 2000 μm	Silt 3.9- 62.4 μm	Clay <3.9 μm
R-AM	NA	0	97	1	2
R-BF	NA	0	7	39	54
Comp BHC-A	Upper	1	97	0	2
BHC-2	36.9-43.9	1	98	0	1
BHC-4	36.6-38.1	0	99	0	1
BHC-5	38.5-39.9	0	97	2	1
BHC-6	43.2-44.7	1	95	1	3
Comp BHC-A	Lower	0	46	31	23
BHC-1	40.8-47.0 Rep 1	1	14	42	43
BHC-2	43.9-47.0	0	60	18	22
BHC-3	39.3-46.4	0	33	31	36
BHC-4	38.1-47.0	0	5	60	35
BHC-5	39.9-47.0	0	55	33	12
BHC-6	44.7-46.4	0	81	14	5
Comp BHC-B		0	21	48	31
BHC-7	36.6-47.0	0	35	42	23
BHC-8	41.8-47.0	0	3	64	33
BHC-9	45.2-46.2	0	38	43	19
TB-10	30.4-40.2	0	9	52	39
TB-12	39.8-47.0	0	5	61	34
Comp TB-C		0	97	1	2
BHC-9	42.0-45.2	0	98	1	1
TB-11	39.7-46.6	0	97	1	2
TB-13	43.0-47.0	0	97	2	1
TB-14	37.1-46.8	0	93	4	3
TB-18	37.1-40.2	1	98	0	1
TB-19	31.9-33.4	0	94	3	3
TB-20	29.2-35.2	0	99	0	1
TB-21	38.0-41.8	0	95	3	2
TB-22	33.0-35.0	0	96	2	2
TB-24	37.4-40.1	0	98	1	1
Comp TB-D	Upper	0	80	12	8
TB-15	29.7-47.0	0	85	9	6
TB-16	28.3-30.6	0	81	11	8
TB-17	28.3-32.5	0	89	7	4
Comp TB-D	Lower	0	79	16	5
TB-10	40.2-46.8	0	80	15	5

TABLE B.1. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Percent Dry Weight			
		Gravel >2000 μm	Sand 62.4- 2000 μm	Silt 3.9- 62.4 μm	Clay <3.9 μm
Comp TB-E Upper		0	87	9	4
TB-21	41.8-44.3	0	87	8	5
TB-22	35.0-44.7	0	90	6	4
Comp TB-E Lower, Rep 1		0	19	54	27
TB-16	30.6-47.0 Rep 1	0	5	51	44
TB-17	32.5-47.0	0	12	65	23
TB-18	40.2-46.9	0	49	37	14
TB-19	33.4-47.0	0	6	60	34
TB-20	35.2-47.2	0	5	68	27
TB-23	29.0-46.3	0	16	55	29
TB-24	40.1-47.0	0	37	43	20
Cores Outside of Proposed Dredging Area					
TB-25	38.4-46.8	0	50	37	13
TB-26	28.6-36.0	0	53	23	24
TB-26	36.0-47.0	0	94	3	3
TB-27	26.8-39.5	0	75	14	11
TB-27	39.5-41.1	0	75	12	13
TB-27	41.1-46.8	0	10	59	31
TB-28	29.0-32.9	0	99	0	1
TB-28	32.9-47.0	0	29	45	26
Quality Control Data					
BHC-1	40.8-47.0 Rep 1	1	14	42	43
BHC-1	40.8-47.0 Rep 2	0	14	43	43
RPD		200%	0%	2%	0%
I-Stat		1.00	0.00	0.01	0.00
Comp TB-E Lower, Rep 1		0	19	54	27
Comp TB-E Lower, Rep 2		0	19	54	27
RPD		0%	0%	0%	0%
I-Stat		0.00	0.00	0.00	0.00
TB-16	30.6-47.0 Rep 1	0	5	51	44
TB-16	30.6-47.0 Rep 2	0	5	51	44
RPD		0%	0%	0%	0%
I-Stat		0.00	0.00	0.00	0.00

TABLE B.2. Sediment Total Solids, Organic Carbon (TOC), Total Volatile Solids (TVS), Total Sulfide, Water Soluble Sulfide, and Total Petroleum Hydrocarbons (TPH)

Sediment Treatment	Vertical Segment (-ft MLLW)	Total % Solids	TOC Batch	TOC (% dry weight)	TVS, Sulfide Batch	TVS (% dry wt)	Total Sulfide (mg/kg dry wt)	Water Soluble Sulfide (mg/kg dry wt)	TPH Batch	TPH (mg/kg dry weight)
Target DL (a)		0.1		0.1		1.0	0.1	0.1		20
Achieved DL		1.0		0.004		1.0	0.055	0.055		10-18
R-AM	NA (b)	78.86	1	0.04	1	0.690	1.31 U (c)	0.15 U	3	20
R-BF	NA	34.95	1	1.28	1	2.11	91.9	0.39 U	3	54
Comp BHC-A Upper		85.93	1	0.17	3	1.40	1.41 U	0.16 U	3	12 U
BHC- 2	36.9-43.9	86.74	2	0.73	1	1.31	1.26 U	0.12 U	1	12 U
BHC- 4	36.6-38.1	78.73	1	0.03	1	0.957	1.53 U	0.14 U	1	13 U
BHC- 5	38.5-39.9	76.80	1	0.10	1	1.09	1.46 U	0.17 U	1	13 U
BHC- 6	43.2-44.7	78.50	1	0.12	1	1.31	1.53 U	0.16 U	1	13 U
Comp BHC-A Lower		63.74	1	0.76	3	3.18	1.81 U	0.20 U	3	22
BHC- 1	40.8-47.0	57.36	2	1.22	1	3.37	23.5	0.17 U	1	34
BHC- 2	43.9-47.0	63.65	2	0.70	1	2.72	152	1.25 U	1	40
BHC- 3	39.3-46.4	63.06	2	0.68	1	3.77	26.5	0.20 U	1	16 U
BHC- 4	38.1-47.0 Rep 1	59.48	1	1.29	1	3.20	1.96 U	0.34	1	19
BHC- 5	39.9-47.0	71.80	2	0.51	1	2.42	24.3	0.19	1	14 U
BHC- 6	44.7-46.4	76.68	1	0.24	1	2.26	1.54 U	0.16 U	1	13 U
Comp BHC-B		58.75	1	2.02	3	3.97	1.96 U	0.20 U	3	20
BHC- 7	36.6-47.0	64.11	1	1.80	1	3.76	1.74 U	0.20	1	20
BHC- 8	41.8-47.0	61.66	1	1.73	1	3.71	6.01	0.20 U	1	32
BHC- 9	45.2-46.2	70.72	1	0.82	1	3.01	16.1 U	1.43 U	1	14 U
TB- 10	30.4-40.2	54.19	2	2.68	1	4.77	88.7	0.25 U	1	18 U
TB- 12	39.8-47.0 Rep 1	61.12	2	1.97	1	3.97	1.69 U	0.23 U	1	16 U
Comp TB-C		82.88	1	0.18	3	1.30	1.36 U	0.14 U	3	14
BHC- 9	42.0-45.2	81.11	1	0.12	1	1.26	1.43 U	0.16 U	1	12 U
TB- 11	39.7-46.6	81.44	2	0.04	1	1.17	1.40 U	0.16 U	2	12 U
TB- 13	43.0-47.0 Rep 1	87.69	2	0.05	2	1.13	1.37 U	0.15 U	2	11 U
TB- 14	37.1-46.8	81.29	2	0.17	2	1.33	1.45 U	0.15 U	2	13
TB- 18	37.1-40.2	80.36	2	0.02	2	0.973	1.48 U	0.16 U	2	12 U
TB- 19	31.9-33.4 Rep 1	78.59	2	0.11	2	1.35	1.48 U	0.15 U	2	13 U
TB- 20	29.2-35.2 Rep 1	86.11	3	0.07	2	0.961	1.46 U	0.14 U	2	12
TB- 21	38.0-41.8	82.51	2	0.09	2	1.04	1.42 U	0.16 U	2	12 U
TB- 22	33.0-35.0	79.03	3	0.17	2	1.19	16.2 U	0.13 U	2	38
TB- 24	37.4-40.1	80.59	3	0.06	3	0.809	1.49 U	0.16 U	3	12 U

TABLE B.2. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Total % Solids	TOC Batch	TOC (% dry weight)	TVS, Sulfide Batch	TVS (% dry wt)	Total Sulfide (mg/kg dry wt)	Water Soluble Sulfide (mg/kg dry wt)	TPH Batch	TPH (mg/kg dry weight)
Comp TB-D Upper Rep 1		75.44	1	0.29	3	1.95	1.50 U	0.18 U	3	13 U
TB- 15	29.7-47.0	76.43	2	0.32	2	1.49	1.55 U	0.15 U	2	13 U
TB- 16	28.3-30.6	71.50	2	0.53	2	2.28	17.1	0.13 U	2	14
TB- 17	28.3-32.5	71.57	2	0.53	2	2.52	1.55 U	0.16 U	2	14
Comp TB-D Lower		76.19	1	0.35	3	1.69	1.50 U	0.15 U	3	13 U
TB- 10	40.2-46.8	75.57	2	0.23	1	1.85	1.63 U	0.14 U	1	13 U
Comp TB-E Upper		78.25	1	0.11	3	1.82	1.46 U	0.17 U	3	14
TB- 21	41.8-44.3	79.13	3	0.30	2	1.53	1.49 U	0.17 U	2	14
TB- 22	35.0-44.7	78.26	3	0.12	2	1.37	1.62 U	0.17 U	2	13 U
Comp TB-E Lower Rep 1		60.97	1	1.42	3	3.39	9.50	0.19 U	3	16
TB- 16	30.6-47.0	59.60	2	2.38	2	4.59	23.7 U	0.20 U	2	24
TB- 17	32.5-47.0	68.98	2	0.97	2	3.39	214	0.16 U	2	14 U
TB- 18	40.2-46.9	73.23	2	0.61	2	2.47	2.81	0.12 U	2	451
TB- 19	33.4-47.0	59.94	3	1.87	2	4.54	15.7	0.23 U	2	17 U
TB- 20	35.2-47.2	67.29	3	1.28	2	3.43	1.86 U	0.18 U	3	15 U
TB- 23	29.0-46.3	63.66	3	1.74	2	3.95	17.8 U	0.21 U	3	19
TB- 24	40.1-47.0	67.13	3	1.51	3	3.91	10.4	0.18 U	3	15 U
Cores Outside of Proposed Dredging Area										
TB- 25	38.4-46.8 Rep 1	73.77	3	0.57	3	2.56	28.4	0.15 U	3	18
TB- 26	28.6-36.0	61.57	3	0.78	3	2.80	29.3	0.20 U	3	20
TB- 26	36.0-47.0	76.90	3	0.52	3	1.73	1.45 U	0.15 U	3	13 U
TB- 27	26.8-39.5	67.74	3	0.64	3	2.41	27.2	0.15 U	3	18
TB- 27	39.5-41.1	53.59	3	5.43	3	6.62	202	0.25 U	3	33
TB- 27	41.1-46.8	64.78	3	1.48	3	3.98	53.2	0.18 U	3	15 U
TB- 28	29.0-32.9	79.61	3	0.05	3	0.861	1.39 U	0.14 U	3	16
TB- 28	32.9-47.0	63.12	1	1.96	3	3.62	1.83 U	0.21 U	3	20

(a) DL Detection limit.

(b) NA Not applicable.

(c) U Undetected above given concentration.

TABLE B.3. Quality Control Data for Sediment Total Solids, Organic Carbon (TOC), Total Volatile Solids (TVS), Total Sulfide, Water Soluble Sulfide, and Total Petroleum Hydrocarbons (TPH)

Sediment Treatment	Vertical Segment (-ft MLLW)	Total % Solids	TOC Batch	TOC (% dry weight)	TVS, Sulfide Batch	TVS (% dry wt)	Total Sulfide (mg/kg dry wt)	Water Soluble Sulfide (mg/kg dry wt)	TPH Batch	TPH (mg/kg dry weight)
<u>Method Blanks</u>										
Blank		1.0 U ^(a)	1	0.004	1	1.0 U	0.06 U	0.06 U	1	10 U
Blank		NA ^(b)	2	0.003	NA	NA	NA	NA	2	10 U
Blank		NA	3	0.002	NA	NA	NA	NA	3	10 U
<u>Matrix Spikes</u>										
TB-12	39.8-47.0	NA	NA	NA	NA	NA	NA	NA	1	16 U
TB-12 MS	39.8-47.0	NA	NA	NA	NA	NA	NA	NA	1	144
Conc. recovered		NA	NA	NA	NA	NA	NA	NA	NA	144
Amount Spiked		NA	NA	NA	NA	NA	NA	NA	NA	110
Percent recovery		NA	NA	NA	NA	NA	NA	NA	NA	131%
TB-20	29.2-35.2	NA	NA	NA	NA	NA	NA	NA	2	12
TB-20 MS	29.2-35.2	NA	NA	NA	NA	NA	NA	NA	2	115
Conc. recovered		NA	NA	NA	NA	NA	NA	NA	NA	103
Amount Spiked		NA	NA	NA	NA	NA	NA	NA	NA	110
Percent recovery		NA	NA	NA	NA	NA	NA	NA	NA	94%
Comp TB-D Upper		NA	NA	NA	NA	NA	NA	NA	3	13 U
Comp TB-D Upper MS		NA	NA	NA	NA	NA	NA	NA	3	118
Conc. recovered		NA	NA	NA	NA	NA	NA	NA	NA	118
Amount Spiked		NA	NA	NA	NA	NA	NA	NA	NA	110
Percent recovery		NA	NA	NA	NA	NA	NA	NA	NA	107%
<u>Analytical Replicates</u>										
BHC-6	43.2-44.7 Rep 1	78.50	1	NA	1	1.31	NA	NA	1	NA
BHC-6	43.2-44.7 Rep 2	78.31	1	NA	1	1.51	NA	NA	1	NA
RPD		0.2%	NA	NA	NA	14.2%	NA	NA	NA	NA
I-Stat		0.00	NA	NA	NA	0.07	NA	NA	NA	NA
TB-17	32.5-47.0 Rep 1	68.98	2	NA	2	3.39	NA	NA	2	NA
TB-17	32.5-47.0 Rep 2	69.63	2	NA	2	3.34	NA	NA	2	NA
RPD		0.9%	NA	NA	NA	1.5%	NA	NA	NA	NA
I-Stat		0.00	NA	NA	NA	0.01	NA	NA	NA	NA

TABLE B.3. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Total % Solids	TOC Batch	TOC (% dry weight)	TVS, Sulfide Batch	TVS (% dry wt)	Total Sulfide (mg/kg dry wt)	Water Soluble Sulfide (mg/kg dry wt)	TPH Batch	TPH (mg/kg dry weight)
Comp TB-C	Rep 1	82.88	1	NA	3	1.30	NA	NA	3	NA
Comp TB-C	Rep 2	83.15	1	NA	3	1.22	NA	NA	3	NA
RPD		0.3%	NA	NA	NA	6.3%	NA	NA	NA	NA
I-Stat		0.00	NA	NA	NA	0.03	NA	NA	NA	NA
BHC-4	38.1-47.0 Rep 1	NA	1	1.29	1	NA	1.96 U	NA	1	NA
BHC-4	38.1-47.0 Rep 2	NA	1	1.29	1	NA	1.97 U	NA	1	NA
RPD		NA	NA	0.0%	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	0.00	NA	NA	NA	NA	NA	NA
Comp TB-E	Lower Rep 1	NA	1	1.42	3	NA	NA	NA	3	NA
Comp TB-E	Lower Rep 2	NA	1	1.47	3	NA	NA	NA	3	NA
RPD		NA	NA	3.5%	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	0.02	NA	NA	NA	NA	NA	NA
Comp TB-D	Upper Rep 1	NA	1	0.29	3	NA	NA	0.18 U	3	13 U
Comp TB-D	Upper Rep 2	NA	1	0.30	3	NA	NA	0.18 U	3	13 U
RPD		NA	NA	3.4%	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	0.02	NA	NA	NA	NA	NA	NA
TB-13	43.0-47.0 Rep 1	NA	2	0.05	2	NA	NA	NA	2	NA
TB-13	43.0-47.0 Rep 2	NA	2	0.04	2	NA	NA	NA	2	NA
RPD		NA	NA	22.2%	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	0.11	NA	NA	NA	NA	NA	NA
TB-19	31.9-33.4 Rep 1	NA	2	0.11	2	NA	NA	NA	2	NA
TB-19	31.9-33.4 Rep 2	NA	2	0.12	2	NA	NA	NA	2	NA
RPD		NA	NA	8.7%	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	0.04	NA	NA	NA	NA	NA	NA
TB-25	38.4-46.8 Rep 1	NA	3	0.57	3	NA	NA	NA	3	NA
TB-25	38.4-46.8 Rep 2	NA	3	0.51	3	NA	NA	NA	3	NA
RPD		NA	NA	11.1%	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	0.06	NA	NA	NA	NA	NA	NA
BHC-8	41.8-47.0 Rep 1	NA	NA	NA	1	NA	NA	0.20 U	1	NA
BHC-8	41.8-47.0 Rep 2	NA	NA	NA	1	NA	NA	0.20 U	1	NA
RPD		NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	NA	NA	NA	NA	NA	NA	NA

B.6

TABLE B.3. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Total % Solids	TOC Batch	TOC (% dry weight)	TVS, Sulfide Batch	TVS (% dry wt)	Total Sulfide (mg/kg dry wt)	Water Soluble Sulfide (mg/kg dry wt)	TPH Batch	TPH (mg/kg dry weight)
TB-14	37.1-46.8 Rep 1	NA	NA	NA	2	NA	NA	0.15 U	2	NA
TB-14	37.1-46.8 Rep 2	NA	NA	NA	2	NA	NA	0.15 U	2	NA
RPD		NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-15	29.7-47.0 Rep 1	NA	NA	NA	2	NA	1.55 U	NA	2	NA
TB-15	29.7-47.0 Rep 2	NA	NA	NA	2	NA	1.54 U	NA	2	NA
RPD		NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-26	36.0-47.0 Rep 1	NA	NA	NA	3	NA	1.45 U	NA	3	NA
TB-26	36.0-47.0 Rep 2	NA	NA	NA	3	NA	1.47 U	NA	3	NA
RPD		NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-12	39.8-47.0 Rep 1	NA	2	NA	1	NA	NA	NA	1	16 U
TB-12	39.8-47.0 Rep 2	NA	2	NA	1	NA	NA	NA	1	16 U
RPD		NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-20	29.2-35.2 Rep 1	NA	3	NA	2	NA	NA	NA	2	12
TB-20	29.2-35.2 Rep 2	NA	3	NA	2	NA	NA	NA	2	12 U
RPD		NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat		NA	NA	NA	NA	NA	NA	NA	NA	NA

(a) U Undetected above given concentration.

(b) NA Not applicable.

TABLE B.4. Metals in Sediment Results

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Metals (mg/kg dry weight)									
			Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
Target DL (a)			0.1	0.1	0.1	0.1	0.1	0.02	0.1	0.1	0.1	1.0
Achieved DL			0.02	2.5	0.084	33	5.5	0.01	7.5	6.2	0.10	7.8
R-AM	NA (b)	3	0.048	8.0	0.084 U (c)	386	11.0	0.026	42.8	14.3	0.10 U	43.7
R-BF	NA	3	0.423	10.8	0.146	164	56.0	0.368	103	34.1	0.29	146
Comp BHC-A Upper		3	0.035	7.6	0.084 U	258	17.0	0.031	83.3	12.1	0.10 U	74.1
BHC-2	36.9-43.9	1	0.034	8.7	0.084 U	211	14.4	0.025	77.3	12.3	0.10 U	65.5
BHC-4	36.6-38.1	1	0.048	5.8	0.115	352	13.2	0.022	75.4	10.8	0.29	74.1
BHC-5	38.5-39.9	1	0.039	7.9	0.084 U	271	14.4	0.024	82.0	15.2	0.18	80.2
BHC-6	43.2-44.7	1	0.039	8.2	0.084 U	272	18.3	0.031	73.6	7.9	0.24	72.8
Comp BHC-A Lower		3	0.079	11.0	0.167	204	46.3	0.138	106	11.9	0.18	91.1
BHC-1	40.8-47.0	1	0.116	10.7	0.173	184	45.7	0.090	104	11.8	0.36	94.5
BHC-2	43.9-47.0	1	0.098	13.6	0.131	240	40.3	0.195	95.1	16.8	0.29	87.7
BHC-3	39.3-46.4	1	0.100	16.3	0.129	225	52.6	0.416	93.9	11.9	0.30	87.6
BHC-4	38.1-47.0	1	0.124	10.5	0.242	145	55.4	0.050	111	9.1	0.29	101
BHC-5	39.9-47.0	1	0.090	8.4	0.137	187	43.5	0.042	113	8.7	0.12	89.2
BHC-6	44.7-46.4	1	0.048	10.2	0.084	204	25.7	0.023	91.5	10.7	0.23	76.0
Comp BHC-B		3	0.099	10.1	0.171	171	64.3	0.051	122	12.3	0.24	102
BHC-7	36.6-47.0	1	0.092	7.8	0.189	185	51.7	0.050	113	13.6	0.41	101
BHC-8	41.8-47.0	1	0.124	10.6	0.188	173	57.6	0.069	112	9.3	0.46	102
BHC-9	45.2-46.2	1	0.106	8.5	0.174	215	52.7	0.043	115	8.2	0.24	96.2
TB-10	30.4-40.2	1	0.132	13.0	0.175	150	59.1	0.071	117	6.4	0.30	104
TB-12	39.8-47.0	1	0.122	7.7	0.198	158	63.8	0.059	120	12.7	0.30	112
Comp TB-C		3	0.027	8.8	0.084 U	230	19.2	0.015	83.5	9.1	0.10 U	71.7
BHC-9	42.0-45.2	1	0.024	10.4	0.058	218	11.7	0.014	78.8	21.9	0.29	83.3
TB-11	39.7-46.6	1	0.042	5.5	0.087	245	15.6	0.022	86.9	9.8	0.10 U	72.5
TB-13	43.0-47.0	1	0.027	8.1	0.084 U	216	14.2	0.016	89.1	11.7	0.10 U	73.9
TB-14	37.1-46.8	1	0.045	6.7	0.084 U	366	17.0	0.016	84.9	9.5	0.10 U	71.2
TB-18	37.1-40.2	2	0.027	5.9	0.084 U	286	14.4	0.016	85.4	11.5	0.10 U	66.9
TB-19	31.9-33.4	2	0.042	9.4	0.088	233	20.0	0.017	81.9	11.4	0.10 U	70.6
TB-20	29.2-35.2	2	0.031	10.8	0.087 U	260	16.2	0.019	84.0	9.1	0.10 U	71.9
TB-21	38.0-41.8	2	0.031	9.1	0.084 U	168	16.6	0.026	82.2	10.6	0.10 U	68.7
TB-22	33.0-35.0	2	0.034	11.9	0.084 U	188	14.8	0.022	82.2	11.2	0.10 U	71.5
TB-24	37.4-40.1	2	0.035	9.4	0.086	211	15.3	0.022	89.7	10.9	0.10 U	71.4

TABLE B.4. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Metals (mg/kg dry weight)									
			Aq	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
Comp TB-D Upper		3	0.045	7.3	0.086	304	23.7	0.021	94.9	7.8	0.18	74.2
TB-15	29.7-47.0	2	0.048	5.2	0.084 U	486	26.6	0.022	104	7.4	0.10 U	83.5
TB-16	28.3-30.6	2	0.049	6.6	0.084 U	227	29.2	0.025	93.9	8.2	0.10 U	83.7
TB-17	28.3-32.5	2	0.031	7.8	0.084 U	204	18.0	0.016	88.4	7.5	0.10 U	66.3
Comp TB-D Lower		3	0.054	6.5	0.089	210	30.6	0.021	101	8.3	0.10 U	77.6
TB-10	40.2-46.8	1	0.059	5.8	0.113	219	30.9	0.024	100	9.1	0.10 U	78.2
Comp TB-E Upper		3	0.042	6.2	0.093	334	29.4	0.018	106	7.3	0.10 U	76.6
TB-21	41.8-44.3	2	0.031	13.7	0.084 U	264	25.4	0.018	94.1	6.7	1.00 U	73.1
TB-22	35.0-44.7	2	0.038	6.0	0.084 U	320	24.7	0.019	97.8	7.6	0.10 U	76.5
Comp TB-E Lower		3	0.104	11.6	0.179	181	60.2	0.048	116	8.4	0.24	102
TB-16	30.6-47.0	2	0.125	12.1	0.192	160	68.4	0.066	126	9.6	0.35	116
TB-17	32.5-47.0	2	0.103	8.9	0.181	180	55.2	0.054	112	11.5	0.17	98.3
TB-18	40.2-46.9	2	0.089	5.9	0.161	241	50.6	0.045	110	10.6	0.10 U	94.2
TB-19	33.4-47.0	2	0.112	9.7	0.214	174	61.3	0.050	120	12.8	0.24	103
TB-20	35.2-47.2	2	0.100	10.9	0.084 U	203	66.0	0.057	125	9.6	0.30	106
TB-23	29.0-46.3	2	0.093	12.1	0.177	178	58.8	0.063	119	9.4	0.30	107
TB-24	40.1-47.0	2	0.068	8.5	0.141	182	44.4	0.045	114	10.6	0.18	87.7
Cores Outside Proposed Dredging Area												
TB-25	38.4-46.8	3	0.072	9.7	0.162	222	40.8	0.032	108	7.0	0.12	88.0
TB-26	28.6-36.0	3	0.078	10.5	0.148	200	33.7	0.045	103	9.1	0.12	89.1
TB-26	36.0-47.0	3	0.038	7.3	0.084 U	192	21.1	0.016	95.0	6.2	0.10 U	64.3
TB-27	26.8-39.5	3	0.045	10.5	0.127	213	25.9	0.018	95.2	5.7	0.10 U	76.7
TB-27	39.5-41.1	3	0.048	18.4	0.151	138	29.8	0.021	99.0	6.5	0.12	76.3
TB-27	41.1-46.8	3	0.120	14.2	0.226	167	59.2	0.077	117	8.6	0.23	102
TB-28	29.0-32.9	3	0.024	10.2	0.084 U	223	14.6	0.017	84.6	10.0	0.10 U	71.3
TB-28	32.9-47.0	3	0.093	11.3	0.176	192	53.0	0.045	112	7.9	0.23	91.8

(a) DL Detection limit.

(b) NA Not applicable.

(c) U Undetected above given concentration.

TABLE B.5. Quality Control Data for Metals in Sediment

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Metals (mg/kg dry weight)									
			Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
Method Blanks												
Blank		1	0.014	NA ^(a)	0.084	NA	NA	0.006 U ^(b)	NA	NA	0.10 U	NA
Blank		2	0.017	NA	0.084 U	NA	NA	0.006 U	NA	NA	0.10 U	NA
Blank		3	0.014	NA	0.084 U	NA	NA	0.006 U	NA	NA	0.10 U	NA
Matrix Spikes												
BHC-7	36.6-47.0	1	0.096 ^(c)	NS ^(d)	0.193 ^(c)	NS	NS	0.050	NS	NS	0.42 ^(c)	NS
BHC-7	36.6-47.0 MS	1	1.06	NS	1.09	NS	NS	0.927	NS	NS	1.55	NS
Concentration Recovered			0.964	NS	0.897	NS	NS	0.877	NS	NS	1.13	NS
Amount Spiked			1.00	NS	1.00	NS	NS	0.995	NS	NS	1.00	NS
Percent Recovery			96%	NS	90%	NS	NS	88%	NS	NS	113%	NS
TB-18	40.2-46.9	2	0.091 ^(c)	NS	0.148 ^(c)	NS	NS	0.047 ^(c)	NS	NS	0.10 U	NS
TB-18	40.2-46.9 MS	2	1.04	NS	0.971	NS	NS	1.00	NS	NS	0.87	NS
Concentration Recovered			0.949	NS	0.823	NS	NS	0.953	NS	NS	0.87	NS
Amount Spiked			1.00	NS	1.00	NS	NS	0.970	NS	NS	1.00	NS
Percent Recovery			95%	NS	82%	NS	NS	98%	NS	NS	87%	NS
Comp BHC-B		3	0.104 ^(c)	NS	0.178 ^(c)	NS	NS	0.052 ^(c)	NS	NS	0.27 ^(c)	NS
Comp BHC-B MS		3	1.27	NS	1.10	NS	NS	0.841	NS	NS	1.05	NS
Concentration Recovered			1.17	NS	0.922	NS	NS	0.789	NS	NS	0.78	NS
Amount Spiked			1.00	NS	1.00	NS	NS	0.978	NS	NS	1.00	NS
Percent Recovery			117%	NS	92%	NS	NS	81%	NS	NS	78%	NS
Standard Reference Material												
Certified			NC ^(e)	11.6	0.36	76	18	0.063	32	28.2	NC	138
Value 1646			NC	±1.3	±0.07	±3	±3	±0.012	±3	±1.8	NC	±6
1646		1	0.100	10.7	0.283	59.7	21.7	NA	29.7	29.7	0.54	133
1646		2	0.120	11.5	0.322	63.4	18.5	NA	31.7	27.0	0.54	135
1646		3	0.107	11.2	0.272	81.0	21.0	NA	30.8	28.4	0.59	133
Certified			NC	NC	NC	NC	NC	0.092	NC	NC	NC	NC
Value BEST-1			NC	NC	NC	NC	NC	±0.009	NC	NC	NC	NC
BEST-1		1	NA	NA	NA	NA	NA	0.102	NA	NA	NA	NA
BEST-1		2	NA	NA	NA	NA	NA	0.099	NA	NA	NA	NA
BEST-1		3	NA	NA	NA	NA	NA	0.085	NA	NA	NA	NA

TABLE B.5. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Metals (mg/kg dry weight)										
			Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	
Analytical Replicates													
BHC-7	36.6-47.0	Rep 1	1	0.092	7.8	0.189	185	51.7	0.050	113	13.6	0.41	101
BHC-7	36.6-47.0	Rep 2	1	0.099	8.9	0.196	195	47.1	0.050	105	14.5	0.42	99.5
RPD				7%	13%	4%	5%	9%	0%	7%	6%	2%	1%
I-Stat				0.04	0.07	0.02	0.03	0.05	0.00	0.04	0.03	0.01	0.01
TB-18	40.2-46.9	Rep 1	2	0.089	5.9	0.161	241	50.6	0.045	110	10.6	0.10 U	94.2
TB-18	40.2-46.9	Rep 2	2	0.092	6.2	0.135	273	48.8	0.048	115	9.9	0.10 U	93.3
RPD				3%	5%	18%	12%	4%	6%	4%	7%	NA	1%
I-Stat				0.02	0.02	0.09	0.06	0.02	0.03	0.02	0.03	NA	0.00
Comp BHC-B	Rep 1		3	0.099	10.1	0.171	171	64.3	0.051	122	12.3	0.24	102
Comp BHC-B	Rep 2		3	0.109	11.6	0.184	173	60.2	0.053	116	9.5	0.29	108
RPD				10%	14%	7%	1%	7%	4%	5%	26% (f)	19%	6%
I-Stat				0.05	0.07	0.04	0.01	0.03	0.02	0.03	0.13	0.09	0.03

- (a) NA Not applicable.
 (b) U Undetected above given concentration.
 (c) Mean of replicated sample.
 (d) NS Not spiked.
 (e) NC Not certified.
 (f) Outside quality control range for precision ($\pm 20\%$).

TABLE B.6. Phthalates in Sediment Including Quality Control Data

<u>Sediment Treatment</u>	<u>Vertical Segment (-ft MLLW)</u>	<u>Batch</u>	<u>Dimethyl Phthalate</u>	<u>Diethyl Phthalate</u>	<u>Di-n-butyl Phthalate</u>	<u>Butyl benzyl Phthalate</u>	<u>Bis (2-ethylhexyl) Phthalate</u>	<u>Di-n-octyl Phthalate</u>
Target DL ^(a)			20	10	10	10	10	10
Achieved DL			84.6-178	84.6-178	84.6-178	84.6-178	84.6-178	84.6-178
R-AM		3	76.8 U ^(b)	76.8 U	76.8 U	76.8 U	76.8 U	76.8 U
R-BF		3	178 U	178 U	178 U	178 U	419	530
Comp BHC-A Upper		3A	97.6 U	97.6 U	97.6 U	97.6 U	97.6 U	97.6 U
Comp BHC-A Lower		3	109 U	109 U	109 U	109 U	109 U	109 U
BHC-6	44.7-46.4	3A	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U
Comp BHC-B		3	126 U	126 U	126 U	126 U	126 U	126 U
Comp TB-C		3A	89.6 U	89.6 U	89.6 U	89.6 U	89.6 U	89.6 U
BHC-9	42.0-45.2	3A	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U
Comp TB-D Upper		3A	99.2 U	99.2 U	99.2 U	99.2 U	99.2 U	99.2 U
Comp TB-D Lower		3	94.4 U	94.4 U	94.4 U	94.4 U	94.4 U	94.4 U
Comp TB-E Upper		3	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U
Comp TB-E Lower		3A	112 U	112 U	112 U	112 U	112 U	112 U
Cores Outside Proposed Dredging Area								
TB-25	38.4-46.8 Rep 1	3	107 U	107 U	107 U	107 U	107 U	107 U
TB-25	38.4-46.8 Rep 2	3	107 U	107 U	107 U	107 U	107 U	107 U
TB-26	28.6-36.0	3A	106 U	106 U	106 U	106 U	106 U	106 U
TB-26	36.0-47.0	3	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U	96.0 U
TB-27	26.8-39.5	3	118 U	118 U	118 U	118 U	118 U	118 U
TB-27	39.5-41.1	3	130 U	130 U	130 U	130 U	130 U	130 U
TB-27	41.1-46.8	3	117 U	117 U	117 U	117 U	117 U	117 U
TB-28	29.0-32.9	3	86.4 U	86.4 U	86.4 U	86.4 U	86.4 U	86.4 U
TB-28	32.9-47.0	3A	112 U	112 U	112 U	112 U	112 U	112 U

TABLE B.6 (contd)

<u>Sediment Treatment</u>	<u>Vertical Segment (-ft MLLW)</u>	<u>Batch</u>	<u>Dimethyl Phthalate</u>	<u>Diethyl Phthalate</u>	<u>Di-n-butyl Phthalate</u>	<u>Butyl benzyl Phthalate</u>	<u>Bis (2-ethylhexyl) Phthalate</u>	<u>Di-n-octyl Phthalate</u>
<u>Quality Control Data</u>								
<u>Method Blanks</u>								
Blank 1		3	114 U	114 U	114 U	114 U	114 U	114 U
Blank 2		3A	114 U	114 U	114 U	114 U	114 U	114 U
<u>Matrix Spike</u> (extracted and spiked with PAHs)								
<u>Standard Reference Material</u> (not available for phthalates)								
<u>Analytical Replicate</u>								
TB-25	38.4-46.8 Rep 1	3	107 U	107 U	107 U	107 U	107 U	107 U
TB-25	38.4-46.8 Rep 2	3	107 U	107 U	107 U	107 U	107 U	107 U
RPD			NA ^(c)	NA	NA	NA	NA	NA
I-Stat			NA	NA	NA	NA	NA	NA

(a) DL Detection limit.

(b) U Undetected above given concentration.

(c) NA Not applicable.

TABLE B.7. Total Polynuclear Aromatic Hydrocarbons (PAHs) in Sediment

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	($\mu\text{g/kg}$ dry weight)		
			Total Low Molecular Weight PAHs	Total High Molecular Weight PAHs	Total PAHs
R-AM	NA ^(a)	3	574	1039	1613
R-BF	NA	3	217	1444	1661
Comp BHC-A Upper		3A	20	27	47
BHC-2	36.9-43.9	1	31	33	64
BHC-4	36.6-38.1	1	167	275	442
BHC-5	38.5-39.9	1	20	27	47
BHC-6	43.2-44.7	1	28	42	70
Comp BHC-A Lower		3	26	79	105
BHC-1	40.8-47.0	1	27	17	44
BHC-2	43.9-47.0	1	93	400	493
BHC-3	39.3-46.4	1	9	15	24
BHC-4	38.1-47.0	1	27	21	48
BHC-5	39.9-47.0	1	7	11	18
BHC-6	44.7-46.4	3A	4	6	10
Comp BHC-B		3	18	12	30
BHC-7	36.6-47.0	1	18	11	29
BHC-8	41.8-47.0	1	25	17	42
BHC-9	45.2-46.2	1	5	6	11
TB-10	30.4-40.2	1	37	21	58
TB-12	39.8-47.0	1	27	21	48
Comp TB-C		3A	10	9	19
BHC-9	42.0-45.2	3A	19	38	57
TB-11	39.7-46.6	1	9	7	16
TB-13	43.0-47.0	1	9	7	16
TB-14	37.1-46.8	1	10	14	24
TB-18	37.1-40.2	2	5	5	10
TB-19	31.9-33.4	2	6	9	15
TB-20	29.2-35.2	2	9	12	21
TB-21	38.0-41.8	2	8	14	22
TB-22	33.0-35.0	2	5	9	14
TB-24	37.4-40.1	2	5	8	13
Comp TB-D Upper		3A	5	6	11
TB-15	29.7-47.0	2	12	8	20
TB-16	28.3-30.6	2	6	11	17
TB-17	28.3-32.5	2	7	9	16
Comp TB-D Lower		3	3	5	8
TB-10	40.2-46.8	1	11	10	21

TABLE B.7. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	(μg/kg dry weight)		
			Total Low Molecular Weight PAHs	Total High Molecular Weight PAHs	Total PAHs
Comp TB-E Upper		3	1	3	4
TB-21	41.8-44.3	2	8	6	14
TB-22	35.0-44.7	2	6	6	12
Comp TB-E Lower		3A	23	13	36
TB-16	30.6-47.0	2	30	21	51
TB-17	32.5-47.0	2	22	25	47
TB-18	40.2-46.9	2	12	11	23
TB-19	33.4-47.0	2	25	22	47
TB-20	35.2-47.2	2	21	21	42
TB-23	29.0-46.3	2	27	26	53
TB-24	40.1-47.0	2	19	15	34
Cores Outside Proposed Dredging Area					
TB-25	38.4-46.8	3	8	7	15
TB-26	28.6-36.0	3A	21	11	32
TB-26	36.0-47.0	3	2	5	7
TB-27	26.8-39.5	3	9	3	12
TB-27	39.5-41.1	3	20	11	31
TB-27	41.1-46.8	3	10	11	21
TB-28	29.0-32.9	3	1	6	7
TB-28	32.9-47.0	3A	13	11	24

(a) NA Not applicable.

TABLE B.8. Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LPAHs) in Sediment

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	LPAHs ($\mu\text{g/kg}$ dry weight)					
			Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene
Target DL ^(a)			20	20	20	20	20	20
Achieved DL			1.03-2.38	1.10-2.54	0.52-1.21	0.81-1.86	1.04-2.42	1.33-3.08
R-AM	NA ^(b)	3	25.4	27.8	12.3	43.4	337	128
R-BF	NA	3	42.2	13.7	9.94 ^(c)	14.5	103	34.1
Comp BHC-A Upper		3A	2.35 B ^(d)	1.44 ^(c) B ^(e)	2.30	3.62	6.07	3.86 ^(c)
BHC-2	36.9-43.9	1	3.76 ^(c) B	1.40 U ^(e)	2.09	5.09	14.8	4.95 ^(c)
BHC-4	36.6-38.1	1	37.5 ^(c) B	1.44 U	0.69 U	1.06 U	129	1.75 U
BHC-5	38.5-39.9	1	2.51 ^(c) B	1.47 U	2.93 ^(c)	3.90 ^(c)	10.7	1.77 U
BHC-6	43.2-44.7	1	4.32 ^(c) B	1.44 U	2.61 ^(c)	5.69	10.4	4.84 ^(c)
Comp BHC-A Lower		3	3.21 ^(c) B	1.58 ^(c) B	2.31	4.65 ^(c)	9.75	4.87 ^(c)
BHC-1	40.8-47.0	1	4.59 ^(c) B	1.83 U	0.87 U	6.62 ^(c)	16.1	2.22 U
BHC-2	43.9-47.0	1	8.62	4.07 ^(c)	4.35	10.1	53.1	12.4
BHC-3	39.3-46.4	1	3.14 U	1.79 U	0.85 U	1.31 U	8.70	2.16 U
BHC-4	38.1-47.0	1	4.60 U	1.88 U	0.89 U	7.14	17.9	2.27
BHC-5	39.9-47.0	1	2.37 U	1.51 U	0.72 U	1.11 U	6.96 ^(c)	1.83 U
BHC-6	44.7-46.4	3A	1.90 ^(c) B	1.37 U	0.65 U	1.01 U	2.01 ^(c)	1.66 U
Comp BHC-B		3	2.90 ^(c) B	1.81 U	0.86 U	4.82 ^(c)	6.16	4.53 ^(c)
BHC-7	36.6-47.0	1	3.33 ^(c) B	1.74 U	0.83 U	4.95	9.30	2.11 U
BHC-8	41.8-47.0	1	3.14 ^(c) B	1.85 U	0.88 U	7.71	13.9	2.25 U
BHC-9	45.2-46.2	1	2.21 U	1.56 U	0.74 U	1.14 U	5.39	1.88 U
TB-10	30.4-40.2	1	5.56 B	1.79 U	3.02 ^(c)	7.17	16.0	5.08 ^(c)
TB-12	39.8-47.0	1	6.15 B	1.79 U	0.85 U	6.87	14.3	2.16 U
Comp TB-C		3A	2.06 B	1.28 U	1.71 ^(c)	2.56 ^(c)	3.71	1.55 ^(c)
BHC-9	42.0-45.2	3A	2.92 ^(c) B	1.54 ^(c) B	2.67	3.63	4.66	3.94 ^(c)
TB-11	39.7-46.6	1	2.92 ^(c) B	1.35 U	0.64 U	0.99 U	6.13	1.64 U
TB-13	43.0-47.0	1	2.41 ^(c) B	1.24 U	0.59 U	0.91 U	6.26	1.50 U
TB-14	37.1-46.8	1	3.02 ^(c) B	1.35 U	0.64 U	0.99 U	7.37 ^(c)	1.64 U
TB-18	37.1-40.2	2	2.67 ^(c) B	1.44 U	0.69 U	1.06 U	2.79 ^(c)	1.75 U
TB-19	31.9-33.4	2	2.59 B	1.40 U	0.66 U	1.02 U	3.24	1.69 U
TB-20	29.2-35.2	2	3.86 B	1.26 U	1.81 ^(c)	0.92 U	3.44	1.52 U
TB-21	38.0-41.8	2	4.49 B	1.35 U	0.64 U	0.99 U	3.58	1.64 U
TB-22	33.0-35.0	2	2.23 ^(c) B	1.12 U	0.53 U	0.82 U	2.66	1.36 U
TB-24	37.4-40.1	2	2.47 ^(c) B	1.31 U	0.62 U	0.96 U	3.01	1.58 U

TABLE B.8. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	LPAHs (µg/kg dry weight)					
			Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene
Comp TB-D Upper 3A			2.22 B	1.42 U	0.68 U	1.04 U	2.37	1.72 U
TB-15	29.7-47.0	2	8.12 B	1.49 U	0.71 U	1.09 U	3.61(c)	1.80 U
TB-16	28.3-30.6	2	2.52 B	1.56 U	0.74 U	1.14 U	3.80	1.88 U
TB-17	28.3-32.5	2	2.71 B	1.53 U	0.73 U	1.13 U	3.84	1.86 U
Comp TB-D Lower 3			1.49(c) B	1.35 U	0.64 U	0.99 U	1.63(c)	1.64 U
TB-10	40.2-46.8	1	3.68 B	1.37 U	0.65 U	1.01 U	7.27	1.66 U
Comp TB-E Upper 3			1.29 U	1.37 U	0.65 U	1.01 U	1.38(c)	1.66 U
TB-21	41.8-44.3	2	3.84 B	1.44 U	0.69 U	1.06 U	3.66	1.75 U
TB-22	35.0-44.7	2	2.34(c) B	1.47 U	0.70 U	1.08 U	3.42(c)	1.77 U
Comp TB-E Lower 3A			4.51 B	1.60(c) B	0.76 U	4.18(c)	8.38	4.68(c)
TB-16	30.6-47.0	2	4.13 B	1.95 U	1.88	6.78	11.8	5.57(c)
TB-17	32.5-47.0	2	3.29 B	1.60 U	1.70	4.68	7.47	4.55(c)
TB-18	40.2-46.9	2	3.46 B	1.56 U	0.74 U	3.46(c)	5.14	1.88 U
TB-19	33.4-47.0	2	7.60 B	1.85 U	2.31(c)	5.59	9.78	2.25 U
TB-20	35.2-47.2	2	3.94 B	1.69 U	0.81 U	4.89	8.25	4.33(c)
TB-23	29.0-46.3	2	6.05 B	1.69 U	1.93	4.92	9.50	4.57(c)
TB-24	40.1-47.0	2	4.54 B	1.33 U	1.86	3.73	5.80	3.51(c)
Cores Outside Proposed Dredging Area								
TB-25	38.4-46.8	3	1.54(c) B	1.53 U	0.73 U	2.83	3.19	1.86 U
TB-26	28.6-36.0	3A	2.96 B	1.51 U	0.72 U	4.00(c)	6.31	7.59
TB-26	36.0-47.0	3	1.29 U	1.37 U	0.65 U	1.01 U	1.84	1.66 U
TB-27	26.8-39.5	3	6.18 B	1.69 U	0.81 U	1.24 U	3.14(c)	2.05 U
TB-27	39.5-41.1	3	3.22 B	2.06 B	0.88 U	3.81	6.11	4.75(c)
TB-27	41.1-46.8	3	1.89(c) B	1.67 U	0.80 U	3.75(c)	4.17	2.02 U
TB-28	29.0-32.9	3	1.16 U	1.24 U	0.59 U	0.91 U	1.35(c)	1.5 U
TB-28	32.9-47.0	3A	3.31 B	1.60 U	0.76 U	4.13	5.87	1.94 U

(a) DL Detection limit.

(b) NA Not applicable.

(c) Ion ratio out or confirmation ion not detected.

(d) B Concentration is less than five times the amount detected in associated method blank.

(e) U Undetected above given concentration.

TABLE B.9. High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAHs) in Sediment

			HPAHs ($\mu\text{g/kg}$ dry weight)									
Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Fluor-anthene	Pyrene	Benzo(a)-anthracene	Chrysene	Benzo(b)-fluor-anthene	Benzo(k)-fluor-anthene	Benzo(a)pyrene	Indeno-(1,2,3-cd)pyrene	Dibenzo-(a,h)anthracene	Benzo-(g,h,i)perylene
Target DL (a)			20	20	20	20	20	20	20	20	20	20
Achieved Low			1.42	1.14	0.57	1.04	0.48	1.05	1.14	2.23	3.21	3.49
Achieved High			3.27	2.63	1.32	2.42	1.11	2.43	2.63	5.15	7.42	8.06
R-AM	NA (b)	3	210	256	120	123	78.9	28.2	88.2	63.1	15.2	56.5
R-BF	NA	3	211	252	94.3	112	162	53.0	145	195	24.1	196
Comp BHC-A Upper		3A	10.3	6.36	4.64 (c) B (d)	1.92 (c)	0.77 (c)	1.33 U (c)	1.45 U (e)	2.97	4.08 U	4.43 U
BHC-2 36.9-43.9		1	11.2	9.19	4.54 (c) B	2.54 (c)	3.65 (c)	1.52 (c)	1.45 U	2.83 U (c)	4.08 U	4.43 U
BHC-4 36.6-38.1		1	93.1	53.6	56.9 (c)	11.0 (c)	33.7 (c)	1.38 U (c)	1.49 U	27.0 (c)	4.21 U	4.58 U
BHC-5 38.5-39.9		1	9.53	6.75	4.11 (c) B	1.90 (c)	2.99 (c)	1.57 (c)	1.52 U	2.97 U	4.28 U	4.65 U
BHC-6 43.2-44.7		1	11.3	25.1	3.74 (c) B	1.37 U	2.35 (c)	1.38 U	1.49 U	2.92 U	4.21 U	4.58 U
Comp BHC-A Lower		3	15.3	14.8	9.02 (c) B	7.24 (c)	7.05	1.85	4.89	9.49	4.55 U	8.94
BHC-1 40.8-47.0		1	5.73	1.90 U	4.20 (c) B	2.71 (c)	4.67	1.75 U	1.90 U	3.71 U	5.35 U	5.81 U
BHC-2 43.9-47.0		1	69.7	86.6	29.9	31.3	40.6	15.3	40.0	37.9	5.17	43.3
BHC-3 39.3-46.4		1	3.63 (c)	1.85 U	3.53 (c) B	1.70 U	2.31 (c)	1.71 U	1.85 (c)	3.62 (c)	5.22 U	5.66 U
BHC-4 38.1-47.0		1	6.83 (c)	2.46	4.60 (c) B	3.16 (c)	4.17	1.79 U	2.26 U	3.81 U	5.48 U	5.96 U
BHC-5 39.9-47.0		1	3.32 (c)	1.57 U	3.51 (c) B	1.60 (c)	2.75 (c)	1.44 U	1.57 U	3.06 U	4.41 U	4.79 U
BHC-6 44.7-46.4		3A	2.25 (c)	1.42 U	3.33 (c) B	1.31 U	0.60 U	1.31 U	1.42 U	2.79 U	4.01 U	4.36 U
Comp BHC-B		3	4.33	1.88 U	5.27 (c) B	2.65 (c)	0.79 U (c)	1.73 U	1.87 U	3.67 U	5.28 U	5.74 U
BHC-7 36.6-47.0		1	4.21 (c)	1.80 U	3.92 (c) B	1.65 U (c)	3.02 (c)	1.66 U	1.80 U	3.53 U	5.08 U	5.52 U
BHC-8 41.8-47.0		1	5.70 (c)	1.92 U	4.44 (c) B	2.50 (c)	4.21	1.77 U	1.92 U	3.76 U	5.42 U	5.88 U
BHC-9 45.2-46.2		1	2.89 (c)	1.61 U	2.96 (c) B	1.48 U	0.68 U	1.49 U	1.61 U	3.16 U	4.55 U	4.94 U
TB-10 30.4-40.2		1	6.12	3.22	4.45 (c) B	2.94 (c)	4.66	1.71 U (c)	1.85 U	3.62 U	5.22 U	5.66 U
TB-12 39.8-47.0		1	5.80	1.98 (c)	4.21 (c) B	2.74 (c)	4.77	1.95 (c)	1.85 U	3.62 U	5.22 U	5.66 U
Comp TB-C		3A	3.88	1.33 U	3.71 (c) B	1.32 (c)	0.56 U	1.22 U	1.33 U	2.60 U	3.75 U	4.07 U
BHC-9 42.0-45.2		3A	9.62 (c)	4.84	4.85 (c) B	5.93	3.18 (c)	1.31 U	1.42 U	3.73	4.01 U	4.36 U
TB-11 39.7-46.6		1	3.02 (c)	1.4 U	2.62 (c) B	1.28 U	1.84 (c)	1.29 U	1.40 U	2.74 U	3.95 U	4.28 U
TB-13 43.0-47.0		1	2.62 (c)	1.28 U	2.28 (c) B	1.18 U	1.81 (c)	1.18 U	1.28 U	2.51 U	3.61 U	3.92 U
TB-14 37.1-46.8		1	3.48 (c)	1.40 U	3.10 (c) B	1.28 U	3.19 (c)	1.76 (c)	1.40 U	2.89	3.95 U	4.28 U
TB-18 37.1-40.2		2	2.73 (c) B	1.50 U	2.76 (c) B	1.37 U	0.63 U (c)	1.38 U	1.49 U	2.92 U	4.21 U	4.58 U
TB-19 31.9-33.4		2	3.61 (c) B	1.45 U	3.08 (c) B	1.33 U	2.15 (c)	1.33 U	1.45 U	2.83 U	4.08 U	4.43 U
TB-20 29.2-35.2		2	4.01 B	2.94 (c)	2.84 (c) B	1.20 U	2.08 (c)	1.20 U	1.30 U	2.55 U	3.68 U	3.99 U
TB-21 38.0-41.8		2	4.03 (c)	3.15 (c)	3.13 (c) B	1.28 U	3.41 (c)	1.29 U	1.40 U	2.74 U	3.95 U	4.28 U
TB-22 33.0-35.0		2	2.84 (c) B	2.45	2.50 (c) B	1.07 U	1.66 (c)	1.07 U	1.16 U	2.27 U	3.28 U	3.56 U
TB-24 37.4-40.1		2	3.21 (c) B	1.35 U	2.84 (c) B	1.24 U	1.84 (c)	1.25 U	1.35 U	2.65 U	3.81 U	4.14 U

B.18

TABLE B.9. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	HPAHs ($\mu\text{g/kg}$ dry weight)									
			Fluor-anthene	Pyrene	Benzo(a)-anthracene	Chrysene	Benzo(b)-fluor-anthene	Benzo(k)-fluor-anthene	Benzo(a)pyrene	Indeno-(1,2,3-cd)pyrene	Dibenzo-(a,h)anthracene	Benzo-(g,h,i)perylene
Comp TB-D Upper		3A	2.37 ^(c)	1.47 U	3.64 ^(c) B	1.35 U	0.62 ^(c)	1.36 U	1.47 U	2.88 U	4.15 U	4.50 U
TB-15 29.7-47.0		2	2.88 ^(c) B	1.54 U	2.81 ^(c) B	1.41 U	1.90 ^(c)	1.42 ^(c)	1.54 U	3.02 U	4.35 U	4.72 U
TB-16 28.3-30.6		2	3.39 ^(c) B	1.61 U	3.23 ^(c) B	1.48 U	2.70 ^(c)	1.81 ^(c)	1.61 U	3.16 U	4.55 U	4.94 U
TB-17 28.3-32.5		2	3.18 ^(c) B	1.59 U	2.91 ^(c) B	1.46 U	2.42 ^(c)	1.47 U	1.59 U	3.11 U	4.48 U	4.87 U
Comp TB-D Lower		3	2.21 ^(c)	1.40 U	3.26 ^(c) B	1.28 U	0.59 ^(c)	1.29 U	1.40 U	2.74 U	3.95 U	4.28 U
TB-10 40.2-46.8		1	2.80 ^(c)	1.42 U	3.09 ^(c) B	1.31	2.35 ^(c)	1.31 U	1.42 U	2.79 U	4.01 U	4.36 U
Comp TB-E Upper		3	1.97 ^(c)	1.42 U	3.30 ^(c) B	1.31 U	0.60 U	1.31 U	1.42 U	2.79 U	4.01 U	4.36 U
TB-21 41.8-44.3		2	2.89 ^(c) B	1.50 U	2.94 ^(c) B	1.37 U	0.63 U	1.38 U	1.49 U	2.92 U	4.21 U	4.58 U
TB-22 35.0-44.7		2	2.84 ^(c) B	1.52 U	2.86 ^(c) B	1.39 U	0.64 U	1.40 U	1.52 U	2.97 U	4.28 U	4.65 U
Comp TB-E Lower		3A	4.43	1.66 U	4.80 ^(c) B	2.63 ^(c)	1.17	1.53 ^(c)	1.66 U	3.25 U	4.68 U	5.08 U
TB-16 30.6-47.0		2	5.97 B	2.02 ^(c)	4.60 ^(c) B	2.80 ^(c)	5.05	2.54 ^(c)	2.02 U	3.95 U	5.69 U	6.17 U
TB-17 32.5-47.0		2	5.14 ^(c) B	2.24 ^(c)	3.99 ^(c) B	2.47	4.28	1.85 ^(c)	1.66 U	3.25 U	4.68 U	5.08
TB-18 40.2-46.9		2	3.93 ^(c) B	1.61 U	3.58 ^(c) B	1.48 ^(c)	3.10 ^(c)	1.49 ^(c)	1.61 U	3.16 U	4.55 U	4.94 U
TB-19 33.4-47.0		2	5.76 ^(c) B	2.42	4.46 ^(c) B	2.49 ^(c)	4.68 ^(c)	2.27 ^(c)	1.92 U	3.76 U	5.42 U	5.88 U
TB-20 35.2-47.2		2	5.38 ^(c) B	2.07	4.15 ^(c) B	2.49	4.47	2.11 ^(c)	1.76 U	3.44 U	4.95 U	5.37 U
TB-23 29.0-46.3		2	6.68 B	3.82	4.71 ^(c) B	3.60	5.57	1.80 ^(c)	1.76 U	3.44 U	4.95 U	5.37 U
TB-24 40.1-47.0		2	3.91 B	1.61	3.12 ^(c) B	1.55 ^(c)	3.05	1.40 ^(c)	1.38 U	2.69 U	3.88 U	4.21 U
Cores Outside Proposed Dredging Area												
TB-25 38.4-46.8		3	2.95 ^(c)	1.59 U	4.11 ^(c) B	1.46 ^(c)	0.67 ^(c)	1.47 U	1.59 U	3.11 U	4.48 U	4.87 U
TB-26 28.6-36.0		3A	3.94 ^(c)	1.57 U	4.25 ^(c) B	2.26 ^(c)	0.75 ^(c)	1.55 U	1.57 U	3.06 U	4.41 U	4.79 U
TB-26 36.0-47.0		3	1.99 ^(c)	1.42 U	3.28 ^(c) B	1.31 U	0.60 U	1.31 U	1.42 U	2.79 U	4.01 U	4.36 U
TB-27 26.8-39.5		3	3.26 ^(c)	1.76 U	0.88 ^(c)	1.61 U	0.74 U	1.62 U	1.76 U	3.44 U	4.95 U	5.37 U
TB-27 39.5-41.1		3	5.40	1.92 U	5.23 ^(c) B	1.76 ^(c)	0.81 U	1.77 U	1.92 U	3.76 U	5.42 U	5.88 U
TB-27 41.1-46.8		3	3.65 ^(c)	1.73 U	4.67 ^(c) B	2.19 ^(c)	0.73 U	1.60 U	1.73 U	3.39 U	4.88 U	5.30 U
TB-28 29.0-32.9		3	2.40 ^(c)	1.28 U	3.92 ^(c) B	1.59 ^(c)	0.54 U	1.18 U	1.28 U	3.51 U	3.61 U	3.92 U
TB-28 32.9-47.0		3A	3.92 ^(c)	1.66 U	4.46 ^(c) B	2.12 ^(c)	0.70 U	1.53 U	1.66 U	3.25 U	4.68 U	5.08 U

(a) DL Detection limit.

(b) NA Not applicable.

(c) Ion ratio out or confirmation ion not detected.

(d) B Concentration is less than five times the amount detected in associated method blank.

(e) U Undetected above given concentration.

TABLE B.10. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	LPAHs (µg/kg dry weight)					Anthra-cene
			Naphtha-lene	Acenaph-thylene	Acenaph-thene	Fluorene	Phenan-threne	
Certified Value			NC	NC	NC	NC	680	140
SRM HS-4			NC	NC	NC	NC	±80	±70
HS-4		1	119	114	32.2	73.4	897	181 ^(f)
HS-4		2	118	96.6	38.4	74.1	632	155 ^(f)
HS-4		3	118	135	43.9	75.2	714	194 ^(f)
<u>Analytical Replicates</u>								
BHC-2	36.9-43.9 Rep 1	1	3.76 B	1.40 U	2.09	5.09	14.8	4.95 ^(a)
BHC-2	36.9-43.9 Rep 2	1	3.82 B	1.37 U	4.13	6.50	12.5	4.16 ^(a)
RPD			2%	NA ^(g)	66% ^(h)	24%	17%	17%
I-Stat			0.01	NA	0.33	0.12	0.08	0.09
TB-24	37.4-40.1 Rep 1	2	2.47 ^(a) B	1.31 U	0.62 U	0.96 U	3.01	1.58 U
TB-24	37.4-40.1 Rep 2	2	2.85 B	1.37 U	0.65 U	1.01 U	2.83	1.66 U
RPD			14%	NA	NA	NA	6%	NA
I-Stat			0.07	NA	NA	NA	0.03	NA
TB-25	38.4-46.8 Rep 1	3	1.54 ^(a) B	1.53 ^(a)	0.73 U	2.83	3.19	1.86 U
TB-25	38.4-46.8 Rep 2	3	1.57 ^(a)	1.53 U	0.73 U	1.13 U	2.70	1.86 U
RPD			2%	NA	NA	NA	17%	NA
I-Stat			0.01	NA	NA	NA	0.08	NA

(a) Ion ratio out or confirmation ion not detected.

(b) U Undetected above given concentration.

(c) B Analyte concentration is less than 5 times the amount detected in method blank associated with the sample.

(d) Outside quality control range (40-120%) for matrix spike recoveries.

(e) NC Not certified.

(f) Outside quality control criteria for SRMs ($\pm 30\%$).

(g) NA Not applicable.

(h) Outside quality control range for RPDs ($\pm 30\%$).

TABLE B.11. Quality Control Data for High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAHs) in Sediment

		HPAHs ($\mu\text{g/kg}$ dry weight)										
Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Fluor-anthene	Pyrene	Benzo(a)-anthracene	Chrysene	Benzo(b)-fluor-anthene	Benzo(k)-fluor-anthene	Benzo(a)pyrene	Indeno-(1,2,3-cd)pyrene	Dibenzo-(a,h)anthracene	Benzo-(g,h,i)perylene
Method Blanks												
Blank		1	2.07 U ^(a)	1.66 U	2.82 ^(b)	1.52 U	0.70 U	1.53 U	1.66 U	3.25 U	4.68 U	5.08 U
Blank		2	2.00 ^(b)	1.19 U	2.24 ^(b)	1.09 U	0.50 U	1.09 U	1.19 U	2.32 U	3.34 U	3.63 U
Blank		3	2.09 U	1.69 U	4.02	1.55 U	0.71 U	1.55 U	1.68 U	3.30 U	4.75 U	5.16 U
Blank		3A	2.43 U	1.69 U	3.96 ^(b)	1.55 U	0.71 U	1.55 U	1.68 U	3.30 U	4.75 U	5.16 U
Matrix Spikes												
BHC-5	38.5-39.9	1	9.53	6.75	4.11 B ^(c)	1.90 ^(b)	2.99 ^(b)	1.57 ^(b)	1.52 U	2.97 U	4.28 U	4.65 U
BHC-5	38.5-39.9 MS	1	56.6	49.9	51.7	53.7	55.6	54.2	40.4	59.6	61.3	53.6
Concentration Recovered			47.1	43.2	47.6	51.8	52.6	52.6	40.4	59.6	61.3	53.6
Amount Spiked			64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4
Percent Recovery			73%	67%	74%	80%	82%	82%	63%	93%	95%	83%
TB-18	37.1-40.2	2	2.73 ^(b) B	1.50 U	2.76 ^(b) B	1.37 U	0.63 U	1.49 U	1.04 U	2.92 U	4.21 U	4.58 U
TB-18	37.1-40.2	2	55.9	52.4	53.9	55.0	59.9	59.3	53.9	60.2	59.9	56.0
Concentration Recovered			53.2	52.4	51.1	55.0	59.9	59.3	53.9	60.2	59.9	56.0
Amount Spiked			63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1
Percent Recovery			84%	83%	81%	87%	95%	94%	85%	95%	95%	89%
Comp BHC-A Upper		3A	10.3	6.36	4.64 ^(b) B	1.92 ^(b)	0.77 ^(b)	1.33 U	1.45 U	2.97 U	4.08 U	4.43 U
Comp BHC-A Upper MS		3	54.0	46.0	85.1	114	79.9	56.3	80.4	67.5	59.1	56.2
Concentration Recovered			43.7	39.6	80.5	112.1	79.1	55.3	80.4	67.5	59.1	56.2
Amount Spiked			54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0
Percent Recovery			81%	73%	149% ^(d)	208% ^(d)	147% ^(d)	102%	149% ^(d)	125% ^(d)	109%	104%
Standard Reference Materials												
Certified Value			981	811	427	380	740	361	628	501	73.9	525
SRM NIST 1941			± 78	± 24	± 25	± 24	± 110	± 18	± 52	± 72	± 9.7	± 67
NIST 1941		1	850	686	423	534 ^(e)	936	309	494	519	129 ^(e)	476
NIST 1941		2	840	681	401	527 ^(e)	932	311	476	506	126 ^(e)	476
NIST 1941		3	904	723	464	570 ^(e)	915	312	478	550	150 ^(e)	470

TABLE B.11. (contd)

				HPAHs ($\mu\text{g/kg}$ dry weight)									
Sediment Treatment	Vertical Segment (-ft MLLW)		Batch	Fluor-anthene	Pyrene	Benzo(a)-anthracene	Chrysene	Benzo(b)-fluor-anthene	Benzo(k)-fluor-anthene	Benzo(a)pyrene	Indeno-(1,2,3-cd)pyrene	Dibenzo-(a,h)anthracene	Benzo-(g,h,i)perylene
Certified Value				1250	940	530	650	700	360	650	510	120	580
SRM HS-4				± 100	± 120	± 50	± 80	± 150	± 50	± 80	± 150	± 50	± 220
HS-4			1	1010	745	461	537	786	283	424 ^(e)	489	122	415
HS-4			2	1080	787	495	575	835	306	452 ^(e)	524	133	442
HS-4			3	1300	910	645	720	905	314	481	666	177 ^(e)	505
Analytical Replicates													
BHC-2	36.9-43.9	Rep 1	1	11.2	9.19	4.54	2.54	3.65	1.52 ^(b)	1.45 U	2.83 U	4.08 U	4.43 U
BHC-2	36.9-43.9	Rep 2	1	9.94	7.98	4.08	1.62	3.20	1.74 ^(b)	1.42 U	2.79 U	4.01 U	4.36 U
RPD				12%	14%	11%	44% ^(f)	13%	13%	NA ^(g)	NA	NA	NA
I-Stat				0.06	0.07	0.05	0.22	0.07	0.07	NA	NA	NA	NA
TB-24	37.4-40.1	Rep 1	2	3.21 ^(b)	1.35 U	2.84 ^(b) B	1.24 U	1.84 ^(b)	1.25 U	1.35 U	2.65 U	3.81 U	4.14 U
TB-24	37.4-40.1	Rep 2	2	3.12 ^(b)	1.42 U	2.84 ^(b) B	1.31 U	1.90 ^(b)	1.31 U	1.42 U	2.79 U	4.01 U	4.36 U
RPD				3%	NA	0%	NA	3%	NA	NA	NA	NA	NA
I-Stat				0.01	NA	0.00	NA	0.02	NA	NA	NA	NA	NA
TB-25	38.4-46.8	Rep 1	3	2.95 ^(b)	1.59 U	4.11 ^(b) B	1.46 U	0.67 U	1.47 U	1.59 U	3.11 U	4.48 U	4.87 U
TB-25	38.4-46.8	Rep 2	3	2.88 ^(b)	1.59 U	4.03 ^(b) B	1.54 ^(b)	0.67 U	1.47 U	1.59 U	3.11 U	4.48 U	4.87 U
RPD				2%	NA	2%	NA	NA	NA	NA	NA	NA	NA
I-Stat				0.01	NA	0.01	NA	NA	NA	NA	NA	NA	NA

(a) U Undetected above given concentration.

(b) Ion ratio out or confirmation ion not detected.

(c) B Concentration is less than 5 times the amount detected in associated method blank.

(d) Outside quality control range (40-120%) for matrix spike recoveries.

(e) Outside quality control criteria for SRMs ($\pm 30\%$).(f) Outside quality control range for precision ($\pm 30\%$).

(g) NA Not applicable.

TABLE B.12. Surrogate Percent Recoveries for Phthalates and Polynuclear Aromatic Hydrocarbons (PAHs) in Sediment, Including Quality Control Samples

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Surrogate Percent Recoveries			
			Naphthalene d8	Acenaphthene d10	Chrysene d12	Dibenzo(a,h,i) Anthracene d14
R-AM	NA ^(a)	3	69	70	90	107
R-BF	NA	3	61	66	90	108
Comp BHC-A Upper		3A	64	68	86	89
BHC-2	36.9-43.9 Rep 1	1	57	63	87	77
BHC-2	36.9-43.9 Rep 2	1	38 ^(b)	40	87	81
BHC-4	36.6-38.1	1	32 ^(b)	39 ^(b)	81	74
BHC-5	38.5-39.9	1	31 ^(b)	47	87	81
BHC-6	43.2-44.7	1	26 ^(b)	35 ^(b)	81	78
Comp BHC-A Lower		3	74	73	94	98
BHC-1	40.8-47.0	1	36 ^(b)	41	84	77
BHC-2	43.9-47.0	1	40	54	91	84
BHC-3	39.3-46.4	1	38 ^(b)	42	81	71
BHC-4	38.1-47.0	1	40	48	80	73
BHC-5	39.9-47.0	1	44	48	91	85
BHC-6	44.7-46.4	3A	75	70	83	80
Comp BHC-B		3	73	72	94	101
BHC-7	36.6-47.0	1	35 ^(b)	53	90	80
BHC-8	41.8-47.0	1	36 ^(b)	52	85	81
BHC-9	45.2-46.2	1	44	53	94	89
TB-10	30.4-40.2	1	51	62	84	75
TB-12	39.8-47.0	1	62	67	84	74
Comp TB-C		3A	70	68	86	83
BHC-9	42.0-45.2	3A	72	71 ^(b)	91	91
TB-11	39.7-46.6	1	35	35 ^(b)	79	74
TB-13	43.0-47.0	1	42	42	88	78
TB-14	37.1-46.8	1	31 ^(b)	36 ^(b)	86	71
TB-18	37.1-40.2	2	68	68	87	75
TB-19	31.9-33.4	2	77	73	85	73
TB-20	29.2-35.2	2	84	79	84	72
TB-21	38.0-41.8	2	59	62	82	70
TB-22	33.0-35.0	2	78	74	85	73
TB-24	37.4-40.1 Rep 1	2	89	84	84	73
TB-24	37.4-40.1 Rep 2	2	88	83	90	78
Comp TB-D Upper		3A	69	69	96	92
TB-15	29.7-47.0	2	63	67	84	75
TB-16	28.3-30.6	2	77	75	88	75
TB-17	28.3-32.5	2	81	76	87	66
Comp TB-D Lower		3	71	71	94	98
TB-10	40.2-46.8	1	44	45	83	70
Comp TB-E Upper		3	69	67	84	81
TB-21	41.8-44.3	2	90	85	94	83
TB-22	35.0-44.7	2	91	85	87	78

TABLE B.12. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Surrogate Percent Recoveries			
			Naphthalene d8	Acenaphthene d10	Chrysene d12	Dibenzo(a,h,i) Anthracene d14
Comp TB-E Lower		3A	47	57	89	88
TB-16	30.6-47.0	2	78	77	91	79
TB-17	32.5-47.0	2	82	81	92	83
TB-18	40.2-46.9	2	63	70	87	78
TB-19	33.4-47.0	2	78	79	88	75
TB-20	35.2-47.2	2	84	81	91	80
TB-23	29.0-46.3	2	73	73	88	77
TB-24	40.1-47.0	2	83	81	91	78
Cores Outside Proposed Dredging Area						
TB-25	38.4-46.8 Rep 1	3	82	80	100	100
TB-25	38.4-46.8 Rep 2	3	70	67	84	86
TB-26	28.6-36.0	3A	66	68	89	91
TB-26	36.0-47.0	3	86	83	97	97
TB-27	26.8-39.5	3	61	60	78	73
TB-27	39.5-41.1	3	75	75	97	110
TB-27	41.1-46.8	3	73	72	88	89
TB-28	29.0-32.9	3	71	70	90	90
TB-28	32.9-47.0	3A	68	68	91	94
Quality Control Samples						
Method Blanks						
Blank-1		1	34 ^(b)	37 ^(b)	53	87
Blank-2		2	62	61	77	53
Blank-1		3	85	81	97	96
Blank-2		3A	81	76	89	78
Matrix Spikes						
Comp BHC-A Upper		3A	64	68	86	89
Comp BHC-A Upper MS		3	73	72	97	109
BHC-5	38.5-39.9	1	31 ^(b)	47	87	81
BHC-5	38.5-39.9 MS	1	29 ^(b)	34 ^(b)	89	83
TB-18	37.1-40.2	2	68	68	87	75
TB-18	37.1-40.2	2	62	64	87	76
Standard Reference Materials						
Certified Value			NA	NA	NA	NA
SRM NIST 1941			NA	NA	NA	NA
NIST 1941		1	40	60	85	81
NIST 1941		2	55	70	84	80
NIST 1941		3	62	70	97	108

TABLE B.12. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Surrogate Percent Recoveries			
			Naphthalene d8	Acenaphthene d10	Chrysene d12	Dibenzo(a,h,i) Anthracene d14
Certified Value			NA	NA	NA	NA
SRM HS-4			NA	NA	NA	NA
		1	42	49	91	92
HS-4		2	60	68	86	86
HS-4		3	64	64	87	104
HS-4						
<u>Analytical Replicates</u>						
BHC-2	36.9-43.9 Rep 1	1	57	63	87	77
BHC-2	36.9-43.9 Rep 2	1	38(b)	40	87	81
			89	84	84	73
TB-24	37.4-40.1 Rep 1	2	88	83	90	78
TB-24	37.4-40.1 Rep 2	2				
			82	80	100	100
TB-25	38.4-46.8 Rep 1	3	70	67	84	86
TB-25	38.4-46.8 Rep 2	3				

(a) NA Not applicable.

(b) Outside quality control range (40-120%).

TABLE B.13. Polychlorinated Biphenyls (PCBs) in Sediment

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	PCBs ($\mu\text{g/kg}$ dry weight)			
			Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
Target DL ^(a)			20	20	20	20
Achieved DL			28	28	28	28
R-AM	NA ^(b)	3	28 U ^(c)	28 U	28 U	28 U
R-BF	NA	3	28 U	28 U	28 U	28 U
Comp BHC-A	Upper	3A	28 U	28 U	28 U	28 U
BHC-2	36.9-43.9	1	28 U	28 U	28 U	28 U
BHC-4	36.6-38.1	1	28 U	28 U	28 U	28 U
BHC-5	38.5-39.9	1	28 U	28 U	28 U	28 U
BHC-6	43.2-44.7	1	28 U	28 U	28 U	28 U
Comp BHC-A	Lower	3	28 U	28 U	28 U	28 U
BHC-1	40.8-47.0	1	28 U	28 U	28 U	28 U
BHC-2	43.9-47.0	1	28 U	28 U	28 U	28 U
BHC-3	39.3-46.4	1	28 U	28 U	28 U	28 U
BHC-4	38.1-47.0	1	28 U	28 U	28 U	28 U
BHC-5	39.9-47.0	1	28 U	28 U	28 U	28 U
BHC-6	44.7-46.4	1	28 U	28 U	28 U	28 U
BHC-6	44.7-46.4	3A	28 U	28 U	28 U	28 U
Comp BHC-B		3	28 U	28 U	28 U	28 U
BHC-7	36.6-47.0	1	28 U	28 U	28 U	28 U
BHC-8	41.8-47.0	1	28 U	28 U	28 U	28 U
BHC-9	45.2-46.2	1	28 U	28 U	28 U	28 U
TB-10	30.4-40.2	1	28 U	28 U	28 U	28 U
TB-12	39.8-47.0	1	28 U	28 U	28 U	28 U
Comp TB-C		3A	28 U	28 U	28 U	28 U
BHC-9	42.0-45.2	1	28 U	28 U	28 U	28 U
BHC-9	42.0-45.2	3A	28 U	28 U	28 U	28 U
TB-11	39.7-46.6	1	28 U	28 U	28 U	28 U
TB-13	43.0-47.0	1	28 U	28 U	28 U	28 U
TB-14	37.1-46.8	1	28 U	28 U	28 U	28 U
TB-18	37.1-40.2	2	28 U	28 U	28 U	28 U
TB-19	31.9-33.4	2	28 U	28 U	28 U	28 U
TB-20	29.2-35.2	2	28 U	28 U	28 U	28 U
TB-21	38.0-41.8	2	28 U	28 U	28 U	28 U
TB-22	33.0-35.0	2	28 U	28 U	28 U	28 U
TB-24	37.4-40.1	2	28 U	28 U	28 U	28 U
Comp TB-D	Upper	3A	28 U	28 U	28 U	28 U
TB-15	29.7-47.0	2	28 U	28 U	28 U	28 U
TB-16	28.3-30.6	2	28 U	28 U	28 U	28 U
TB-17	28.3-32.5	2	28 U	28 U	28 U	28 U

TABLE B.13. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	PCBs ($\mu\text{g/kg}$ dry weight)			
			Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
Comp TB-D	Lower	3A	28 U	28 U	28 U	28 U
TB-10	40.2-46.8	1	28 U	28 U	28 U	28 U
Comp TB-E	Upper	3	28 U	28 U	28 U	28 U
TB-21	41.8-44.3	2	28 U	28 U	28 U	28 U
TB-22	35.0-44.7	2	28 U	28 U	28 U	28 U
Comp TB-E	Lower	3A	28 U	28 U	28 U	28 U
TB-16	30.6-47.0	2	28 U	28 U	28 U	28 U
TB-17	32.5-47.0	2	28 U	28 U	28 U	28 U
TB-18	40.2-46.9	2	28 U	28 U	28 U	28 U
TB-19	33.4-47.0	2	28 U	28 U	28 U	28 U
TB-20	35.2-47.2	2	28 U	28 U	28 U	28 U
TB-23	29.0-46.3	2	28 U	28 U	28 U	28 U
TB-24	40.1-47.0	2	28 U	28 U	28 U	28 U

Cores Outside Proposed Dredging Area

TB-25	38.4-46.8	3	28 U	28 U	28 U	28 U
TB-26	28.6-36.0	3A	28 U	28 U	28 U	28 U
TB-26	36.0-47.0	3	28 U	28 U	28 U	28 U
TB-27	26.8-39.5	3	28 U	28 U	28 U	28 U
TB-27	39.5-41.1	3	28 U	28 U	28 U	28 U
TB-27	41.1-46.8	3	28 U	28 U	28 U	28 U
TB-28	29.0-32.9	3	28 U	28 U	28 U	28 U
TB-28	32.9-47.0	3A	28 U	28 U	28 U	28 U

(a) DL Detection limit.

(b) NA Not applicable.

(c) U Undetected above given concentration.

TABLE B.14. Quality Control Data for Polychlorinated Biphenyls (PCBs) in Sediment

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	PCBs (µg/kg dry weight)			
			Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
<u>Method Blanks</u>						
Blank		1	28 U ^(a)	28 U	28 U	28 U
Blank		2	28 U	28 U	28 U	28 U
Blank		3	28 U	28 U	28 U	28 U
Blank		3A	28 U	28 U	28 U	28 U
<u>Matrix Spikes</u>						
BHC-5	38.5-39.9	1	NS ^(b)	NS	28 U	NS
BHC-5	38.5-39.9 MS	1	NS	NS	63.1	NS
Concentration Recovered			NS	NS	63.1	NS
Amount Spiked			NS	NS	64.0	NS
Percent Recovery			NS	NS	99%	NS
TB-18	37.1-40.2	2	NS	NS	28 U	NS
TB-18	37.1-40.2 MS	2	NS	NS	64.6	NS
Concentration Recovered			NS	NS	64.6	NS
Amount Spiked			NS	NS	63.0	NS
Percent Recovery			NS	NS	103%	NS
Comp BHC-A Upper		3A	NS	NS	28 U	NS
Comp BHC-A Upper MS		3A	NS	NS	51.5	NS
Concentration Recovered			NS	NS	51.5	NS
Amount Spiked			NS	NS	54.0	NS
Percent Recovery			NS	NS	95%	NS
<u>Standard Reference Materials</u>						
No SRM certified for PCBs.						
<u>Analytical Replicates</u>						
BHC-2	36.9-43.9 Rep 1	1	28 U	28 U	28 U	28 U
BHC-2	36.9-43.9 Rep 2	1	28 U	28 U	28 U	28 U
RPD			NA ^(c)	NA	NA	NA
I-Stat			NA	NA	NA	NA
TB-24	37.4-40.1 Rep 1	2	28 U	28 U	28 U	28 U
TB-24	37.4-40.1 Rep 2	2	28 U	28 U	28 U	28 U
RPD			NA	NA	NA	NA
I-Stat			NA	NA	NA	NA

TABLE B.14. (contd)

<u>Sediment Treatment</u>	<u>Vertical Segment (-ft MLLW)</u>	<u>Batch</u>	<u>PCBs (μg/kg dry weight)</u>			
			<u>Aroclor 1242</u>	<u>Aroclor 1248</u>	<u>Aroclor 1254</u>	<u>Aroclor 1260</u>
TB-25	38.4-46.8 Rep 1	3	28 U	28 U	28 U	28 U
TB-25	38.4-46.8 Rep 2	3	28 U	28 U	28 U	28 U
RPD			NA	NA	NA	NA
I-Stat			NA	NA	NA	NA

-
- (a) U Undetected above given concentration.
 (b) NS Not spiked.
 (c) NA Not applicable.

TABLE B.15. Surrogate Recoveries for Chlorinated Pesticides and PCBs in Sediment Including Quality Control Samples

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Surrogate Percent Recoveries	
			PCB 103	PCB 198
R-AM	NA ^(a)	3	70	451 ^(b)
R-BF	NA	3	68	424 ^(b)
Comp BHC-A	Upper	3A	70	114
BHC-2	36.9-43.9	1	76	84
BHC-4	36.6-38.1	1	69	86
BHC-5	38.5-39.9	1	73	83
BHC-6	43.2-44.7	1	75	83
Comp BHC-A	Lower	3	70	198 ^(b)
BHC-1	40.8-47.0	1	72	82
BHC-2	43.9-47.0	1	80	87
BHC-3	39.3-46.4	1	69	80
BHC-4	38.1-47.0	1	70	77
BHC-5	39.9-47.0	1	73	93
BHC-6	44.7-46.4	1	62	92
BHC-6	44.7-46.4	3A	68	88
Comp BHC-B		3	72	331 ^(b)
BHC-7	36.6-47.0	1	80	85
BHC-8	41.8-47.0	1	77	86
BHC-9	45.2-46.2	1	83	99
TB-10	30.4-40.2	1	77	80
TB-12	39.8-47.0	1	74	84
Comp TB-C		3A	67	104
BHC-9	42.0-45.2	1	67	88
BHC-9	42.0-45.2	3A	72	102
TB-11	39.7-46.6	1	55	87
TB-13	43.0-47.0	1	70	97
TB-14	37.1-46.8	1	66	88
TB-18	37.1-40.2	2	78	81
TB-19	31.9-33.4	2	73	75
TB-20	29.2-35.2	2	77	77
TB-21	38.0-41.8	2	72	66
TB-22	33.0-35.0	2	75	74
TB-24	37.4-40.1	2	80	76
Comp TB-D	Upper	3A	67	151 ^(b)
TB-15	29.7-47.0	2	75	75
TB-16	28.3-30.6	2	70	73
TB-17	28.3-32.5	2	76	76
Comp TB-D	Lower	3A	75	112
TB-10	40.2-46.8	1	76	96

TABLE B.15. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Surrogate Percent Recoveries	
			PCB 103	PCB 198
Comp TB-E Upper		3	70	86
TB-21	41.8-44.3	2	84	84
TB-22	35.0-44.7	2	81	80
Comp TB-E Lower		3A	66	236 ^(b)
TB-16	30.6-47.0	2	79	77
TB-17	32.5-47.0	2	82	78
TB-18	40.2-46.9	2	77	78
TB-19	33.4-47.0	2	77	73
TB-20	35.2-47.2	2	82	77
TB-23	29.0-46.3	2	73	73
TB-24	40.1-47.0	2	78	79
Cores Outside Proposed Dredging Area				
TB-25	38.4-46.8	3	79	142 ^(b)
TB-26	28.6-36.0	3A	66	207 ^(b)
TB-26	36.0-47.0	3	76	119
TB-27	26.8-39.5	3	60	154 ^(b)
TB-27	39.5-41.1	3	73	271 ^(b)
TB-27	41.1-46.8	3	67	149 ^(b)
TB-28	29.0-32.9	3	71	95
TB-28	32.9-47.0	3A	65	164 ^(b)
<u>Quality Control Samples</u>				
<u>Method Blanks</u>				
Blank		1	91	86
Blank		2	94	98
Blank		3	78	108
Blank		3A	75	102
<u>Matrix Spikes</u>				
BHC-5	38.5-39.9	1	73	93
BHC-5	38.5-39.9 MS	1	71	90
TB-18	37.1-40.2	2	78	81
TB-18	37.1-40.2 MS	2	73	75
Comp BHC-A Upper		3A	70	114
Comp BHC-A Upper MS		3A	68	776 ^(c)

TABLE B.15. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Surrogate Percent Recoveries	
			PCB 103	PCB 198
<u>Standard Reference Materials</u>				
Certified Value			NA	NA
SRM NIST 1941a		1	68	50
SRM NIST 1941a		2	64	44
SRM NIST 1941a		3	25	60
<u>Analytical Replicates</u>				
BHC-2	36.9-43.9 Rep 1	1	76	84
BHC-2	36.9-43.9 Rep 2	1	72	88
TB-24	37.4-40.1 Rep 1	2	80	76
TB-24	37.4-40.1 Rep 2	2	83	79
TB-25	38.4-46.8 Rep 1	3	79	142 ^(b)
TB-25	38.4-46.8 Rep 2	3	66	125 ^(b)

(a) NA Not applicable.

(b) Outside quality control range (40-120%).

(c) Outside quality control range (40-120%) for matrix spike recoveries.

TABLE B.16. Chlorinated Pesticides in Sediment (alphabetical, Aldrin - 4,4' DDT)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides (µg/kg dry weight)								
			Aldrin	Alpha-BHC	Beta-BHC	Delta-BHC	Gamma-BHC	T-Chlordane	4,4'-DDE	4,4'-DDD	4,4'-DDT
Target DL ^(a)			2	2	2	2	2	30	2	2	2
Achieved DL			0.04-0.08	0.76-1.58	0.76-1.58	0.76-1.58	0.04-0.08	30	0.05-0.10	0.11-0.23	0.32-0.66
R-AM NA ^(b)		3	0.03 U ^(c)	0.68 U	0.68 U	0.68 U	0.04 U	30 U	0.04 U	0.53	0.55
R-BF NA		3	0.08 U	1.58 U	1.58 U	1.58 U	0.08 U	30 U	1.53	1.63	6.05
Comp BHC-A Upper		3A	0.04 U	0.87 U	0.87 U	0.87 U	0.05 U	30 U	0.05 U	0.13 U	0.36 U
BHC-2	36.9-43.9	1	0.05 U	0.94 U	0.94 U	0.94 U	0.05 U	30 U	0.06 U	0.14 U	0.39 U
BHC-4	36.6-38.1	1	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.75	0.37 U
BHC-5	38.5-39.9	1	0.05 U	0.91 U	0.91 U	0.91 U	0.05 U	30 U	0.06 U	0.13 U	0.38 U
BHC-6	43.2-44.7	1	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.75	0.37 U
Comp BHC-A Lower		3	0.05 U	0.97 U	0.97 U	0.97 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
BHC-1	40.8-47.0	1	0.06 U	1.20 U	1.20 U	1.20 U	0.06 U	30 U	0.07 U	0.17 U	0.50 U
BHC-2	43.9-47.0	1	0.05 U	1.10 U	1.10 U	1.10 U	0.06 U	30 U	0.07 U	0.16 U	0.46 U
BHC-3	39.3-46.4	1	0.06 U	1.11 U	1.11 U	1.11 U	0.06 U	30 U	0.07 U	0.16 U	0.46 U
BHC-4	38.1-47.0	1	0.06 U	1.17 U	1.17 U	1.17 U	0.06 U	30 U	0.07 U	0.17 U	0.49 U
BHC-5	39.9-47.0	1	0.05 U	0.94 U	0.94 U	0.94 U	0.05 U	30 U	0.06 U	0.14 U	0.39 U
BHC-6	44.7-46.4	1	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.13 U	0.37 U
BHC-6	44.7-46.4	3A	0.04 U	0.81 U	0.81 U	0.81 U	0.04 U	30 U	0.05 U	0.12 U	0.34 U
Comp BHC-B		3	0.06 U	1.12 U	1.12 U	1.12 U	0.06 U	30 U	0.07 U	0.16 U	0.47 U
BHC-7	36.6-47.0	1	0.05 U	1.08 U	1.08 U	1.08 U	0.06 U	30 U	0.07 U	0.16 U	0.45 U
BHC-8	41.8-47.0	1	0.06 U	1.15 U	1.15 U	1.15 U	0.06 U	30 U	0.07 U	0.17 U	0.48 U
BHC-9	45.2-46.2	1	0.05 U	0.97 U	0.97 U	0.97 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
TB-10	30.4-40.2	1	0.06 U	1.11 U	1.11 U	1.11 U	0.06 U	30 U	0.07 U	0.16 U	0.46 U
TB-12	39.8-47.0	1	0.06 U	1.11 U	1.11 U	1.11 U	0.06 U	30 U	0.07 U	0.17 U	0.46 U
Comp TB-C		3A	0.04 U	0.80 U	0.80 U	0.80 U	0.04 U	30 U	0.05 U	0.12 U	0.33 U
BHC-9	42.0-45.2	1	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.13 U	0.37 U
BHC-9	42.0-45.2	3A	0.04 U	0.81 U	0.81 U	0.81 U	0.04 U	30 U	0.05 U	0.12 U	0.34 U
TB-11	39.7-46.6	1	0.04 U	0.84 U	0.84 U	0.84 U	0.04 U	30 U	0.05 U	0.55	0.35 U
TB-13	43.0-47.0	1	0.04 U	0.77 U	0.77 U	0.77 U	0.40 U	30 U	0.05 U	0.11 U	0.32 U
TB-14	37.1-46.8	1	0.04 U	0.84 U	0.84 U	0.84 U	0.04 U	30 U	0.05 U	0.52	0.35 U
TB-18	37.1-40.2	2	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.13 U	0.37 U
TB-19	31.9-33.4	2	0.04 U	0.87 U	0.87 U	0.87 U	0.05 U	30 U	0.05 U	0.13 U	0.36 U
TB-20	29.2-35.2	2	0.04 U	0.78 U	0.78 U	0.78 U	0.04 U	30 U	0.05 U	0.60	0.33 U
TB-21	38.0-41.8	2	0.04 U	0.84 U	0.84 U	0.84 U	0.04 U	30 U	0.05 U	0.38	0.35 U
TB-22	33.0-35.0	2	0.03 U	0.70 U	0.70 U	0.70 U	0.04 U	30 U	0.04 U	0.32	0.29 U
TB-24	37.4-40.1	2	0.04 U	0.81 U	0.81 U	0.81 U	0.04 U	30 U	0.05 U	0.12 U	0.34 U

B.34

TABLE B.16. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides ($\mu\text{g/kg}$ dry weight)								4,4'-DDT
			Aldrin	Alpha-BHC	Beta-BHC	Delta-BHC	Gamma-BHC	T-Chlordane	4,4'-DDE	4,4'-DDD	
Comp TB-D Upper		3A	0.04 U	0.88 U	0.88 U	0.88 U	0.05 U	30 U	0.05 U	0.13 U	0.37 U
TB-15	29.7-47.0	2	0.50 U	0.93 U	0.93 U	0.93 U	0.05 U	30 U	0.06 U	0.13 U	0.39 U
TB-16	28.3-30.6	2	0.05 U	0.97 U	0.97 U	0.97 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
TB-17	28.3-32.5	2	0.05 U	0.95 U	0.95 U	0.95 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
Comp TB-D Lower		3A	0.04 U	0.84 U	0.84 U	0.84 U	0.04 U	30 U	0.05 U	0.12 U	0.35 U
TB-10	40.2-46.8	1	0.04 U	0.90 U	0.90 U	0.90 U	0.49	30 U	0.06 U	0.13 U	0.37 U
Comp TB-E Upper		3	0.04 U	0.85 U	0.85 U	0.85 U	0.04 U	30 U	0.05 U	0.12 U	0.36 U
TB-21	41.8-44.3	2	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.13 U	0.37 U
TB-22	35.0-44.7	2	0.05 U	0.91 U	0.91 U	0.91 U	0.05 U	30 U	0.06 U	0.13 U	0.38 U
Comp TB-E Lower		3A	0.05 U	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
TB-16	30.6-47.0	2	0.06 U	1.21 U	1.21 U	1.21 U	0.06 U	30 U	0.08 U	0.18 U	0.50 U
TB-17	32.5-47.0	2	0.05 U	1.00 U	1.00 U	1.99 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
TB-18	40.2-46.9	2	0.05 U	0.97 U	0.97 U	0.97 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
TB-19	33.4-47.0	2	0.06 U	1.15 U	1.15 U	1.15 U	0.06 U	30 U	0.07 U	0.17 U	0.48 U
TB-20	35.2-47.2	2	0.05 U	1.05 U	1.05 U	1.05 U	0.05 U	30 U	0.07 U	0.15 U	0.44 U
TB-23	29.0-46.3	2	0.05 U	1.05 U	1.05 U	1.05 U	0.05 U	30 U	0.07 U	0.15 U	0.40 U
TB-24	40.1-47.0	2	0.04 U	0.83 U	0.83 U	0.83 U	0.04 U	30 U	0.05 U	0.12 U	0.34 U
Cores Outside Proposed Dredging Area											
TB-25	38.4-46.8	3	0.05 U	0.95 U	0.95 U	0.95 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
TB-26	28.6-36.0	3A	0.05 U	0.94 U	0.94 U	0.94 U	0.05 U	30 U	0.06 U	0.14 U	0.39 U
TB-26	36.0-47.0	3	0.04 U	0.85 U	0.85 U	0.85 U	0.04 U	30 U	0.05 U	0.12 U	0.36 U
TB-27	26.8-39.5	3	0.05 U	1.05 U	1.05 U	1.05 U	0.05 U	30 U	0.07 U	0.15 U	0.44 U
TB-27	39.5-41.1	3	0.05 U	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
TB-27	41.1-46.8	3	0.05 U	1.04 U	1.04 U	1.04 U	0.05 U	30 U	0.06 U	0.15 U	0.43 U
TB-28	29.0-32.9	3	0.05 U	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
TB-28	32.9-47.0	3A	0.05 U	1.05 U	1.05 U	1.05 U	0.05 U	30 U	0.07 U	0.15 U	0.44 U

(a) DL Detection limit.

(b) NA Not applicable.

(c) U Undetected above given concentration.

TABLE B.17. Chlorinated Pesticides in Sediment (alphabetical, Dieldrin - Toxaphene)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides ($\mu\text{g}/\text{kg}$ dry weight)								Toxaphene
			Dieldrin	Endo-Sulfan I	Endo-Sulfan II	Endo-Sulfan Sulfate	Endrin	Endrin Aldehyde	Hepta-chlor	Hepta-chlor-epoxide	
Target DL (a)			2	2	2	2	2	2	2	2	30
Achieved DL			0.24-0.49	0.76-1.58	0.76-1.58	0.09-0.19	0.76-1.58	0.76-1.58	0.28-0.58	0.17-0.36	30
R-AM	NA (b)	3	0.21 U (c)	0.68 U	0.68 U	0.68 U	0.68 U	0.68 U	0.25 U	0.15 U	30 U
R-BF	NA	3	0.49 U	1.58 U	1.58 U	1.58 U	1.58 U	1.58 U	0.58 U	0.36 U	30 U
Comp BHC-A	Upper	3A	0.27 U	0.87 U	0.87 U	0.87 U	0.87 U	0.87 U	0.32 U	0.20 U	30 U
BHC-2	36.9-43.9	1	0.29 U	0.94 U	0.94 U	0.94 U	0.94 U	0.94 U	0.35 U	0.21 U	30 U
BHC-4	36.6-38.1	1	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
BHC-5	38.5-39.9	1	0.28 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.34 U	0.21 U	30 U
BHC-6	43.2-44.7	1	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
Comp BHC-A	Lower	3	0.30 U	0.97 U	0.97 U	0.97 U	0.97 U	0.97 U	0.36 U	0.22 U	30 U
BHC-1	40.8-47.0	1	0.37 U	1.20 U	1.20 U	1.20 U	1.20 U	1.20 U	0.44 U	0.27 U	30 U
BHC-2	43.9-47.0	1	0.34 U	1.10 U	1.10 U	1.10 U	1.10 U	1.10 U	0.40 U	0.25 U	30 U
BHC-3	39.3-46.4	1	0.35 U	1.11 U	1.11 U	1.11 U	1.11 U	1.11 U	0.41 U	0.25 U	30 U
BHC-4	38.1-47.0	1	0.36 U	1.17 U	1.17 U	1.17 U	1.17 U	1.17 U	0.43 U	0.26 U	30 U
BHC-5	39.9-47.0	1	0.29 U	0.94 U	0.94 U	0.94 U	0.94 U	0.94 U	0.35 U	0.21 U	30 U
BHC-6	44.7-46.4	1	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
BHC-6	44.7-46.4	3A	0.25 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.30 U	0.18 U	30 U
Comp BHC-B	3	0.35 U		1.12 U	1.12 U	1.12 U	1.12 U	1.12 U	0.41 U	0.25 U	30 U
BHC-7	36.6-47.0	1	0.34 U	1.08 U	1.08 U	1.08 U	1.08 U	1.08 U	0.40 U	0.24 U	30 U
BHC-8	41.8-47.0	1	0.36 U	1.15 U	1.15 U	1.15 U	1.15 U	1.15 U	0.43 U	0.26 U	30 U
BHC-9	45.2-46.2	1	0.30 U	0.97 U	0.97 U	0.97 U	0.97 U	0.97 U	0.36 U	0.22 U	30 U
TB-10	30.4-40.2	1	0.35 U	1.17 U	1.11 U	1.11 U	1.11 U	1.11 U	0.41 U	0.25 U	30 U
TB-12	39.8-47.0	1	0.35 U	1.11 U	1.11 U	1.11 U	1.11 U	1.11 U	0.41 U	0.25 U	30 U
Comp TB-C	3A	0.25 U		0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.29 U	0.18 U	30 U
BHC-9	42.0-45.2	1	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
BHC-9	42.0-45.2	3A	0.25 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.30 U	0.18 U	30 U
TB-11	39.7-46.6	1	0.26 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.31 U	0.19 U	30 U
TB-13	43.0-47.0	1	0.24 U	0.77 U	0.77 U	0.77 U	0.77 U	0.77 U	0.28 U	0.17 U	30 U
TB-14	37.1-46.8	1	0.26 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.31 U	0.19 U	30 U
TB-18	37.1-40.2	2	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
TB-19	31.9-33.4	2	0.27 U	0.87 U	0.87 U	0.87 U	0.87 U	0.87 U	0.32 U	0.20 U	30 U
TB-20	29.2-35.2	2	0.24 U	0.78 U	0.78 U	0.78 U	0.78 U	0.78 U	0.29 U	0.18 U	30 U
TB-21	38.0-41.8	2	0.26 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.31 U	0.19 U	30 U
TB-22	33.0-35.0	2	0.22 U	0.70 U	0.70 U	0.70 U	0.70 U	0.70 U	0.26 U	0.16 U	30 U
TB-24	37.4-40.1	2	0.25 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.30 U	0.18 U	30 U

TABLE B.17. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides ($\mu\text{g}/\text{kg}$ dry weight)								Toxa- phene
			Dieldrin	Endo-Sulfan I	Endo-Sulfan II	Endo-Sulfan Sulfate	Endrin	Endrin Aldehyde	Hepta-chlor	Hepta-chlor-epoxide	
Comp TB-D Upper		3A	0.28 U	0.88 U	0.88 U	0.88 U	0.88 U	0.88 U	0.33 U	0.20 U	30 U
TB-15	29.7-47.0	2	0.29 U	0.93 U	0.93 U	0.93 U	0.93 U	0.93 U	0.34 U	0.21 U	30 U
TB-16	28.3-30.6	2	0.30 U	0.97 U	0.97 U	0.97 U	0.97 U	0.97 U	0.36 U	0.22 U	30 U
TB-17	28.3-32.5	2	0.30 U	0.95 U	0.95 U	0.95 U	0.95 U	0.95 U	0.35 U	0.22 U	30 U
Comp TB-D Lower		3A	0.26 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.31 U	0.19 U	30 U
TB-10	40.2-46.8	1	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
Comp TB-E Upper		3	0.27 U	0.85 U	0.85 U	0.85 U	0.85 U	0.85 U	0.31 U	0.19 U	30 U
TB-21	41.8-44.3	2	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
TB-22	35.0-44.7	2	0.28 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.34 U	0.21 U	30 U
Comp TB-E Lower		3A	0.31 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
TB-16	30.6-47.0	2	0.38 U	1.21 U	1.21 U	1.21 U	1.21 U	1.21 U	0.45 U	0.27 U	30 U
TB-17	32.5-47.0	2	0.31 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
TB-18	40.2-46.9	2	0.30 U	0.97 U	0.97 U	0.97 U	0.97 U	0.97 U	0.36 U	0.22 U	30 U
TB-19	33.4-47.0	2	0.36 U	1.15 U	1.15 U	1.15 U	1.15 U	1.15 U	0.43 U	0.26 U	30 U
TB-20	35.2-47.2	2	0.33 U	1.05 U	1.05 U	1.05 U	1.05 U	1.05 U	0.39 U	0.24 U	30 U
TB-23	29.0-46.3	2	0.33 U	1.05 U	1.05 U	1.05 U	1.05 U	1.05 U	0.39 U	0.24 U	30 U
TB-24	40.1-47.0	2	0.26 U	0.83 U	0.83 U	0.83 U	0.83 U	0.83 U	0.30 U	0.19 U	30 U
Cores Outside Proposed Dredging Area											
TB-25	38.4-46.8	3	0.30 U	0.95 U	0.95 U	0.95 U	0.95 U	0.95 U	0.35 U	0.22 U	30 U
TB-26	28.6-36.0	3A	0.90	0.94 U	0.94 U	0.94 U	0.94 U	0.94 U	0.35 U	0.21 U	30 U
TB-26	36.0-47.0	3	0.27 U	0.85 U	0.85 U	0.85 U	0.85 U	0.85 U	0.31 U	0.19 U	30 U
TB-27	26.8-39.5	3	0.33 U	1.05 U	1.05 U	1.05 U	1.05 U	1.05 U	0.39 U	0.24 U	30 U
TB-27	39.5-41.1	3	0.59	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
TB-27	41.1-46.8	3	0.32 U	1.04 U	1.04 U	1.04 U	1.04 U	1.04 U	0.38 U	0.24 U	30 U
TB-28	29.0-32.9	3	0.31 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
TB-28	32.9-47.0	3A	0.33 U	1.05 U	1.05 U	1.05 U	1.05 U	1.05 U	0.39 U	0.24 U	30 U

(a) DL Detection limit.

(b) NA Not applicable.

(c) U Undetected above given concentration.

TABLE B.18. Quality Control Data for Chlorinated Pesticides in Sediment (alphabetical, Aldrin - 4,4' DDT)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides (μg/kg dry weight)								
			Aldrin	Alpha-BHC	Beta-BHC	Delta-BHC	Gamma-BHC	Chlordane	4,4'-DDE	4,4'-DDD	4,4'-DDT
Method Blanks											
Blank		1	0.05 U ^(a)	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.01 U	0.14 U	0.42 U
Blank		2	0.05 U	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
Blank		3	0.05 U	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
Blank		3A	0.05 U	1.00 U	1.00 U	1.00 U	0.05 U	30 U	0.06 U	0.14 U	0.42 U
Matrix Spikes											
BHC-5	38.5-39.9	1	0.05 U	NS ^(b)	NS	NS	0.05 U	NS	NS	NS	0.38 U
BHC-5	38.5-39.9 MS	1	3.93	NS	NS	NS	2.90	NS	NS	NS	12.7
Concentration Recovered			3.93	NS	NS	NS	2.90	NS	NS	NS	12.7
Amount Spiked			3.20	NS	NS	NS	3.20	NS	NS	NS	12.8
Percent Recovery			123% ^(c)	NS	NS	NS	91%	NS	NS	NS	99%
TB-18	37.1-40.2	2	0.04 U	NS	NS	NS	0.05 U	NS	NS	NS	0.37 U
TB-18	37.1-40.2 MS	2	4.93	NS	NS	NS	4.56	NS	NS	NS	12.6
Concentration Recovered			4.39	NS	NS	NS	4.56	NS	NS	NS	12.6
Amount Spiked			3.15	NS	NS	NS	3.15	NS	NS	NS	12.6
Percent Recovery			139% ^(c)	NS	NS	NS	145% ^(c)	NS	NS	NS	100%
Comp BHC-A Upper		3A	0.04 U	NS	NS	NS	0.05 U	NS	NS	NS	0.37 U
Comp BHC-A Upper MS		3A	4.50	NS	NS	NS	4.06	NS	NS	NS	12.5
Concentration Recovered			4.50	NS	NS	NS	4.06	NS	NS	NS	12.5
Amount Spiked			2.70	NS	NS	NS	2.70	NS	NS	NS	10.8
Percent Recovery			167% ^(c)	NS	NS	NS	150% ^(c)	NS	NS	NS	116%
Standard Reference Materials											
Certified Value			NC ^(d)	NC	NC	NC	NC	NC	6.59	5.06	NC
SRM NIST 1941a									±0.56	±0.58	
NIST 1941a		1	NA ^(e)	NA	NA	NA	NA	NA	7.73	3.70	NA
NIST 1941a		2	NA	NA	NA	NA	NA	NA	6.47 ^(f)	3.60 ^(f)	NA
NIST 1941a		3	NA	NA	NA	NA	NA	NA	8.69 ^(f)	6.65 ^(f)	NA

TABLE B.18. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides (µg/kg dry weight)								
			Aldrin	Alpha-BHC	Beta-BHC	Delta-BHC	Gamma-BHC	Chlordane	4,4'-DDE	4,4'-DDD	4,4'-DDT
Analytical Replicates											
BHC-2	36.9-43.9 Rep 1	1	0.05 U	0.94 U	0.94 U	0.94 U	0.05 U	30 U	0.06 U	0.14 U	0.39 U
BHC-2	36.9-43.9 Rep 2	1	0.04 U	0.85 U	0.85 U	0.85 U	0.04 U	30 U	0.05 U	0.56	0.36 U
RPD			NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat			NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-24	37.4-40.1 Rep 1	2	0.04 U	0.81 U	0.81 U	0.81 U	0.04 U	30 U	0.05 U	0.12 U	0.34 U
TB-24	37.4-40.1 Rep 2	2	0.04 U	0.85 U	0.85 U	0.85 U	0.04 U	30 U	0.05 U	0.12 U	0.36 U
RPD			NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat			NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-25	38.4-46.8 Rep 1	3	0.05 U	0.95 U	0.95 U	0.95 U	0.05 U	30 U	0.06 U	0.14 U	0.40 U
TB-25	38.4-46.8 Rep 2	3	0.04 U	0.90 U	0.90 U	0.90 U	0.05 U	30 U	0.06 U	0.13 U	0.37 U
RPD			NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat			NA	NA	NA	NA	NA	NA	NA	NA	NA

- (a) U Undetected above given concentration.
 (b) NS Not spiked.
 (c) Outside quality control range (40-120%) for matrix spike recoveries.
 (d) NC Not certified.
 (e) NA Not applicable.
 (f) Outside quality control criteria for SRMs ($\pm 30\%$).

TABLE B.19. Quality Control Data for Chlorinated Pesticides in Sediment (alphabetical, Dieldrin - Toxaphene)

			Pesticides ($\mu\text{g}/\text{kg}$ dry weight)								
Sediment Segment Treatment	Vertical Segment (-ft MLLW)	Batch	Dieldrin	Endo-Sulfan I	Endo-Sulfan II	Endo-Sulfan Sulfate	Endrin	Endrin Aldehyde	Hepta-chlor	Hepta-chlor-epoxide	Toxa-phene
Method Blanks											
Blank		1	0.31 U ^(a)	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
Blank		2	0.31 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
Blank		3	0.31 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
Blank		3A	0.31 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.37 U	0.23 U	30 U
Matrix Spikes											
BHC-5	38.5-39.9	1	0.28 U	NS ^(b)	NS	NS	0.90 U	NS	0.34 U	NS	NS
BHC-5	38.5-39.9 MS	1	12.3	NS	NS	NS	10.6	NS	1.63	NS	NS
Concentration Recovered			12.3	NS	NS	NS	10.6	NS	1.63	NS	NS
Amount Spiked			12.8	NS	NS	NS	12.8	NS	3.20	NS	NS
Percent Recovery			96%	NS	NS	NS	83%	NS	51%	NS	NS
TB-18	37.1-40.2	2	0.28 U	NS	NS	NS	0.90 U	NS	0.33 U	NS	NS
TB-18	37.1-40.2 MS	2	12.5	NS	NS	NS	12.9	NS	2.71	NS	NS
Concentration Recovered			12.5	NS	NS	NS	12.9	NS	2.71	NS	NS
Amount Spiked			12.6	NS	NS	NS	12.6	NS	3.15	NS	NS
Percent Recovery			99%	NS	NS	NS	102%	NS	86%	NS	NS
Comp BHC-A Upper		3A	0.27 U	NS	NS	NS	0.87 U	NS	0.32 U	NS	NS
Comp BHC-A Upper MS		3A	12.8	NS	NS	NS	12.8	NS	2.80	NS	NS
Concentration Recovered			12.8	NS	NS	NS	12.8	NS	2.80	NS	NS
Amount Spiked			10.8	NS	NS	NS	10.8	NS	2.70	NS	NS
Percent Recovery			119%	NS	NS	NS	119%	NS	104%	NS	NS
Standard Reference Materials											
Certified Value			NC ^(c)	NC	NC	NC	NC	NC	NC	NC	NC
SRM NIST 1941a											
NIST 1941a		1	NA ^(d)	NA	NA	NA	NA	NA	NA	NA	NA
NIST 1941a		2	NA	NA	NA	NA	NA	NA	NA	NA	NA
NIST 1941a		3	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE B.19. (contd)

Sediment Treatment	Vertical Segment (-ft MLLW)	Batch	Pesticides (µg/kg dry weight)									Toxa- phene
			Dieldrin	Endo-Sulfan I	Endo-Sulfan II	Endo-Sulfan Sulfate	Endrin	Endrin Aldehyde	Hepta-chlor	Hepta-chlor-epoxide		
Analytical Replicates												
BHC-2	36.9-43.9	Rep 1	1	0.29 U	0.94 U	0.94 U	0.94 U	0.94 U	0.94 U	0.35 U	0.21 U	30 U
BHC-2	36.9-43.9	Rep 2	1	0.27 U	0.85 U	0.85 U	0.85 U	0.85 U	0.85 U	0.31 U	0.19 U	30 U
RPD				NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat				NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-24	37.4-40.1	Rep 1	2	0.25 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.30 U	0.18 U	30 U
TB-24	37.4-40.1	Rep 2	2	0.27 U	0.85 U	0.85 U	0.85 U	0.85 U	0.85 U	0.31 U	0.19 U	30 U
RPD				NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat				NA	NA	NA	NA	NA	NA	NA	NA	NA
TB-25	38.4-46.8	Rep 1	3	0.30 U	0.95 U	0.95 U	0.95 U	0.95 U	0.95 U	0.35 U	0.22 U	30 U
TB-25	38.4-46.8	Rep 2	3	0.28 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.33 U	0.20 U	30 U
RPD				NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat				NA	NA	NA	NA	NA	NA	NA	NA	NA

- (a) U Undetected above given concentration.
 (b) NS Not spiked.
 (c) NC Not certified.
 (d) NA Not applicable.

TABLE B.20. Sediment Butyltin Results

Sediment Treatment	Batch	Triphenyltin Percent Internal Standard	Butyltin Species ($\mu\text{g/kg}$ dry weight)		
			Tri-butyltin	Di-butyltin	Mono-butyltin
Target DL (a)			10	10	10
Achieved DL			0.25	0.41	0.43
R-AM	3	172 ^(b)	0.25 U ^(c)	0.41 U	0.71
R-BF	3	114	3.63	11.5	3.00
Comp BHC-A Upper	3	101	0.25 U	0.41 U	0.43 U
BHC-2 (-36.9 to -43.9 ft MLLW) Rep 1	1	78	0.25 U	1.96	1.41
BHC-2 (-36.9 to -43.9 ft MLLW) Rep 2	1	94	0.58	0.41 U	0.43 U
BHC-4 (-36.6 to -38.1 ft MLLW)	1	96	0.25 U	0.41 U	0.43 U
BHC-5 (-38.5 to -39.9 ft MLLW)	1	93	0.25 U	0.41 U	1.43
BHC-6 (-43.2 to -44.7 ft MLLW)	1	95	0.25 U	0.41 U	0.43 U
Comp BHC-A Lower	3	99	0.25 U	0.41 U	0.43 U
BHC-1 (-40.8 to -47.0 ft MLLW)	1	126 ^(b)	0.25 U	0.41 U	0.43 U
BHC-2 (-43.9 to -47.0 ft MLLW)	1	96	0.25 U	0.41 U	0.43 U
BHC-3 (-39.3 to -46.4 ft MLLW)	1	91	0.25 U	0.41 U	0.43 U
BHC-4 (-38.1 to -47.0 ft MLLW)	1	91	0.25 U	3.14	1.67
BHC-5 (-39.9 to -47.0 ft MLLW)	1	89	0.25 U	0.41 U	0.43 U
BHC-6 (-44.7 to -46.4 ft MLLW)	1	96	0.25 U	0.41 U	0.43 U
Comp BHC-B	3	97	0.25 U	1.96	1.88
BHC-7 (-36.6 to -47.0 ft MLLW)	1	97	0.25 U	0.41 U	2.48
BHC-8 (-41.8 to -47.0 ft MLLW)	1	99	0.25 U	0.41 U	0.43 U
BHC-9 (-45.2 to -46.2 ft MLLW)	1	87	0.25 U	0.41 U	0.43 U
TB-10 (-30.4 to -40.2 ft MLLW)	1	90	0.25 U	0.41 U	0.43 U
TB-12 (-39.8 to -47.0 ft MLLW)	1	95	0.25 U	0.41 U	0.43 U
Comp TB-C	3	95	0.25 U	0.41 U	0.43 U
BHC-9 (-42.0 to -45.2 ft MLLW)	1	92	1.42	0.41 U	0.43 U
TB-11 (-39.7 to -46.6 ft MLLW)	1	94	0.25 U	2.95	0.43 U
TB-13 (-43.0 to -47.0 ft MLLW)	1	94	0.25 U	0.41 U	0.43 U
TB-14 (-37.1 to -46.8 ft MLLW)	1	100	0.25 U	0.41 U	0.43 U
TB-18 (-37.1 to -40.2 ft MLLW)	2	100	0.25 U	0.41 U	0.43 U
TB-19 (-31.9 to -33.4 ft MLLW)	2	96	0.25 U	0.41 U	0.43 U
TB-20 (-29.2 to -35.2 ft MLLW) Rep 1	2	93	0.25 U	0.41 U	0.43 U
TB-20 (-29.2 to -35.2 ft MLLW) Rep 2	2	104	0.25 U	0.41 U	0.43 U
TB-21 (-38.0 to -41.8 ft MLLW)	2	92	0.25 U	0.41 U	0.43 U
TB-22 (-33.0 to -35.0 ft MLLW)	2	103	0.25 U	0.41 U	0.43 U
TB-24 (-37.4 to -40.1 ft MLLW)	2	74	0.25 U	0.41 U	0.43 U
Comp TB-D Upper	3	85	0.25 U	0.41 U	0.43 U
TB-15 (-29.7 to -47.0 ft MLLW)	2	107	0.25 U	0.41 U	0.43 U
TB-16 (-28.3 to -30.6 ft MLLW)	2	106	0.25 U	0.41 U	0.43 U
TB-17 (-28.3 to -32.5 ft MLLW)	2	90	0.25 U	0.41 U	0.43 U
Comp TB-D Lower Replicate 1	3	96	0.25 U	0.41 U	0.43 U
Comp TB-D Lower Replicate 2	3	101	0.25 U	0.41 U	0.43 U
TB-10 (-40.2 to -46.8 ft MLLW)	1	63	0.25 U	0.41 U	0.43 U
Comp TB-E Upper	3	96	0.25 U	0.41 U	0.43 U
TB-21 (-41.8 to -44.3 ft MLLW)	2	83	0.25 U	0.41 U	0.43 U
TB-22 (-35.0 to -44.7 ft MLLW)	2	100	0.25 U	0.41 U	0.43 U

TABLE B.20. (contd)

Sediment Treatment	Batch	Triptyltylin Percent Internal Standard	Butyltin Species ($\mu\text{g/kg}$ dry weight)		
			Tri- butyltin	Di- butyltin	Mono- butyltin
Comp TB-E Lower	3	98	0.25 U	0.41 U	0.43 U
TB-16 (-30.6 to -47.0 ft MLLW)	2	95	0.25 U	0.41 U	0.43 U
TB-17 (-32.5 to -47.0 ft MLLW)	2	90	0.25 U	0.41 U	0.43 U
TB-18 (-40.2 to -46.9 ft MLLW)	2	103	0.25 U	0.41 U	0.43 U
TB-19 (-33.4 to -47.0 ft MLLW)	2	108	0.25 U	0.41 U	0.43 U
TB-20 (-35.2 to -47.2 ft MLLW)	2	94	0.25 U	0.41 U	0.43 U
TB-23 (-29.0 to -46.3 ft MLLW)	2	97	0.25 U	0.41 U	0.43 U
TB-24 (-40.1 to -47.0 ft MLLW)	2	102	0.25 U	0.41 U	0.43 U
Cores Outside of Proposed Dredging Area					
TB-25 (-38.4 to -46.8 ft MLLW)	3	103	0.39	0.41 U	1.36
TB-26 (-28.6 to -36.0 ft MLLW)	3	100	0.25 U	0.41 U	0.43 U
TB-26 (-36.0 to -47.0 ft MLLW)	3	103	0.25 U	0.41 U	0.43 U
TB-27 (-26.8 to -39.5 ft MLLW)	3	105	0.25 U	0.41 U	0.43 U
TB-27 (-39.5 to -41.1 ft MLLW)	3	101	0.25 U	0.41 U	0.43 U
TB-27 (-41.1 to -46.8 ft MLLW)	3	101	0.25 U	0.41 U	0.43 U
TB-28 (-29.0 to -32.9 ft MLLW)	3	104	0.25 U	0.41 U	0.43 U
TB-28 (-32.9 to -47.0 ft MLLW)	3	93	0.25 U	0.41 U	0.43 U

(a) DL Detection limit.

(b) Outside quality control range (40-120%).

(c) U Undetected above given concentration.

TABLE B.21. Quality Control Data for Sediment Butyltin Analysis

Sediment Treatment	Batch	Triphenyltin Percent Internal Standard	Butyltin Species ($\mu\text{g/kg}$ dry weight)		
			Tri- butyltin	Di- butyltin	Mono- butyltin
<u>Method Blanks</u>					
Method Blank	1	101	0.25 U ^(a)	0.79	0.43 U
Method Blank	2	96	0.25 U	0.41 U	0.43 U
Method Blank	3	104	0.25 U	0.41 U	0.43 U
<u>Matrix Spikes</u>					
BHC-5 (-38.5 to -39.9 ft MLLW)	1	93	0.25 U	0.41 U	1.43
BHC-5 MS (-38.5 to -39.9 ft MLLW)	1	91	30.1	28.8	10.3
Concentration Recovered		NA ^(b)	30.1	28.8	8.87
Amount Spiked		NS ^(c)	32.1	32.1	32.1
Percent Recovery		NA	94%	90%	28% ^(d)
TB-19 (-31.9 to -33.4 ft MLLW)	2	96	0.25 U	0.41 U	0.43 U
TB-19 MS (-31.9 to -33.4 ft MLLW)	2	99	32.3	28.1	5.38
Concentration Recovered		NA	32.3	28.1	5.38
Amount Spiked		NA	30.9	30.9	30.9
Percent Recovery		NA	105%	91%	17% ^(d)
TB-28 (-29.0 to -32.9 ft MLLW)	3	104	0.25 U	0.41 U	0.43 U
TB-28 MS (-29.0 to -32.9 ft MLLW)	3	98	29.6	25.3	10.3
Concentration Recovered		NA	29.6	25.3	10.3
Amount Spiked		NA	29.9	29.9	29.9
Percent Recovery		NA	99%	85%	34% ^(d)
<u>Standard Reference Material</u>					
Certified		NA	1270	1160	280
Value PACS-1		NA	± 220	± 180	170
PACS-1	1	113	1020	1180	176
PACS-1	2	102	1130	1250	246 ^(e)
PACS-1	3	104	1140	1090	106 ^(e)
<u>Analytical Replicates</u>					
BHC-2 (-36.9 to -43.9 ft MLLW) Rep 1	1	78	0.25 U	1.96	1.41
BHC-2 (-36.9 to -43.9 ft MLLW) Rep 2	1	94	0.58	0.41 U	0.43 U
RPD		NA	NA	NA	NA
I-Stat		NA	NA	NA	NA
TB-20 (-29.2 to -35.2 ft MLLW) Rep 1	2	93	0.25 U	0.41 U	0.43 U
TB-20 (-29.2 to -35.2 ft MLLW) Rep 2	2	104	0.25 U	0.41 U	0.43 U
RPD	2	NA	NA	NA	NA
I-Stat	2	NA	NA	NA	NA
Comp TB-D Lower Replicate 1	3	96	0.25 U	0.41 U	0.43 U
Comp TB-D Lower Replicate 2	3	101	0.25 U	0.41 U	0.43 U
RPD		NA	NA	NA	NA
I-Stat		NA	NA	NA	NA

(a) Undetected above given concentration.

(b) NA Not applicable.

(c) NS Not spiked.

(d) Outside quality control range (40-120%).

(e) Outside accuracy quality control range of $\pm 30\%$.

APPENDIX C

10-DAY SOLID PHASE TEST WITH *Rhepoxynius abronius*

TABLE C.1. Test Results for All Replicates in the *R. abronius* 10-Day Suspended-Particulate-Phase Test

Sediment Treatment	Replicate	Number Alive	Number Dead or Missing	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)	Number Did Not Rebury	Number Survivors Reburied	Effective Proportion Survival	Mean Effective Proportion Survival	Standard Deviation (b)
R-AM	1	19	1	0.95			1	18	0.90		
R-AM	2	20	0	1.00			0	20	1.00		
R-AM	3	20	0	1.00			0	20	1.00		
R-AM	4	17	3	0.85			1	16	0.80		
R-AM	5	20	0	1.00	0.96	0.07	0	20	1.00	0.94	0.09
R-BF	1	15	5	0.75			0	15	0.75		
R-BF	2	18	2	0.90			0	18	0.90		
R-BF	3	20	0	1.00			0	20	1.00		
R-BF	4	18	2	0.90			0	18	0.90		
R-BF	5	14	6	0.70	0.85	0.12	0	14	0.70	0.85	0.12
Comp BHC-A Upper	1	18	2	0.90			0	18	0.90		
Comp BHC-A Upper	2	20	0	1.00			0	20	1.00		
Comp BHC-A Upper	3	18	2	0.90			0	18	0.90		
Comp BHC-A Upper	4	20	0	1.00			0	20	1.00		
Comp BHC-A Upper	5	18	2	0.90	0.94	0.05	0	18	0.90	0.94	0.05
Comp BHC-A Lower MA ^(c)	1	19	1	0.95			0	19	0.95		
Comp BHC-A Lower MA	2	18	2	0.90			0	18	0.90		
Comp BHC-A Lower MA	3	20	0	1.00			0	20	1.00		
Comp BHC-A Lower MA	4	19	1	0.95			0	19	0.95		
Comp BHC-A Lower MA	5	18	2	0.90	0.94	0.04	0	18	0.90	0.94	0.04
Comp BHC-B MA	1	15	5	0.75			2	13	0.65		
Comp BHC-B MA	2	18	2	0.90			1	17	0.85		
Comp BHC-B MA	3	16	4	0.80			0	16	0.80		
Comp BHC-B MA	4	14	6	0.70			1	13	0.65		
Comp BHC-B MA	5	18	2	0.90	0.81	0.09	0	18	0.90	0.77	0.12
Comp TB-C	1	19	1	0.95			0	19	0.95		
Comp TB-C	2	18	2	0.90			0	18	0.90		
Comp TB-C	3	20	0	1.00			0	20	1.00		
Comp TB-C	4	20	0	1.00			0	20	1.00		
Comp TB-C	5	20	0	1.00	0.97	0.04	0	20	1.00	0.97	0.04
Comp TB-D Upper	1	19	1	0.95			1	18	0.90		
Comp TB-D Upper	2	20	0	1.00			0	20	1.00		
Comp TB-D Upper	3	19	1	0.95			0	19	0.95		
Comp TB-D Upper	4	20	0	1.00			2	18	0.90		
Comp TB-D Upper	5	19	1	0.95	0.97	0.03	2	17	0.85	0.92	0.06

C.1

TABLE C.1. (contd)

Sediment Treatment	Replicate	Number Alive	Number Dead or Missing	Proportion Survival	Mean Proportion Survival	Standard Deviation ^(a)	Number Did Not Rebury	Number Survivors Reburied	Effective Proportion Survival	Mean Effective Proportion Survival	Standard Deviation ^(b)
Comp TB-D Lower	1	17	3	0.85			1	16	0.80		
Comp TB-D Lower	2	17	3	0.85			2	15	0.75		
Comp TB-D Lower	3	19	1	0.95			0	19	0.95		
Comp TB-D Lower	4	19	1	0.95			0	19	0.95		
Comp TB-D Lower	5	19	1	0.95	0.91	0.05	0	19	0.95	0.88	0.10
Comp TB-E Upper	1	18	2	0.90			0	18	0.90		
Comp TB-E Upper	2	19	1	0.95			0	19	0.95		
Comp TB-E Upper	3	19	1	0.95			2	17	0.85		
Comp TB-E Upper	4	18	2	0.90			1	17	0.85		
Comp TB-E Upper	5	20	0	1.00	0.94	0.04	0	20	1.00	0.91	0.07
Comp TB-E Lower MA	1	18	2	0.90			1	17	0.85		
Comp TB-E Lower MA	2	17	3	0.85			4	13	0.65		
Comp TB-E Lower MA	3	18	2	0.90			0	18	0.90		
Comp TB-E Lower MA	4	15	5	0.75			0	15	0.75		
Comp TB-E Lower MA	5	15	5	0.75	0.83	0.08	1	14	0.70	0.77	0.10
Comp TB-E Lower	1	0	20	0.00			0	0	0.00		
Comp TB-E Lower	2	4	16	0.20			1	3	0.15		
Comp TB-E Lower	3	4	16	0.20			0	4	0.20		
Comp TB-E Lower	4	3	17	0.15			0	3	0.15		
Comp TB-E Lower	5	1	19	0.05	0.12	0.09	0	1	0.05	0.11	0.08
C-WB	1	20	0	1.00			0	20	1.00		
C-WB	2	18	2	0.90			0	18	0.90		
C-WB	3	20	0	1.00			0	20	1.00		
C-WB	4	20	0	1.00			0	20	1.00		
C-WB	5	20	0	1.00	0.98	0.04	0	20	1.00	0.98	0.04

(a) Standard deviation based on proportion surviving.

(b) Standard deviation based on effective proportion surviving.

(c) MA Manipulated sediment to reduce porewater ammonia.

TABLE C.2. Water Quality Summary for the *R. abronius* 10-Day Solid-Phase Static Test

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	5.4	NA ^(a)	28.0	32.0
R-AM	15.3	16.7	7.79	8.13	6.9	8.8	30.5	32.0
R-BF	15.3	16.7	7.75	8.08	6.4	8.5	30.0	32.0
Comp BHC-A Upper	15.2	16.8	7.64	8.06	7.0	8.4	29.0	31.5
Comp BHC-A Lower	15.0	16.6	7.82	8.08	6.9	8.7	30.5	32.0
Comp BHC-B	15.0	16.7	7.88	8.13	6.9	8.6	29.5	32.0
Comp TB-C	15.3	16.7	7.75	8.07	7.0	8.6	30.0	31.5
Comp TB-D Upper	15.3	16.7	7.76	8.15	6.9	8.6	29.5	32.0
Comp TB-D Lower	15.3	16.7	7.77	8.12	7.0	8.5	30.0	31.5
Comp TB-E Upper	15.3	16.7	7.78	8.13	6.8	8.4	30.0	31.5
Comp TB-E Lower MA	14.9	16.7	7.75	8.11	7.2	8.6	30.5	32.0
Comp TB-E Lower	15.0	16.6	7.91	8.25	6.9	8.7	29.5	31.5
C-WB	15.3	16.6	7.87	8.08	7.0	8.5	30.5	32.0

(a) NA Not applicable.

TABLE C.3. Test Results for All Replicates in the 96-Hour *R. abronius* Reference Toxicant Test

<u>Cadmium Concentration (mg/L)</u>	<u>Replicate</u>	<u>Number Alive</u>	<u>Number Dead or Missing</u>	<u>Proportion Survival</u>	<u>Mean Proportion Survival</u>	<u>Standard Deviation ^(a)</u>
0.0	1	18	2	0.90		
0.0	2	17	3	0.85		
0.0	3	20	0	1.00	0.92	0.08
0.5	1	14	6	0.70		
0.5	2	13	7	0.65		
0.5	3	14	6	0.70	0.68	0.03
1.0	1	7	13	0.35		
1.0	2	7	13	0.35		
1.0	3	12	8	0.60	0.43	0.14
2.0	1	3	17	0.15		
2.0	2	2	18	0.10		
2.0	3	6	14	0.30	0.18	0.10
4.0	1	0	20	0.00		
4.0	2	0	20	0.00		
4.0	3	0	20	0.00	0.00	0.00

(a) Standard deviation of proportion surviving.

TABLE C.4. Water Quality Summary for the 96-Hour *R. abronius* Reference Toxicant Test

Cadmium Concentration (mg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	6.0	NA ^(a)	28.0	32.0
0.0	15.3	15.6	7.76	7.95	7.6	8.1	30.0	31.5
0.5	15.3	15.6	7.76	7.92	7.7	8.2	30.5	32.0
1.0	15.3	15.6	7.73	7.92	7.8	8.2	30.5	31.5
2.0	15.3	15.6	7.67	7.89	7.9	8.2	30.5	32.0
4.0	15.3	15.6	7.64	7.79	7.9	8.3	30.0	32.0

(a) NA Not applicable.

APPENDIX D

10-DAY SOLID PHASE TEST WITH *Eohaustorius estuarius*

TABLE D.1. Test Results for all Replicates in the *E. estuarius* 10-Day Suspended-Particulate-Phase Test

<u>Sediment Treatment</u>	<u>Replicate</u>	<u>Number Alive</u>	<u>Number Dead or Missing</u>	<u>Proportion Survival</u>	<u>Mean Proportion Survival</u>	<u>Standard Deviation (a)</u>
R-AM	1	19	1	0.95		
R-AM	2	19	1	0.95		
R-AM	3	20	0	1.00		
R-AM	4	20	0	1.00		
R-AM	5	20	0	1.00	0.98	0.03
R-BF	1	12	8	0.60		
R-BF	2	13	7	0.65		
R-BF	3	17	3	0.85		
R-BF	4	18	2	0.90		
R-BF	5	14	6	0.70	0.74	0.13
Comp BHC-A Upper	1	20	0	1.00		
Comp BHC-A Upper	2	19	1	0.95		
Comp BHC-A Upper	3	19	1	0.95		
Comp BHC-A Upper	4	18	2	0.90		
Comp BHC-A Upper	5	18	2	0.90	0.94	0.04
Comp BHC-A Lower MA ^(b)	1	19	1	0.95		
Comp BHC-A Lower MA	2	4	16	0.20		
Comp BHC-A Lower MA	3	19	1	0.95		
Comp BHC-A Lower MA	4	19	1	0.95	0.96 ^(c)	0.03 ^(c)
Comp BHC-A Lower MA	5	21	0	1.00	0.81	0.34
Comp BHC-B MA	1	15	5	0.75		
Comp BHC-B MA	2	15	5	0.75		
Comp BHC-B MA	3	14	6	0.70		
Comp BHC-B MA	4	17	3	0.85		
Comp BHC-B MA	5	13	7	0.65	0.74	0.07
Comp TB-C	1	20	0	1.00		
Comp TB-C	2	19	1	0.95		
Comp TB-C	3	19	1	0.95		
Comp TB-C	4	20	0	1.00		
Comp TB-C	5	20	0	1.00	0.98	0.03
Comp TB-D Upper	1	19	1	0.95		
Comp TB-D Upper	2	18	2	0.90		
Comp TB-D Upper	3	20	0	1.00		
Comp TB-D Upper	4	19	1	0.95		
Comp TB-D Upper	5	19	1	0.95	0.95	0.04
Comp TB-D Lower	1	17	3	0.85		
Comp TB-D Lower	2	19	1	0.95		
Comp TB-D Lower	3	19	1	0.95		
Comp TB-D Lower	4	19	1	0.95		
Comp TB-D Lower	5	20	0	1.00	0.94	0.05
Comp TB-E Upper	1	20	0	1.00		
Comp TB-E Upper	2	20	0	1.00		
Comp TB-E Upper	3	20	0	1.00		
Comp TB-E Upper	4	18	2	0.90		
Comp TB-E Upper	5	19	1	0.95	0.97	0.04

TABLE D.1. (contd)

<u>Sediment Treatment</u>	<u>Replicate</u>	<u>Number Alive</u>	<u>Number Dead or Missing</u>	<u>Proportion Survival</u>	<u>Mean Proportion Survival</u>	<u>Standard Deviation (a)</u>
Comp TB-E Lower MA	1	12	8	0.60		
Comp TB-E Lower MA	2	13	7	0.65		
Comp TB-E Lower MA	3	14	6	0.70		
Comp TB-E Lower MA	4	21	0	1.00		
Comp TB-E Lower MA	5	22	2	0.92	0.77	0.18
Comp TB-E Lower ^(d)	1	13	7	0.65		
Comp TB-E Lower	2	12	8	0.60		
Comp TB-E Lower	3	15	5	0.75		
Comp TB-E Lower	4	12	8	0.60		
Comp TB-E Lower	5	16	4	0.80	0.68	0.09
C-E0	1	20	0	1.00		
C-E0	2	20	0	1.00		
C-E0	3	20	0	1.00		
C-E0	4	19	1	0.95		
C-E0	5	20	0	1.00	0.99	0.02

(a) Standard deviation of proportion surviving.

(b) MA Manipulated to reduce porewater ammonia before adding animals to chamber.

(c) Mean and standard deviation calculated without anomalous Rep 2 value.

(d) Not manipulated to reduce porewater ammonia.

TABLE D.2. Water Quality Summary for the *E. estuarius* 10-Day Solid-Phase Static Test

Sediment Treatment	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	5.4	NA ^(a)	28.0	32.0
R-AM	13.9	14.9	7.57	8.10	7.3	8.9	30.0	32.0
R-BF	14.0	14.8	7.71	8.11	7.6	8.9	30.0	31.5
Comp BHC-A Upper	14.0	14.7	7.70	8.05	7.6	9.1	30.0	31.0
Comp BHC-A Lower MA	14.0	14.8	7.75	8.05	7.4	8.9	30.0	31.5
Comp BHC-B MA	13.9	15.3	7.70	8.14	7.4	9.2	30.0	31.5
Comp TB-C	14.0	14.8	7.56	8.08	7.4	9.0	30.0	31.5
Comp TB-D Upper	14.0	14.7	7.70	8.19	7.5	8.9	29.0	31.0
Comp TB-D Lower	14.0	14.7	7.74	8.08	7.4	8.7	29.5	31.0
Comp TB-E Upper	14.0	14.7	7.78	8.15	7.4	9.0	30.0	31.0
Comp TB-E Lower MA	14.1	14.9	7.50	8.09	7.4	9.0	30.0	31.5
Comp TB-E Lower	13.9	15.3	7.91	8.18	7.5	8.9	28.5	31.0
C-EO	14.0	14.8	7.82	8.10	7.5	8.8	28.0	31.0

(a) NA Not applicable.

TABLE D.3. Test Results for All Replicates in the 96-Hour *E. estuarius* Reference Toxicant Test

<u>Cadmium Concentration (mg/L)</u>	<u>Replicate</u>	<u>Number Alive</u>	<u>Number Dead or Missing</u>	<u>Proportion Survival</u>	<u>Mean Proportion Survival</u>	<u>Standard Deviation (a)</u>
0.0	1	19	1	0.95	0.95	0.05
0.0	2	18	2	0.90		
0.0	3	20	0	1.00		
6.0	1	17	3	0.85	0.90	0.05
6.0	2	19	1	0.95		
6.0	3	18	2	0.90		
12.0	1	12	8	0.60	0.57	0.06
12.0	2	12	8	0.60		
12.0	3	10	10	0.50		
18.0	1	8	12	0.40	0.40	0.10
18.0	2	6	14	0.30		
18.0	3	10	10	0.50		
24.0	1	2	18	0.10	0.15	0.05
24.0	2	3	17	0.15		
24.0	3	4	16	0.20		

(a) Standard deviation of proportion surviving.

TABLE D.4. Water Quality Summary for the 96-Hour *E. estuarius* Reference Toxicant Test

Cadmium Concentration (mg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	13.0	17.0	7.30	8.30	5.4	NA ^(a)	28.0	32.0
0.0	15.1	16.0	7.79	7.97	7.5	8.0	31.5	32.0
6.0	15.3	16.0	7.66	8.04	7.6	8.2	31.0	32.0
12.0	15.3	16.0	7.74	8.03	7.4	8.1	31.5	32.0
18.0	15.3	16.0	7.76	8.03	7.5	8.1	31.0	32.0
24.0	15.3	16.0	7.75	8.04	7.3	8.3	31.0	32.0

(a) NA Not applicable.

APPENDIX E

48-HOUR SUSPENDED-PARTICULATE-PHASE TEST
WITH *Mytilus galloprovincialis*

TABLE E.1. Test Results for All Replicates in the 48-Hour Larval *M. galloprovincialis* Suspended-Particulate-Phase Test

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
R-AM	0	1	269	286	0	0	1.00 ^(b)		1.00 ^(b)		
R-AM	0	2	269	276	0	4	1.00 ^(b)		1.00 ^(b)		
R-AM	0	3	269	288	0	3	1.00 ^(b)		1.00 ^(b)		
R-AM	0	4	269	269	0	4	1.00 ^(b)		1.00 ^(b)		
R-AM	0	5	269	254	0	3	0.94	0.99	0.96	0.99	0.02
R-AM	1	1	269	252	0	7	0.94		0.96		
R-AM	1	2	269	239	0	3	0.89		0.90		
R-AM	1	3	269	244	0	3	0.91 ^(b)		0.92 ^(b)		
R-AM	1	4	269	276	0	3	1.00 ^(b)		1.00 ^(b)		
R-AM	1	5	269	281	0	6	1.00 ^(b)	0.95	1.00 ^(b)	0.96	0.05
R-AM	10	1	269	286	0	4	1.00 ^(b)		1.00 ^(b)		
R-AM	10	2	269	285	0	7	1.00 ^(b)		1.00 ^(b)		
R-AM	10	3	269	274	0	3	1.00 ^(b)		1.00 ^(b)		
R-AM	10	4	269	259	0	1	0.96 ^(b)		0.97 ^(b)		
R-AM	10	5	269	290	0	2	1.00 ^(b)	0.99	1.00 ^(b)	0.99	0.01
R-AM	50	1	269	273	0	4	1.00 ^(b)		1.00 ^(b)		
R-AM	50	2	269	267	0	5	0.99		1.00 ^(b)		
R-AM	50	3	269	254	0	5	0.94 ^(b)		0.96 ^(b)		
R-AM	50	4	269	282	1	5	1.00 ^(b)		1.00 ^(b)		
R-AM	50	5	269	296	0	1	1.00 ^(b)	0.99	1.00 ^(b)	0.99	0.02
R-AM	100	1	269	256	0	11	0.95		0.99		
R-AM	100	2	269	257	0	4	0.96 ^(b)		0.97 ^(b)		
R-AM	100	3	269	299	0	2	1.00 ^(b)		1.00 ^(b)		
R-AM	100	4	269	294	0	10	1.00 ^(b)		1.00 ^(b)		
R-AM	100	5	269	245	0	3	0.91	0.96	0.92	0.98	0.03
R-BF	0	1	242	214	0	7	0.88		0.91		
R-BF	0	2	242	218	0	19	0.90 ^(b)		0.98 ^(b)		
R-BF	0	3	242	255	0	1	1.00 ^(b)		1.00 ^(b)		
R-BF	0	4	242	225	0	10	0.93		0.97		
R-BF	0	5	242	212	0	8	0.88	0.92	0.91	0.95	0.04

E.1

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
R-BF	1	1	242	228	0	11	0.94		0.99		
R-BF	1	2	242	240	0	18	0.99		1.00 ^(b)		
R-BF	1	3	242	278	0	12	1.00 ^(b)		1.00 ^(b)		
R-BF	1	4	242	213	0	10	0.88		0.92		
R-BF	1	5	242	245	0	3	1.00 ^(b)	0.96	1.00 ^(b)	0.98	0.03
R-BF	10	1	242	202	0	14	0.83		0.89		
R-BF	10	2	242	228	0	6	0.94		0.97		
R-BF	10	3	242	224	0	10	0.93		0.97		
R-BF	10	4	242	218	0	10	0.90		0.94		
R-BF	10	5	242	193	0	15	0.80	0.88	0.86	0.93	0.05
R-BF	50	1	242	201	0	14	0.83		0.89		
R-BF	50	2	242	223	0	12	0.92		0.97		
R-BF	50	3	242	215	0	20	0.89		0.97		
R-BF	50	4	242	225	0	17	0.93		1.00 ^(b)		
R-BF	50	5	242	204	0	12	0.84	0.88	0.89	0.94	0.05
R-BF	100	1	242	240	0	23	0.99		1.00 ^(b)		
R-BF	100	2	242	265	0	10	1.00 ^(b)		1.00 ^(b)		
R-BF	100	3	242	239	0	26	0.99		1.00 ^(b)		
R-BF	100	4	242	197	0	11	0.81		0.86		
R-BF	100	5	242	233	0	25	0.96	0.95	1.00 ^(b)	0.97	0.06
Comp BHC-A Upper	0	1	242	238	0	8	0.98		1.00 ^(b)		
Comp BHC-A Upper	0	2	242	225	0	9	0.93		0.97		
Comp BHC-A Upper	0	3	242	229	0	13	0.95		1.00		
Comp BHC-A Upper	0	4	242	233	0	3	0.96		0.98		
Comp BHC-A Upper	0	5	242	174	0	5	0.72	0.91	0.74	0.94	0.11
Comp BHC-A Upper	1	1	242	201	0	14	0.83		0.89		
Comp BHC-A Upper	1	2	242	214	0	21	0.88		0.97		
Comp BHC-A Upper	1	3	242	203	0	20	0.84		0.92		
Comp BHC-A Upper	1	4	242	195	0	10	0.81		0.85		
Comp BHC-A Upper	1	5	242	219	0	22	0.90	0.85	1.00	0.92	0.06
Comp BHC-A Upper	10	1	242	234	0	13	0.97		1.00 ^(b)		
Comp BHC-A Upper	10	2	242	223	0	15	0.92		0.98		
Comp BHC-A Upper	10	3	242	234	0	12	0.97		1.00 ^(b)		
Comp BHC-A Upper	10	4	242	215	0	13	0.89		0.94		
Comp BHC-A Upper	10	5	242	226	0	6	0.93	0.94	0.96	0.98	0.03

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
Comp BHC-A Upper	50	1	242	217	0	21	0.90		0.98		
Comp BHC-A Upper	50	2	242	223	0	6	0.92		0.95		
Comp BHC-A Upper	50	3	242	211	0	15	0.87		0.93		
Comp BHC-A Upper	50	4	242	223	0	9	0.92		0.96		
Comp BHC-A Upper	50	5	242	201	0	12	0.83	0.89	0.88	0.94	0.04
Comp BHC-A Upper	100	1	242	218	0	20	0.90		0.98		
Comp BHC-A Upper	100	2	242	215	0	6	0.89		0.91		
Comp BHC-A Upper	100	3	242	206	0	21	0.85 ^(b)		0.94 ^(b)		
Comp BHC-A Upper	100	4	242	244	0	12	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Upper	100	5	242	232	0	10	0.96	0.92	1.00	0.97	0.04
Comp BHC-A Lower	0	1	269	275	0	5	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	0	2	269	270	0	5	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	0	3	269	294	0	5	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	0	4	269	263	0	3	0.98		0.99		
Comp BHC-A Lower	0	5	269	294	0	14	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
Comp BHC-A Lower	1	1	269	313	0	5	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	1	2	269	260	0	8	0.97		1.00		
Comp BHC-A Lower	1	3	269	244	0	1	0.91		0.91		
Comp BHC-A Lower	1	4	269	293	0	11	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	1	5	269	286	0	5	1.00 ^(b)	0.97	1.00 ^(b)	0.98	0.04
Comp BHC-A Lower	10	1	269	327	0	15	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	10	2	269	286	0	7	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	10	3	269	288	0	6	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	10	4	269	286	0	8	1.00 ^(b)		1.00 ^(b)		
Comp BHC-A Lower	10	5	269	302	0	7	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
Comp BHC-A Lower	50	1	269	0	0	282	0.00		1.00 ^(b)		
Comp BHC-A Lower	50	2	269	2	0	226	0.01		0.85		
Comp BHC-A Lower	50	3	269	0	0	231	0.00		0.86		
Comp BHC-A Lower	50	4	269	0	0	216	0.00		0.80		
Comp BHC-A Lower	50	5	269	0	0	262	0.00	0.00	0.97	0.90	0.09
Comp BHC-A Lower	100	1	269	0	0	276	0.00		1.00 ^(b)		
Comp BHC-A Lower	100	2	269	0	0	248	0.00		0.92		
Comp BHC-A Lower	100	3	269	3	0	280	0.01		1.00 ^(b)		
Comp BHC-A Lower	100	4	269	0	0	239	0.00		0.89		
Comp BHC-A Lower	100	5	269	0	0	245	0.00	0.00	0.91	0.94	0.05

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
Comp BHC-B	0	1	269	332	0	10	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	0	2	269	334	0	6	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	0	3	269	337	0	3	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	0	4	269	289	0	0	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	0	5	269	279	0	9	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
Comp BHC-B	1	1	269	289	0	5	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	1	2	269	291	0	5	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	1	3	269	318	0	3	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	1	4	269	313	0	6	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	1	5	269	313	0	5	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
Comp BHC-B	10	1	269	332	0	6	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	10	2	269	306	0	9	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	10	3	269	320	0	9	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	10	4	269	331	0	2	1.00 ^(b)		1.00 ^(b)		
Comp BHC-B	10	5	269	378	0	10	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
Comp BHC-B	50	1	269	0	0	283	0.00		1.00 ^(b)		
Comp BHC-B	50	2	269	0	0	313	0.00		1.00 ^(b)		
Comp BHC-B	50	3	269	0	0	335	0.00		1.00 ^(b)		
Comp BHC-B	50	4	269	0	0	277	0.00		1.00 ^(b)		
Comp BHC-B	50	5	269	0	3	281	0.00	0.00	1.00 ^(b)	1.00	0.00
Comp BHC-B	100	1	269	0	1	243	0.00		0.91		
Comp BHC-B	100	2	269	0	0	118	0.00		0.44		
Comp BHC-B	100	3	269	0	0	84	0.00		0.31		
Comp BHC-B	100	4	269	0	0	136	0.00		0.51		
Comp BHC-B	100	5	269	0	0	318	0.00	0.00	1.00 ^(b)	0.63	0.30
Comp TB-C	0	1	158	145	0	2	0.92		0.93		
Comp TB-C	0	2	158	153	0	5	0.97		1.00		
Comp TB-C	0	3	158	158	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	0	4	158	181	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	0	5	158	144	0	5	0.91	0.96	0.94	0.97	0.03
Comp TB-C	1	1	158	145	0	3	0.92		0.94		
Comp TB-C	1	2	158	131	0	2	0.83		0.84		
Comp TB-C	1	3	158	140	0	4	0.89		0.91		
Comp TB-C	1	4	158	163	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	1	5	158	161	0	1	1.00 ^(b)	0.93	1.00 ^(b)	0.94	0.07

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
Comp TB-C	10	1	158	136	0	3	0.86		0.88		
Comp TB-C	10	2	158	162	0	0	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	10	3	158	165	0	6	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	10	4	158	166	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	10	5	158	176	0	2	1.00 ^(b)	0.97	1.00 ^(b)	0.98	0.05
Comp TB-C	50	1	158	159	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	50	2	158	151	0	7	0.96		1.00		
Comp TB-C	50	3	158	150	0	2	0.95		0.96		
Comp TB-C	50	4	158	165	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	50	5	158	156	0	2	0.99	0.98	1.00	0.99	0.02
Comp TB-C	100	1	158	183	0	4	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	100	2	158	181	0	8	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	100	3	158	225	0	6	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	100	4	158	213	0	6	1.00 ^(b)		1.00 ^(b)		
Comp TB-C	100	5	158	169	0	0	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
Comp TB-D Upper	0	1	242	228	0	21	0.94		1.00 ^(b)		
Comp TB-D Upper	0	2	242	232	0	4	0.96		0.98		
Comp TB-D Upper	0	3	242	199	0	12	0.82		0.87		
Comp TB-D Upper	0	4	242	235	0	8	0.97		1.00 ^(b)		
Comp TB-D Upper	0	5	242	222	0	4	0.92	0.92	0.93	0.96	0.05
Comp TB-D Upper	1	1	242	254	0	8	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Upper	1	2	242	226	0	18	0.93		1.00 ^(b)		
Comp TB-D Upper	1	3	242	245	0	3	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Upper	1	4	242	241	0	12	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Upper	1	5	242	214	0	10	0.88	0.96	0.93	0.99	0.03
Comp TB-D Upper	10	1	242	201	0	7	0.83		0.86		
Comp TB-D Upper	10	2	242	226	0	17	0.93		1.00 ^(b)		
Comp TB-D Upper	10	3	242	216	0	15	0.89		0.95		
Comp TB-D Upper	10	4	242	220	0	12	0.91		0.96		
Comp TB-D Upper	10	5	242	221	0	13	0.91	0.90	0.97	0.95	0.05
Comp TB-D Upper	50	1	242	16	20	210	0.07		1.00 ^(b)		
Comp TB-D Upper	50	2	242	6	11	235	0.02		1.00 ^(b)		
Comp TB-D Upper	50	3	242	8	13	237	0.03		1.00 ^(b)		
Comp TB-D Upper	50	4	242	1	16	214	0.00		0.95		
Comp TB-D Upper	50	5	242	0	16	203	0.00	0.03	0.90	0.97	0.04

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
Comp TB-D Upper	100	1	242	0	0	237	0.00		0.98		
Comp TB-D Upper	100	2	242	0	3	204	0.00		0.86		
Comp TB-D Upper	100	3	242	0	3	230	0.00		0.96		
Comp TB-D Upper	100	4	242	0	0	259	0.00		1.00 ^(b)		
Comp TB-D Upper	100	5	242	2	9	239	0.01	0.00	1.00 ^(b)	0.96	0.06
Comp TB-D Lower	0	1	158	172	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Lower	0	2	158	174	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Lower	0	3	158	151	0	1	0.96		0.96		
Comp TB-D Lower	0	4	158	146	0	1	0.92		0.93		
Comp TB-D Lower	0	5	158	154	0	1	0.97	0.97	0.98	0.97	0.03
Comp TB-D Lower	1	1	158	348	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Lower	1	2	158	148	0	0	0.94		0.94		
Comp TB-D Lower	1	3	158	176	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Lower	1	4	158	148	0	3	0.94		0.96		
Comp TB-D Lower	1	5	158	155	0	1	0.98	0.97	0.99	0.98	0.03
Comp TB-D Lower	10	1	158	149	0	7	0.94		0.99		
Comp TB-D Lower	10	2	158	120	0	2	0.76		0.77		
Comp TB-D Lower	10	3	158	336	0	4	1.00 ^(b)		1.00 ^(b)		
Comp TB-D Lower	10	4	158	141	0	3	0.89		0.91		
Comp TB-D Lower	10	5	158	155	0	3	0.98	0.92	1.00	0.93	0.10
Comp TB-D Lower	50	1	158	0	0	155	0.00		0.98		
Comp TB-D Lower	50	2	158	0	0	161	0.00		1.00 ^(b)		
Comp TB-D Lower	50	3	158	0	0	141	0.00		0.89		
Comp TB-D Lower	50	4	158	0	0	150	0.00		0.95		
Comp TB-D Lower	50	5	158	0	0	136	0.00	0.00	0.86	0.94	0.06
Comp TB-D Lower	100	1	158	0	0	162	0.00		1.00 ^(b)		
Comp TB-D Lower	100	2	158	0	0	218	0.00		1.00 ^(b)		
Comp TB-D Lower	100	3	158	0	0	107	0.00		0.68		
Comp TB-D Lower	100	4	158	0	0	122	0.00		0.77		
Comp TB-D Lower	100	5	158	0	0	132	0.00	0.00	0.84	0.86	0.14

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
Comp TB-E Upper	0	1	158	154	0	3	0.97		0.99		
Comp TB-E Upper	0	2	158	145	0	3	0.92		0.94		
Comp TB-E Upper	0	3	158	155	0	1	0.98		0.99		
Comp TB-E Upper	0	4	158	159	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	0	5	158	163	0	1	1.00 ^(b)	0.97	1.00 ^(b)	0.98	0.03
Comp TB-E Upper	1	1	158	177	0	3	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	1	2	158	154	0	2	0.97		0.99		
Comp TB-E Upper	1	3	158	160	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	1	4	158	188	0	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	1	5	158	146	0	1	0.92	0.98	0.93	0.98	0.03
Comp TB-E Upper	10	1	158	162	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	10	2	158	152	0	7	0.96		1.00 ^(b)		
Comp TB-E Upper	10	3	158	180	0	3	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	10	4	158	181	1	1	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Upper	10	5	158	164	0	5	1.00 ^(b)	0.99	1.00 ^(b)	1.00	0.00
Comp TB-E Upper	50	1	158	62	0	54	0.39		0.73		
Comp TB-E Upper	50	2	158	75	9	76	0.47		1.00 ^(b)		
Comp TB-E Upper	50	3	158	108	7	40	0.68		0.98		
Comp TB-E Upper	50	4	158	74	5	61	0.47		0.89		
Comp TB-E Upper	50	5	158	76	6	67	0.48	0.50	0.94	0.91	0.11
Comp TB-E Upper	100	1	158	0	0	132	0.00		0.84		
Comp TB-E Upper	100	2	158	0	0	270	0.00		1.00 ^(b)		
Comp TB-E Upper	100	3	158	0	1	237	0.00		1.00 ^(b)		
Comp TB-E Upper	100	4	158	0	0	87	0.00		0.55		
Comp TB-E Upper	100	5	158	0	0	45	0.00	0.00	0.28 ^(c)	0.85	0.21
Comp TB-E Lower	0	1	158	179	0	4	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Lower	0	2	158	148	0	2	0.94		0.95		
Comp TB-E Lower	0	3	158	153	0	2	0.97		0.98		
Comp TB-E Lower	0	4	158	161	0	4	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Lower	0	5	158	207	0	6	1.00 ^(b)	0.98	1.00 ^(b)	0.99	0.02
Comp TB-E Lower	1	1	158	153	0	2	0.97		0.98		
Comp TB-E Lower	1	2	158	228	0	4	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Lower	1	3	158	167	0	5	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Lower	1	4	158	143	1	4	0.91		0.94		
Comp TB-E Lower	1	5	158	166	0	2	1.00 ^(b)	0.97	1.00 ^(b)	0.98	0.03

TABLE E.1. (contd)

Sediment Treatment	Concentration (Percent SPP)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation ^(a)
Comp TB-E Lower	10	1	158	82	10	50	0.52 ^(b)		0.90		
Comp TB-E Lower	10	2	158	184	0	0	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Lower	10	3	158	216	0	2	1.00 ^(b)		1.00 ^(b)		
Comp TB-E Lower	10	4	158	145	0	4	0.92 ^(b)		0.94		
Comp TB-E Lower	10	5	158	158	0	1	1.00 ^(b)	0.89	1.00 ^(b)	0.97	0.05
Comp TB-E Lower	50	1	158	0	0	126	0.00		0.80		
Comp TB-E Lower	50	2	158	0	0	141	0.00		0.89		
Comp TB-E Lower	50	3	158	0	6	190	0.00		1.00 ^(b)		
Comp TB-E Lower	50	4	158	0	35	160	0.00		1.00 ^(b)		
Comp TB-E Lower	50	5	158	0	5	138	0.00	0.00	0.91	0.92	0.08
Comp TB-E Lower	100	1	158	0	1	50	0.00		0.32		
Comp TB-E Lower	100	2	158	0	0	59	0.00		0.37		
Comp TB-E Lower	100	3	158	0	0	65	0.00		0.41		
Comp TB-E Lower	100	4	158	0	11	64	0.00		0.47		
Comp TB-E Lower	100	5	158	0	0	39	0.00	0.00	0.25	0.37	0.09

(a) Standard deviation of proportion surviving.

(b) When number normal or number surviving exceeded the stocking density, a proportion normal and/or proportion survival of 1.00 was used for mean calculations.

(c) Not included in mean calculation.

TABLE E.2. Water Quality Summary for the 48-Hour Larval *M. galloprovincialis* Suspended-Particulate-Phase Test

Concentration (Percent SPP)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	14.0	18.0	7.30	8.30	4.0	NA ^(a)	28.0	32.0
<u>R-AM</u>								
0	15.4	15.9	7.79	8.10	7.6	8.5	31.5	32.0
1	15.4	15.6	7.91	8.23	7.9	8.6	31.5	32.0
10	15.4	15.5	7.89	8.24	7.9	8.6	31.5	32.0
50	15.4	15.6	7.84	8.23	7.8	8.6	31.5	32.0
100	15.5	15.5	7.77	8.25	7.8	8.6	31.0	32.0
<u>R-BF</u>								
0	15.4	15.6	7.52	8.11	8.1	8.7	31.5	32.0
1	15.4	15.6	7.58	8.08	8.1	8.8	31.5	31.5
10	15.4	15.5	7.61	8.11	8.0	8.7	31.0	32.0
50	15.4	15.5	7.55	8.10	7.0	8.6	31.0	32.0
100	15.4	15.5	7.48	8.11	5.0	8.6	30.5	32.0
<u>Comp BHC-A Upper</u>								
0	15.3	15.5	7.72	8.09	7.9	8.6	31.5	32.0
1	15.4	15.5	7.75	8.10	8.0	8.6	31.5	32.0
10	15.4	15.5	7.74	8.11	8.1	8.6	31.0	32.0
50	15.4	15.5	7.63	8.11	8.1	8.5	31.0	31.5
100	15.4	15.6	7.48	8.10	8.1	8.3	30.0	31.0
<u>Comp BHC-A Lower</u>								
0	15.4	15.5	7.82	8.08	7.8	8.6	31.5	32.0
1	15.4	15.6	7.86	8.14	7.9	8.6	31.0	32.0
10	15.4	15.6	7.86	8.10	7.8	8.4	30.5	32.0
50	15.4	15.7	7.73	8.13	7.4	8.6	30.0	30.5
100	15.4	15.7	7.59	8.15	6.3	8.4	29.5	30.0
<u>Comp BHC-B</u>								
0	15.4	15.6	7.88	8.04	7.7	8.4	31.5	32.0
1	15.4	15.6	7.89	8.11	7.8	8.4	31.5	32.0
10	15.4	15.6	7.89	8.14	7.8	8.4	31.0	32.0
50	15.4	15.5	7.87	8.21	7.7	8.5	30.5	31.5
100	15.4	15.5	7.84	8.29	6.6	8.4	30.0	31.5
<u>Comp TB-C</u>								
0	15.5	15.7	7.58	8.03	7.2	8.2	32.0	32.0
1	15.4	15.6	7.77	8.04	7.2	8.2	32.0	32.0
10	15.4	15.6	7.74	8.09	7.2	8.2	31.5	32.0
50	15.5	15.6	7.73	8.03	7.1	8.2	31.0	32.0
100	15.5	15.6	7.68	8.03	7.2	8.2	30.0	31.5

TABLE E.2. (contd)

Concentration (Percent SPP)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
<u>Comp TB-D Upper</u>								
0	15.4	15.6	7.67	8.05	7.7	8.5	31.5	32.0
1	15.4	15.5	7.64	8.07	8.0	8.5	31.5	32.0
10	15.4	15.5	7.70	8.07	7.9	8.4	31.0	32.0
50	15.4	15.5	7.71	8.03	7.9	8.3	30.5	31.0
100	15.4	15.5	7.64	8.26	7.7	8.2	29.5	30.0
<u>Comp TB-D Lower</u>								
0	15.5	15.6	7.70	8.09	7.4	8.2	31.5	32.0
1	15.5	15.6	7.70	8.09	7.3	8.2	31.5	32.0
10	15.5	15.6	7.72	8.04	7.3	8.1	31.5	32.0
50	15.4	15.7	7.77	8.13	7.2	8.1	31.0	32.0
100	15.4	15.6	7.84	8.13	7.2	8.0	30.0	31.5
<u>Comp TB-E Upper</u>								
0	15.4	15.6	7.70	8.07	7.2	8.2	31.5	32.0
1	15.5	15.6	7.87	8.08	7.2	8.0	31.5	32.0
10	15.4	15.6	7.87	8.09	7.2	8.0	31.5	32.0
50	15.5	15.6	7.84	8.06	7.2	8.1	31.5	32.0
100	15.5	15.6	7.84	8.09	7.2	8.0	31.0	32.0
<u>Comp TB-E Lower</u>								
0	15.4	15.6	7.65	8.09	7.2	8.2	31.0	32.0
1	15.4	15.5	7.71	8.09	7.4	8.2	31.0	32.0
10	15.4	15.6	7.37	8.04	7.3	8.2	30.5	32.0
50	15.4	15.7	7.57	8.11	7.0	8.2	30.0	31.5
100	15.4	15.7	7.52	8.20	6.2	8.1	30.0	30.5

(a) NA Not applicable.

TABLE E.3. Test Results for All Replicates in the 48-Hour Larval *M. galloprovincialis* Reference Toxicant Test

Copper Concentration ($\mu\text{g/L}$)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
Test 1: Batch of embryos used for SPP Tests of Comps TB-E Lower, TB-D Lower, TB-C, and TB-E Upper										
0	1	158	182	0	2	1.00 ^(b)		1.00 ^(b)		
0	2	158	161	0	1	1.00 ^(b)		1.00 ^(b)		
0	3	158	134	0	6	0.85	0.95	0.89	0.96	0.07
1	1	158	143	0	3	0.91		0.92		
1	2	158	187	0	2	1.00 ^(b)		1.00 ^(b)		
1	3	158	132	0	2	0.84	0.91	0.85	0.92	0.08
4	1	158	106	0	5	0.67		0.70		
4	2	158	136	0	2	0.86		0.87		
4	3	158	135	2	3	0.85	0.80	0.89	0.82	0.10
16	1	158	0	0	4	0.00		0.03		
16	2	158	0	0	49	0.00		0.31		
16	3	158	0	0	87	0.00	0.00	0.55	0.30	0.26
64	1	158	0	0	0	0.00		0.00		
64	2	158	0	0	0	0.00		0.00		
64	3	158	0	0	0	0.00	0.00	0.00	0.00	0.00
Test 2: Batch of embryos used for SPP Tests of R-AM, Comp BHC-A Lower, and Comp BHC-B										
0	1	269	293	0	4	1.00 ^(b)		1.00 ^(b)		
0	2	269	271	0	5	1.00 ^(b)		1.00 ^(b)		
0	3	269	300	0	6	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
1	1	269	308	0	8	1.00 ^(b)		1.00 ^(b)		
1	2	269	327	0	7	1.00 ^(b)		1.00 ^(b)		
1	3	269	318	1	4	1.00 ^(b)	1.00	1.00 ^(b)	1.00	0.00
4	1	269	321	23	5	1.00 ^(b)		1.00 ^(b)		
4	2	269	257	14	14	0.96		1.00 ^(b)		
4	3	269	292	28	15	1.00 ^(b)	0.99	1.00 ^(b)	1.00	0.00
16	1	269	1	0	104	0.00		0.39		
16	2	269	0	0	87	0.00		0.32		
16	3	269	2	0	146	0.01	0.00	0.55	0.42	0.12

TABLE E.3. (contd)

Copper Concentration ($\mu\text{g/L}$)	Replicate	Stocking Density (per 10 mL)	Normal Larvae	Abnormal	Other Stages	Proportion Normal	Mean Proportion Normal	Proportion Survival	Mean Proportion Survival	Standard Deviation (a)
64	1	269	0	0	30	0.00		0.11		
64	2	269	0	0	0	0.00		0.00		
64	3	269	0	0	9	0.00	0.00	0.03	0.05	0.06
Test 3: Batch of embryos used for SPP Tests of R-BF, Comp BHC-A Upper, and Comp TB-D Upper										
0	1	242	183	0	1	0.76		0.76		
0	2	242	184	0	12	0.76		0.81		
0	3	242	203	0	10	0.84	0.79	0.88	0.82	0.06
1	1	242	199	0	9	0.82		0.86		
1	2	242	184	0	16	0.76		0.83		
1	3	242	187	0	9	0.77	0.79	0.81	0.83	0.03
4	1	242	202	0	12	0.83		0.88		
4	2	242	211	0	11	0.87		0.92		
4	3	242	216	0	4	0.89	0.87	0.91	0.90	0.02
16	1	242	0	0	22	0.00		0.09		
16	2	242	0	2	55	0.00		0.24		
16	3	242	0	0	72	0.00	0.00	0.30	0.21	0.11
64	1	242	0	0	0	0.00		0.00		
64	2	242	0	0	0	0.00		0.00		
64	3	242	0	0	0	0.00	0.00	0.00	0.00	0.00

(a) Standard deviation of proportion surviving.

(b) When number normal or number surviving exceeded the stocking density, a proportion normal and/or proportion survival of 1.00 was used for mean calculations.

TABLE E.4. Water Quality Summary for the 48-Hour Larval *M. galloprovincialis* Reference Toxicant Test

Copper Concentration (µg/L)	Temperature (°C)		pH		Dissolved Oxygen (mg/L)		Salinity (o/oo)	
	Min	Max	Min	Max	Min	Max	Min	Max
Acceptable Range	14.0	18.0	7.30	8.30	4.0	NA ^(a)	28.0	32.0
Test 1								
0	15.3	15.6	7.78	8.07	7.2	8.2	31.5	32.0
2.9	15.3	15.6	7.78	8.04	7.1	8.0	31.5	32.0
9.0	15.3	15.6	7.75	8.06	7.1	8.1	31.5	32.0
30	15.3	15.6	7.72	8.07	7.1	8.1	31.0	32.0
100	15.3	15.6	7.74	8.07	7.1	8.0	31.5	32.0
Test 2								
0	15.4	15.6	7.73	8.01	7.7	8.1	31.0	32.0
2.9	15.5	15.6	7.77	8.05	7.7	8.2	30.5	32.0
9.0	15.5	15.6	7.79	8.02	7.7	8.2	30.5	32.0
30	15.4	15.6	7.80	8.00	7.8	8.3	31.5	32.0
100	15.4	15.6	7.78	8.03	7.8	8.2	31.0	32.0
Test 3								
0	15.4	15.6	7.67	8.08	7.8	8.2	31.5	32.0
2.9	15.3	15.6	7.61	8.08	7.9	8.1	31.5	32.0
9.0	15.3	15.7	7.66	7.98	7.9	8.1	31.5	32.0
30	15.3	15.7	7.70	8.11	7.9	8.1	31.5	32.0
100	15.4	15.6	7.70	8.04	7.9	8.1	31.5	32.0
(a) NA Not applicable.								

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