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Ecological Evaluation of Oakland Harbor Phase III -38-Foot Composites Relative to the Alcatraz Island Environs (R-AM)

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Battelle/Marine Sciences Laboratory
Sequim, Washington

January 1992

Prepared for the
U.S. Army Corps of Engineers San Francisco District
under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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SUMMARY

The Water Resources Development Act of 1986 (Public Law 99-662) authorized the U.S. Army Corps of Engineers (USACE) San Francisco District, to deepen and widen the navigational channels of the Oakland Inner Harbors to accommodate deeper-draft vessels. Battelle/Marine Sciences Laboratory (MSL) conducted a study for USACE to determine whether potential dredged sediments in Oakland Inner Harbor were suitable for open-water disposal, following the guidelines of the *Draft Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters*, otherwise known as the Implementation Manual (EPA/USACE 1990). This report summarizes the collection, chemical analysis, toxicity testing, and bioaccumulation analysis of sediments collected to -38 ft relative to mean lower low water from Oakland Inner Harbor. Six dredged material composite samples (COMPs) were compared to reference sediment from the area surrounding Alcatraz Island and its dredged material disposal site, designated the Alcatraz Island Environs (R-AM). Examination of the results of toxicity tests and bioaccumulation analysis will assist USACE in determining the effects of in-bay disposal of the Oakland Inner Harbor dredged material on the Alcatraz Island Environs.

Sediment core samples were collected from 29 sites representing potential dredging areas in Oakland Inner Harbor. The samples were allocated to six composite treatments for biological testing (COMPs I to VI). Individual sediment samples from each site were retained for physical and chemical analysis only. Reference and control sediments were also collected to provide a basis for comparison in the testing program. Test treatments (potential dredged material), the reference treatment R-AM, and control treatments were tested for physical and chemical parameters, water column effects, acute toxicity, and bioaccumulation potential. Physical and chemical analyses of sediment consisted of grain size, total volatile solids (TVS), total organic carbon (TOC), oil and grease, total petroleum hydrocarbons (TPH), metals, polynuclear aromatic hydrocarbons (PAHs), chlorinated pesticides, polychlorinated biphenyls (PCBs), and butyltin compounds. These physical and chemical data were used in support of the toxicological and bioaccumulation testing.

To evaluate water column effects, suspended-particulate-phase (SPP) tests were conducted, using the mysid shrimp *Holmesimysis sculpta*, the speckled sanddab *Citharichthys stigmaeus*, and larvae of the Pacific oyster *Crassostrea gigas*. To evaluate acute toxicity, solid-

phase tests were conducted using the bent-nose clam *Macoma nasuta*, the polychaete *Nephtys caecoides*, the speckled sanddab *Citharichthys stigmaeus*, and the amphipod *Rhepoxynius abronius*. Bioaccumulation potential was evaluated by exposing *M. nasuta* and *N. caecoides* to solid-phase treatments for 28 days and then measuring the contaminants of concern present in their tissues. These SPP and solid-phase tests were conducted on the six Inner Harbor composites and the reference (R-AM). Solid-phase tests also included control sediment treatments.

Contaminants of concern were found at elevated levels in the composite sediment treatments and their contributing samples, relative to the reference sediment R-AM. There was evidence that COMP V was acutely toxic to *R. abronius*, and that COMP VI was acutely toxic to *N. caecoides*, relative to R-AM. No acute toxicity was observed in any of the SPP tests, indicating that water column effects are not expected as a result of dredged material disposal.

The potential for bioaccumulation of contaminants associated with dredged material by sensitive marine organisms was measured by exposing two species, *M. nasuta* and *N. caecoides*, to composite and reference sediment treatments for 28 days. Contaminant levels in the tissues of organisms that had been exposed to the composite sediment treatments were statistically compared to contaminant levels in tissues of organisms exposed to R-AM. Comparisons were made on both a wet weight and dry weight basis for all parameters except metals, which were compared on a dry weight basis only. In general, tissues of *M. nasuta* showed more incidents of significantly elevated contaminant levels than *N. caecoides*. High molecular weight PAHs were elevated in tissues of both *M. nasuta* and *N. caecoides* that had been exposed to COMP III, COMP IV, COMP V, and COMP VI. In general, *M. nasuta* and *N. caecoides* exposed to COMP I and COMP II showed the fewest incidents of elevated contaminant levels, while COMP V and COMP VI showed the most incidents of elevated tissue contaminant levels.

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1.0 INTRODUCTION

Oakland Harbor is located on the eastern shoreline of central San Francisco Bay in Alameda County, between the cities of Oakland and Alameda, California (Figure 1.1). Oakland Harbor and its access channels are no longer wide or deep enough to accommodate modern, deeper-draft vessels. The Water Resources Development Act of 1986 (Public Law 99-662) authorized the U. S. Army Corps of Engineers (USACE), San Francisco District, to deepen and widen the navigation channels in Oakland Harbor. Several options for disposal of the material from this dredging project are under consideration by USACE. Those options include disposal within San Francisco Bay, at open-ocean sites, or at uplands disposal sites.

Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), Public Law 92-532, specifies that all proposed disposal of dredged material into open water be evaluated to determine the potential environmental impacts of those activities. To comply with those requirements, the potential harmful effects of the dredged material must be evaluated by chemical characterization, toxicity testing, and bioaccumulation testing prior to dredging and disposal.

Between March 1988 and February 1990, Battelle/Marine Sciences Laboratory (MSL)[a], operating under contract to USACE, completed three studies to evaluate the acceptability of Oakland Harbor sediments for the open-ocean disposal option: Oakland Harbor 38-Foot, 42-Foot Phase I, and 42-Foot Phase II Projects (Word et al. 1988; 1990a,b). These studies included sediment chemistry analysis, solid- and suspended-particulate-phase (SPP) sediment toxicity tests, and 10-day bioaccumulation measurements. The Oakland Harbor 38-Foot, 42-Foot Phase I, and 42-Foot Phase II evaluations, which were conducted from 1988 to 1990, were under the guidance of the 1977 *Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters; Implementation Manual of Section 103 of Public Law 92-532* (1977 Implementation Manual) (EPA/USACE 1977). Since the above tests were completed, the Implementation Manual was revised by the Environmental Protection Agency (EPA) and the USACE, and released initially as the *Draft Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters* (EPA/USACE 1990). Subsequent revisions have resulted in the final version of the *Evaluation of Dredged*

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

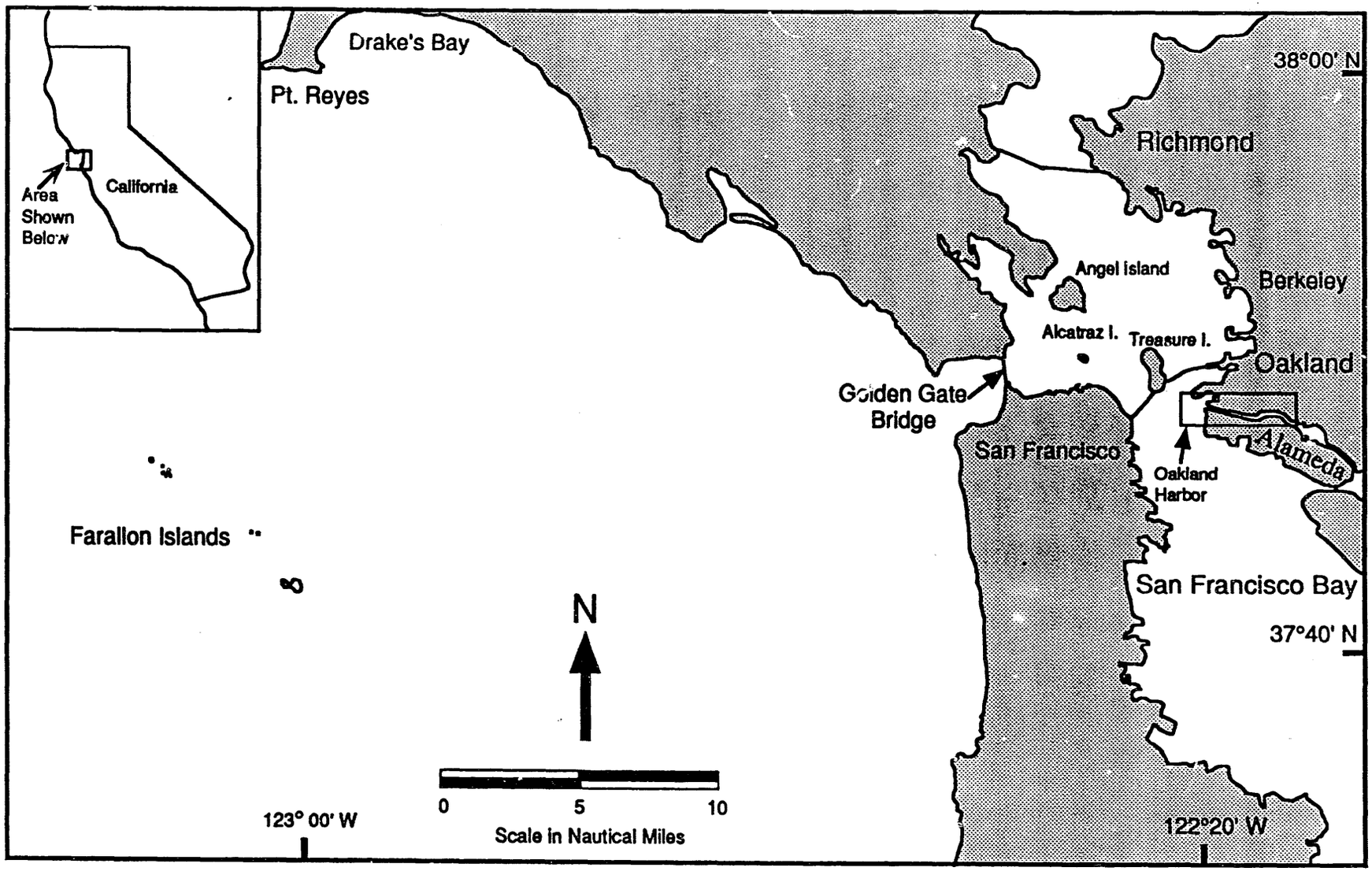


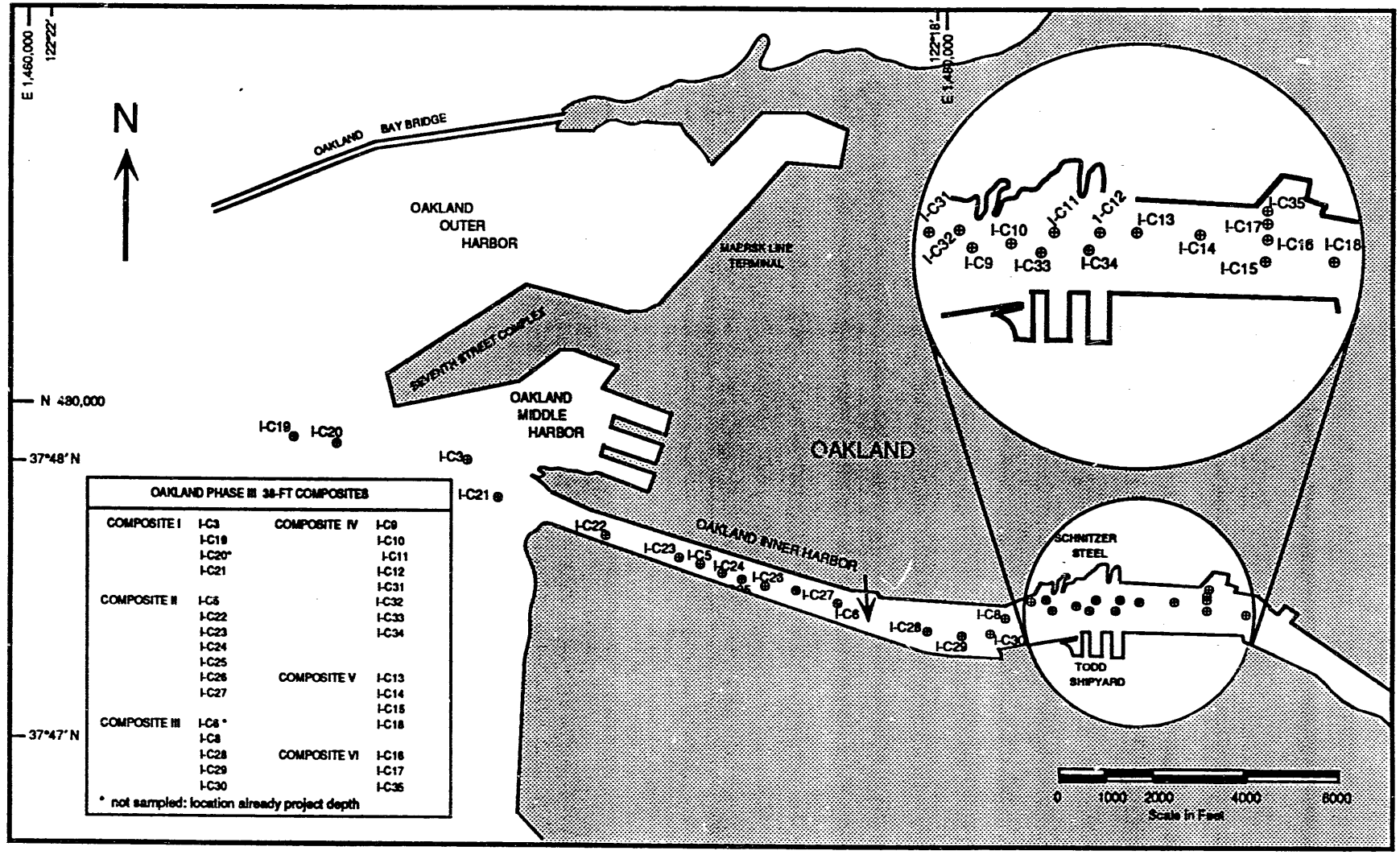
FIGURE 1.1. Oakland Harbor Phase III -38 ft Study Area

Material Porposed for Ocean Disposal Testing Manual (EPA/USACE 1991). The revised version is hereinafter referred to as the 1991 Implementation Manual.

In 1990, USACE requested that MSL resample sites included in the earlier Oakland Harbor 38-Foot, Phase I, and Phase II studies, as well as some additional sites, and evaluate the sediments following the 1990 Draft Implementation Manual for ocean disposal testing. This request developed into the Oakland Harbor Phase III Program. Because of the number of sites and associated evaluations, Phase III was divided into three projects. The Oakland Harbor Phase III A Project, conducted in June 1990, covered the proposed deepening of Oakland Inner Harbor from -38 ft to -42 ft mean lower low water (MLLW). The Oakland Harbor Phase III B Project, conducted in November 1990, covered the proposed deepening of Oakland Outer Harbor from its existing depth to -42 ft MLLW. The Oakland Harbor Phase III 38-Foot Project, conducted in September 1990, covered the proposed deepening of Oakland Inner Harbor from its existing depth to -38 ft MLLW. The Oakland Harbor Phase III A and Phase III B sediment evaluations are presented in separate documents.

The study area for the Phase III 38-Foot Project included 29 of the 32 proposed sites in Oakland Inner Harbor (Figure 1.2). The project consisted of collecting sediment from mudline to -39 ft MLLW (-38 ft plus 1 ft overdepth) to represent the dredged material. Selected samples were combined into six composites (COMPs) and subjected to chemical measurement and biological toxicity tests. Sediment chemistry was conducted on individual samples as well as on the composite samples. Tests were conducted for the 38-Foot Project followed the guidance in the 1990 Draft Implementation Manual. In addition to dredged material samples, reference and control sediment samples were collected and tested following the sample procedures. The reference sediment allows the biological responses and contaminant levels of a proposed dredged sediment sample to be compared to those of a potential disposal area that is "...substantially free of contaminants and which...reflects conditions that would exist in the vicinity of the disposal site had no dredged-material disposal ever occurred...". The control sediments allow validation of test results through evaluation of the health and normal response of the test organisms.

The purpose of these analyses was to provide information required to address potential ecological effects resulting from in-bay disposal of the dredged material for Oakland Harbor at the Alcatraz Island Environs reference area (R-AM). Accordingly, results of the six composite samples were statistically compared only to the reference sediment R-AM



OAKLAND PHASE III 38-FT COMPOSITES			
COMPOSITE I	I-C3	COMPOSITE IV	I-C9
	I-C19		I-C10
	I-C20*		I-C11
	I-C21		I-C12
			I-C31
COMPOSITE II	I-C5		I-C32
	I-C22		I-C33
	I-C23		I-C34
	I-C24		
	I-C25		
	I-C26	COMPOSITE V	I-C13
	I-C27		I-C14
			I-C15
COMPOSITE III	I-C6 *		I-C18
	I-C8		
	I-C28	COMPOSITE VI	I-C16
	I-C29		I-C17
	I-C30		I-C35

* not sampled: location already project depth

FIGURE 1.2. Oakland Harbor Phase III -38 ft Sampling Stations

collected from the Alcatraz Island Environs reference area. These comparisons were made according to the 1991 Implementation Manual.

Chemical analyses included measurements of EPA priority pollutant metals, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and chlorinated pesticides as well as butyltins and conventional sediment parameters. Biological toxicity tests included controlled laboratory exposures of sensitive marine organisms to the solid phase and SPP of the dredged material. Four species were exposed to the solid phase (the polychaete *Nephtys caecoides*, bentnose clam *Macoma nasuta*, amphipod *Rhepoxynius abronius*, and juvenile sanddab *Citharichthys stigmaeus*) and three species were exposed to the SPP (the mysid *Holmesimysis sculpta*, juvenile sanddab *Citharichthys stigmaeus*, and larvae of the Pacific oyster *Crasostea gigas*). Bioaccumulation potential was determined through a 28-day exposure of *M. nasuta* and *N. caecoides* to the solid phase of the proposed dredged material followed by chemical analyses of the tissues for the above EPA priority pollutants and butyltins. The results of these tests provide information required to address potential ecological effects resulting from in-bay disposal of the dredged material for Oakland Harbor at the Alcatraz Island Environs reference area.

2.0 MATERIALS AND METHODS

2.1 SEDIMENT AND TEST ORGANISM COLLECTION

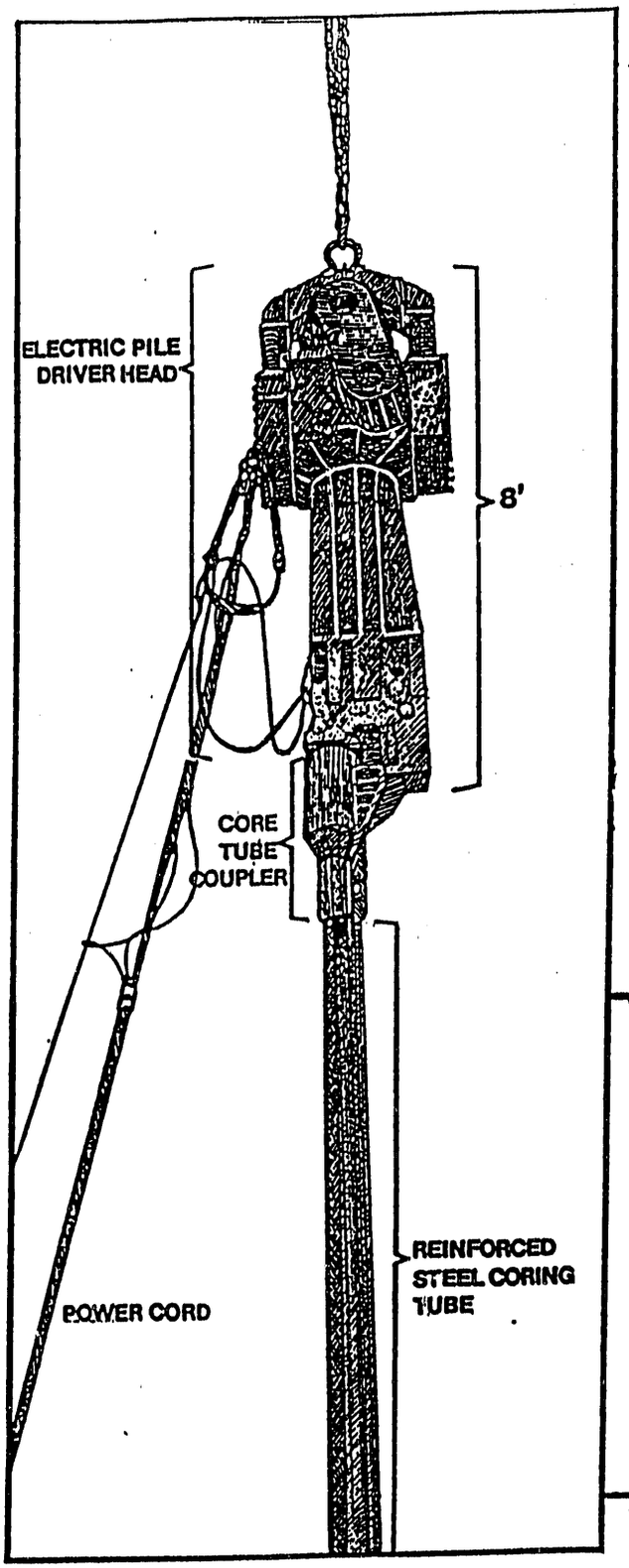
Sediment core samples were collected for the Oakland Phase III 38-Foot Project to -39 ft MLLW (38 ft plus 1 ft overdepth) from 29 stations in Oakland Harbor. Sediment from six reference areas was collected using a pipe dredge sampler and sediment from four control stations was collected using either an MSL-designed sand dredge, a modified grab sampler, or a shovel and bucket. Specific locations of sediment sampling sites are presented with the sampling results in Section 3.1. The core samples taken from 29 stations were subjected to geological description, toxicity testing, bioaccumulation evaluations, and sediment chemistry. Reference and control samples were taken for toxicity testing, bioaccumulation evaluations, and sediment chemistry. Specimens of the species of marine organisms were collected during this period for use in solid-phase and SPP toxicity tests.

2.1.1 Oakland Harbor Core Samples

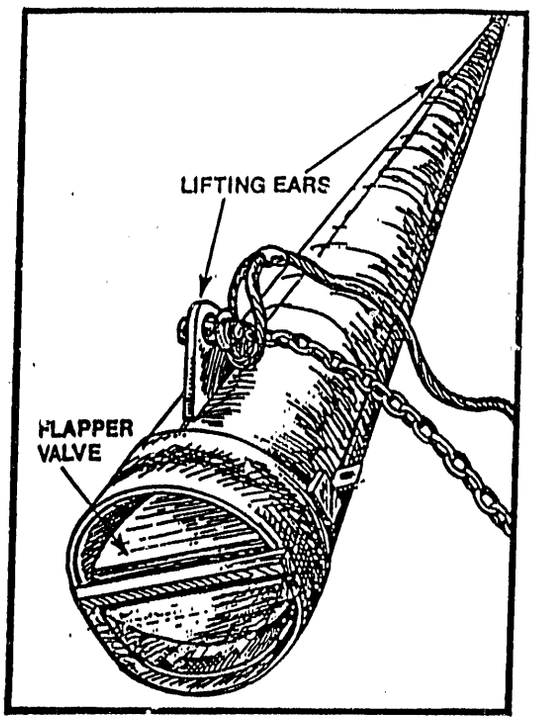
Navigation support necessary for locating stations in Oakland Harbor was provided by Towill, Inc., of Concord, California. The surveyors used a laser/range azimuth positioning system (EDM-Geodimeter AGA-120, Wild T-2 one second theodolite). Towill provided corrected water depths at each station by measuring the actual depth with a recording fathometer (DE719-E), measuring the water surface elevation relative to a known benchmark, and calculating the difference between the water surface elevation and 0 ft MLLW.

All stations were sampled to -39 ft MLLW using a 12-in.-diameter vibratory-hammer split corer and a 4-in.-diameter vibratory-hammer corer. Both samplers were designed and constructed by MSL and Manson Construction (Figure 2.1). The 12-in. corer was used to collect the large volume of sediment needed for biological testing while minimizing contamination caused by excessive sample handling. The 4-in. cores were collected and stored in noncontaminating Lexan polycarbonate tubes to maintain the stratigraphic integrity of the sediment and provide sediment for the chemical characterization from known depths at individual sites. Both coring systems have been used successfully in previous sampling programs in Oakland Harbor.

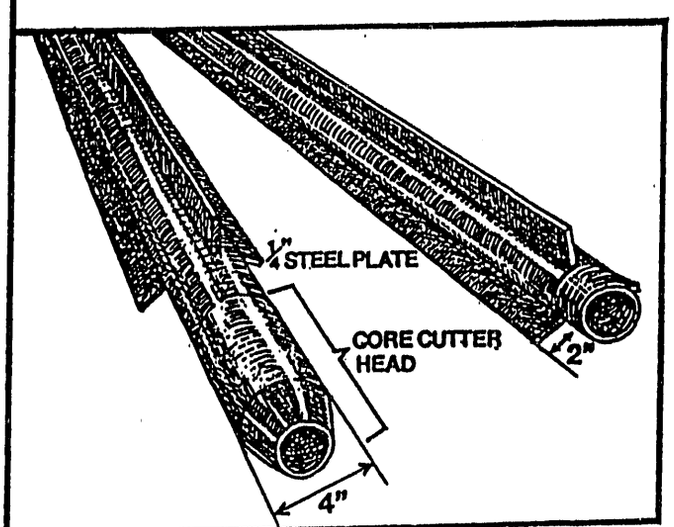
Detailed sampling records contained the station name, date, type of core (12-in. or 4-in.), replicate number, uncorrected water depth, tide height, corrected depth, required core



Vibratory-hammer Core



12-in. Coring Device



4-in. Coring Device

FIGURE 2.1. Components of the 4-in. and 12-in. Vibra ry-hammer Coring Devices

length, sampling time, total core collected, and comments. Sediment samples were stored in a refrigerated van at the staging area until all samples were collected. An inventory of samples was maintained as samples were loaded onto the truck. When sampling was completed, the inventory was confirmed on chain-of-custody forms. The custody forms were signed by the field leader who kept one copy and sealed the others in a water-proof bag attached to samples within the van. The refrigerated truck then transported the samples to MSL in Sequim, Washington, where they were stored at 4°±2°C.

Both the 12-in. and 4-in. core samplers were deployed from the Manson Construction derrick barge *Hagar*. The two sizes of cores were collected in a similar manner, but the sediment samples were handled differently. After the coring apparatus was attached to an electric vibratory hammer, the corer and the hammer were suspended by the crane on the derrick barge. When the coring apparatus was directly above the sampling site, the sampling gear was lowered through the water. When the end of the sampler reached the sediment surface, the vibratory hammer was switched on, unless the sediment was so soft that the corer penetrated because of its weight. Vibrating continued until the sampler penetrated beyond project depth, indicated by the water surface level relative to marks on the outside of the core barrel. Project depth was reached when the water level was at least the uncorrected depth plus the core length required. The coring apparatus was then pulled from the sediment, detached from the vibratory hammer, and lowered onto the barge deck.

Sediment was collected to -39 ft MLLW using the 12-in. vibratory-hammer split corer. One core was collected per site. As each core was brought on board the barge platform, the hinged door of the core barrel was opened and the sediment was measured from the mudline down to ensure that appropriate depth was reached. If the required core length was not collected, the barrel was emptied and another core was taken. If the required core length was collected, the sediment was marked at the appropriate depth and prepared for shipment. The fraction or volume to be contributed from each sample to a composite was determined based on the volume of sediment necessary for laboratory testing. Once the core segments were measured, the appropriate volume of sediment was evenly distributed over the required sample length and using a stainless steel shovel, was transferred from the core barrel to an epoxy-coated container. Each sample container was labeled with the project name, station or composite designation, contributing station(s), vertical segment contributed (i.e., -35 to -38 ft),

and sampling date(s). The containers were sealed and kept cool (~4°C) in a freezer on board the sampling vessel until loaded into a refrigerated van at the end of the sampling day.

Sediment was also collected to -39 ft MLLW using the 4-in. vibratory-hammer core sampler. One core was collected per site. The core barrel was lined with a 3.125-in. (inner diameter) clear Lexan core liner that had been steam cleaned. When each core was brought on board, the liner was pulled from the barrel and the sediment measured from the mudline down to determine if appropriate depth (-38 ft MLLW) was reached. If not, the liner was replaced and another sample taken. If the core was long enough, it was carefully carried to the cutting stand where it was capped, sealed, labeled, and cut into shorter sections, if necessary, to fit in the freezer. Each core label included an arrow pointing to the top of the core, the station designation, core section indicator (i.e., Section 1 of 2 and Section 2 of 2), length interval from the mudline (i.e., 0-3 ft), and sampling date. When each 4-in. core was labeled and sealed, it was kept cool (~4°C) in a freezer on board the sampling vessel until it was transferred to the refrigerated van.

2.1.2 Reference and Control Samples

Sediment samples from the reference site R-AM (Alcatraz Island Disposal Site) (Figure 2.2) were collected with a pipe dredge deployed from the *FV Cobra*, a charter boat owned and operated by Bob Smith Sportfishing. Sampling locations were determined by LORAN C and variable fix and range radar systems aboard the vessel. Reference sampling records were maintained in a log book, and consisted of station position, date, time, replicate, water depth, sediment type, and comments. All reference samples were kept in labeled coolers on board the sampling vessel until they were stored at 4°±2°C in the refrigerated van.

The control sediment sampling sites were Sequim Bay, Washington; West Beach, Whidbey Island, Washington; and Dillon Beach/Tomales Bay, California. Sediment from Sequim Bay, Washington was collected for use as an experimental control with a modified van Veen grab sampler (0.1 m^2) deployed from an MSL research vessel. Control sediment from West Beach (*R. abronius* native control) and Dillon Beach (*N. caecoides* and *C. stigmaeus* native controls) was collected at the same time test organisms were collected. West Beach sediment was collected with an MSL-designed sand-dredge sampler. The dredge was deployed from MSL's 17-ft Boston Whaler in approximately 15 ft of water. The West Beach sampling location was determined by reference to shoreline features. Dillon

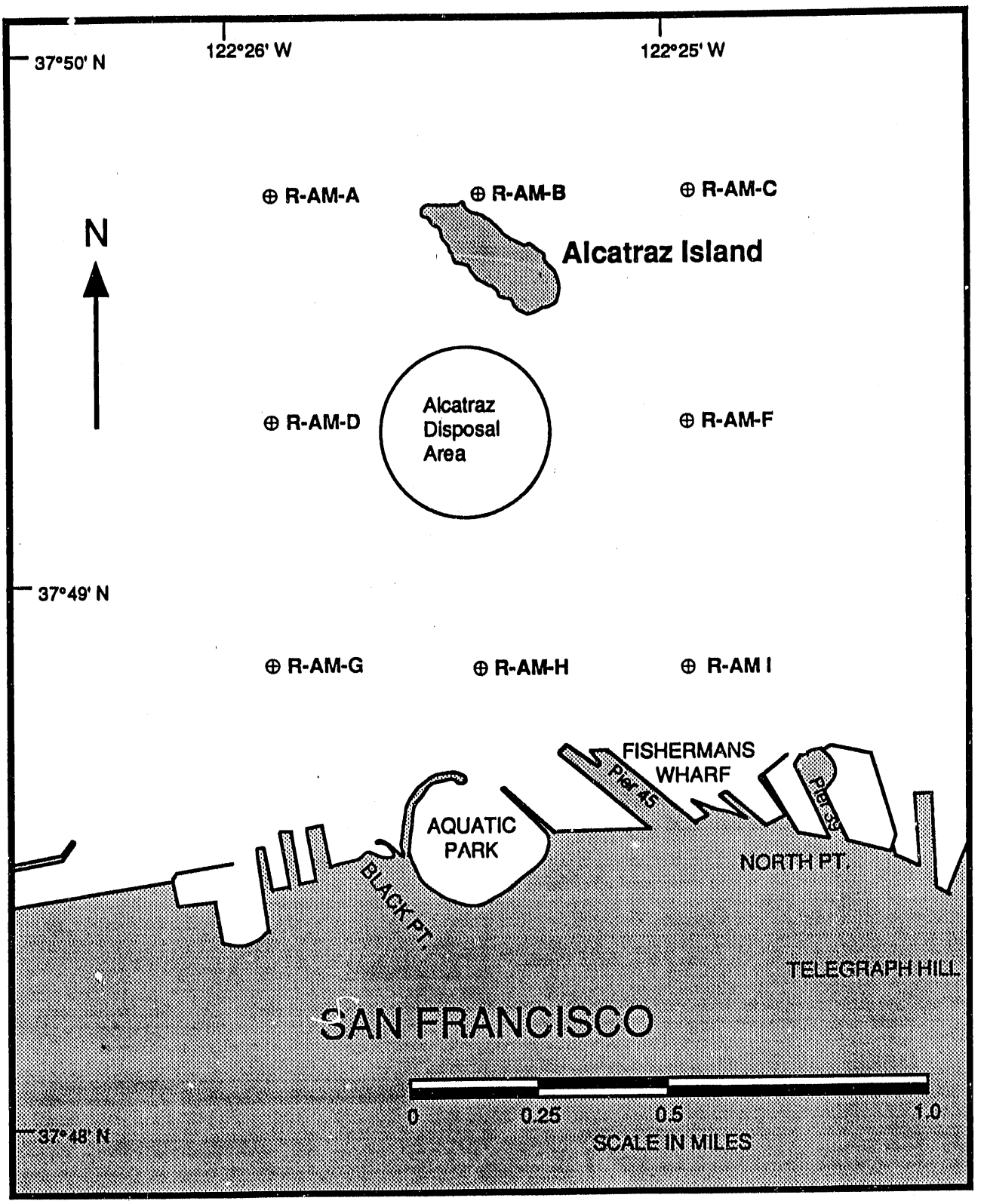


FIGURE 2.2. Reference Sediment Sampling Site Near Alcatraz Island Environs (R-AM)

Beach control sediment was collected by Brezina and Associates, using a shovel, at the same time *N. caecoides* and *C. stigmaeus* were collected. Sampling location was determined by reference to shoreline features. The Dillon Beach sediment was shipped overnight to MSL, where it was stored at 4°±2°C.

2.1.3 Test Organism Collection

Six species of marine organisms were used in Oakland Harbor Phase III 38-Foot Project toxicity tests:

- Bentnose clam *Macoma nasuta*
- Polychaete *Nephtys caecoides*
- Phoxocephalid amphipod *Rhepoxynius abronius*
- Juvenile flatfish (sanddab) *Citharichthys stigmaeus*
- Juvenile mysid shrimp *Holmesimysis sculpta*
- Oyster larvae *Crassostrea gigas*

Most of the organisms were wild-captured and collected either by a commercial supplier or by MSL. The amphipod (*R. abronius*) was collected by MSL off West Beach, Whidbey Island, using the specially designed sand-dredge deployed from MSL's 17-ft Boston Whaler. Sediment brought up with the dredge was sieved through a 2-mm mesh screen to remove large debris and predatory species. Amphipods were kept in coolers partially filled with their native sediment and seawater until they were delivered to a holding tank at MSL that day. *M nasuta* were collected from intertidal zones in Discovery Bay near Gardiner, Washington, by Gunstone and Johnson, a commercial supplier, using a shovel, sieve, and bucket. In the field, clams were kept cool in large tubs containing sediment and seawater taken from the collection site.

Brezina and Associates (Dillon Beach, California) supplied *N. caecoides*, *C. stigmaeus*, and *H. sculpta* organisms for toxicity testing. *N. caecoides* were collected from mud flats in Tomales Bay, California, using a shovel, bucket, and sieve. The worms were placed into clean coolers containing sediment and seawater from the collection site. Before overnight shipment to MSL, the seawater in each cooler was supersaturated with oxygen (22 ppm). The *C. stigmaeus* were collected from Tomales Bay, California, in 12 to 15 ft of water. *C. stigmaeus* were captured with a small trawl with a 0.25-in. mesh net with no cod end. The trawl was held close to the work boat so a dip net could be used to transfer the fish from the otter trawl into double plastic bags containing oxygen-saturated seawater. *H. sculpta* were collected with a plankton dip net in Monterey Bay, California, and transferred to a holding

container aboard the work boat. Brezina and Associates were responsible for sorting *H. sculpta* of the appropriate age and size class and shipping them to MSL in bags containing oxygen-saturated water. Complete test organism holding and care procedures undertaken prior to testing are discussed in Section 2.4.

2.2 SEDIMENT SAMPLE PREPARATION

Sediment sample preparation involves all steps in the laboratory between delivery of the samples to MSL and the preparation of samples for chemical and/or biological testing. Sample preparation was completed within the 14-day holding limit between the sampling date and toxicity test initiation. The following sections describe equipment preparation, geological descriptions of core samples, homogenizing sediment samples, and SPP sample preparation.

2.2.1 Laboratory Glassware and Equipment Preparation

All glassware, stainless steel utensils, plastic, and other laboratory containers and equipment undergo stringent cleaning procedures to avoid potential contamination of samples. Glassware, including test containers, aquaria, and sediment transfer dishes were washed with warm, soapy water, rinsed five times with deionized water, then soaked in a 5% reagent-grade nitric acid bath for a minimum of 4 h. After acid soaking, glassware was rinsed with deionized water five times and allowed to dry. Titanium tools, PVC, Nalgene, and other plastic items such as funnels were also washed and soaked in acid baths in the same manner as glassware.

Stainless steel bowls, spoons, spatulas, and other utensils were washed with warm, soapy water, rinsed five times with deionized water, and allowed to air dry. They were then rinsed with methylene chloride under a fume hood and the methylene chloride was allowed to evaporate under the hood.

Neoprene stoppers and other porous materials were washed with warm, soapy water and rinsed five times with deionized water. These items were then "seasoned" by continuous soaking in or exposure to 0.45-µm-filtered seawater for at least 2 days prior to use.

Large pieces of laboratory equipment such as the epoxy-coated mixer used to mix sediment and epoxy-coated boards used to hold cores for geological descriptions were washed with mild soap solution and thoroughly rinsed with tap water followed by deionized water.

2.2.2 Geological Description of Cores

A detailed characterization of each core sample from the Oakland Harbor Phase III 38-Foot Project was conducted by a geologist. The description was performed on the 4-in. core that was collected and stored in the Lexan core tube. All core sections from one station were removed from storage and scored longitudinally with a circular saw. A linoleum knife was used to split the core open to expose the sediment stratigraphy. The geologist measured and described the core from top to bottom, recording data on a core data log. The geological characterization protocol (Ward et al. 1991, Appendix A) was consistent with ASTM Method D2488-84.

2.2.3 Preparation of Solid-Phase Samples

Solid phase, also called bulk sediment or whole sediment, refers to the sediment itself, as opposed to suspended or dissolved phases. In biological tests, the solid phase of sediments represents either dredged material once it has settled at an aquatic disposal site (test sediment), the existing environment of a disposal site without dredged material (reference sediment), or the environment of a benthic test organism (control sediment). Solid-phase preparation also applies to samples for sediment chemistry. All solid-phase samples were thoroughly homogenized before use in biological tests or chemical analysis.

Sediment used for composites were collected in the field using material from the 4-in. and 12-in. core from each contributing station. These sediments were placed either in 5-gal, epoxy-coated metal pails and stored in freezers maintained at approximately 4°C in the field or they remained in the Lexan core liner sections. When the samples contained in the epoxy-coated metal pails were received in the laboratory, they were mixed into appropriate composites and homogenized using an epoxy-coated mixer. Subsamples of these composited sediments were removed for chemical analysis, grain size measurements and for solid-phase and SPP testing. After the geological description was complete, sediments within the 4-in. Lexan tubes were homogenized, measured for grain size, and analyzed for chemical concentrations.

The procedure for homogenizing Oakland Harbor test sediment samples varied according to sediment type. Compacted clay sediments were separated into smaller pieces with a stainless steel metal grater and then mixed either with stainless steel spoons or a mixer coated with a special epoxy paint (TNEMEC Epoxy converter 83-83-B). Silt, soft clay, and

sandy sediments were mixed with spoons in stainless steel bowls. Sediment samples were mixed until uniform consistency and color were visible throughout the sediment in the bowl or mixer. Minimal amounts of 0.45-µm-filtered seawater were added as needed to achieve a homogeneous consistency. The volume of added water was recorded on a sample-preparation form. After mixing, sample aliquots for chemical analyses were placed in cleaned and labeled containers appropriate for the parameters to be measured. If solid-phase samples were not used immediately for testing or SPP preparation, they were returned to the labeled, epoxy-coated metal pails for storage at 4°±2°C. All sediments were homogenized, subsampled for chemistry, and used for testing within the recommended 14-day holding period.

The reference and control sediments were contained in ice chests at approximately 4°C while in the field and at 4°±2°C while at the laboratory until sieving and mixing. The sediments were placed onto stacked screens having mesh diameters of 0.5 and 1.0 mm set on top of a sieving stand. The sieving stand was designed to empty directly into a clean 55-gal, acid-washed aquarium containing approximately 15 gal of filtered seawater. A Simms Geyser submersible pump was placed in the aquarium to recirculate sieving water. Sediment that passed through these sieves was collected in the 55-gal aquarium. Organisms collected on the sieves were discarded. The sieved sediment was allowed to settle in the aquarium overnight at 4°±2°C. After settling, the overlying water was siphoned off and the sediment was transferred to an epoxy-coated mixer for compositing. The sediment was mixed for 5 to 10 min or longer if needed to obtain a homogenous mixture. At the end of the mixing period, the sediment was transferred from the mixer to the 55-gal aquarium and stored at 4°±2°C until needed for testing. Between sieving of each reference or control sediment, all equipment was thoroughly rinsed with 0.45-µm-filtered seawater to avoid potential cross-contamination between samples.

2.2.4 Preparation of Suspended-Particulate Phase

The SPP of sediment samples was used to evaluate water column effects of open water dredged material disposal. The SPP is the liquid supernatant and suspended-particulate materials that remain after mixing sediment with seawater and allowing either heavier particles to settle out or centrifuging until the supernatant is clear enough to observe test organisms during the tests. Because the sample preparation does not involve filtration, this phase contains suspended particles as well as dissolved constituents. The SPP tests

evaluate effects caused by both the physical presence of the suspended particles and the chemical toxicity of contaminants associated with the particles or dissolved fractions. The process is intended to approximate exposure conditions created as a result of materials being discharged through the water column during dredge-disposal operations.

The first step of SPP preparation was creating a 4:1 (volume:volume) water to sediment slurry in 1-L glass jars with Teflon-lined lids. The jars were marked at 200 mL and 400 mL. Seawater filtered through a 0.45-µm cartridge was added to the 200-mL mark, then homogenized sediment was added until the water was displaced to the 400-mL mark and then the jar was filled to 1 L with filtered seawater. A set of 12 jars of sediment and water was placed on a shaker table and agitated for 30 min at a shaking rate of 120 to 150 cycles/min. After shaking, the slurry was poured into 500-mL Teflon containers with tightly fitted lids. These containers were placed in a centrifuge and spun for 10 to 15 min at approximately 1750 rpm. The 10-min centrifugation was necessary to ensure that test organisms would be visible at the first observation after exposure to SPP test treatments. After centrifugation, the supernatant was composited by pouring it into a clean 10-gal aquarium and then used in the SPP tests as soon as possible. If SPP was not used immediately, the aquarium was stored at 4°±2°C. The Teflon jars were rinsed after each use with deionized water and the above process was continued until an adequate amount of SPP was produced for each composite. Between SPP preparations, all glass and Teflon containers were appropriately cleaned according to procedures described in Section 2.2.1. Each SPP test required a dilution series of 0%, 10%, 50%, and 100% SPP.

2.3 SEDIMENT AND TISSUE CHEMISTRY PROCEDURES

Sediment samples were analyzed for conventional sediment measurements (e.g., grain size, oil and grease). Chemical analyses were conducted on sediment samples for PAHs, PCBs, metals, and butyltins. Table2.1 lists the parameters for which the Oakland Phase III 38-Foot Project sediment samples (including duplicate and replicate) were analyzed, as well as analytical goals for detection limits, range of recovery, and relative precision. *N. caecoides* and *M. nasuta* tissue samples were analyzed for the same set of PAHs, chlorinated pesticides,

TABLE 2.1. Analytical Chemistry Requirements for Oakland Harbor Phase III 38-Foot Project Sediment Samples

Parameters	Detection Limits [a] (mg/kg dry wt)	Number of Samples	Range of Recovery (%)	Relative Precision (%)
Sediment Conventionals				
TOC	0.1%	47	NA[b]	10
Oil and Grease	20	47	50 - 150	10
TPH	20	47	50 - 150	15
Grain Size	NA	47	NA	NA
Total Volatile Solids	0.1%	47	NA	10
Metals				
Ag	1.0	47	75 - 125	15
As	1.0	47	75 - 120	15
Cd	0.1	47	NA	15
Cr	1.0	47	85 - 115	15
Cu	1.0	47	NA	15
Hg	0.02	47	75 - 125	15
Ni	1.0	47	NA	15
Pb	1.0	47	NA	15
Se	0.1	47	75 - 115	15
Zn	1.0	47	NA	15
Organic Compounds				
Butyltins	0.01	47	40 - 120	20
PCBs [c]	0.02	47	50 - 150	20
PAHs [d]	0.02	48	50 - 150	20
Pesticides [e]	0.002	47	50 - 150	20

(a) Target detection limits; all efforts were made to reach lowest practical detection limits.
(b) Not applicable.
(c) Reported as Aroclor equivalents 1242, 1248, 1254, and 1260 and total PCB. Analyzed using EPA Method 8080.
(d) All compounds on EPA Method 610 list. Analyzed using Method 8270 in Selective Ion Mode.
(e) All compounds on EPA Method 608 list. Analyzed using Method 8080.

PCBs, metals, and butyltins. Table 2.2 lists the parameters for which the Oakland Phase III 38-Foot Project tissue samples were analyzed, as well as analytical goals for detection limits, range of recovery, and relative precision.

The following sections briefly describe the methods used for analysis of sediments and tissues for the required physical and chemical parameters. Analyses followed established EPA procedures where applicable. Quality control samples included method blanks, matrix spike (MS) and matrix spike duplicate (MSD) analyses, standard reference materials (SRMs), analytical replicates, and compositing duplicates. The MS, MSD, and SRM samples were used to evaluate analytical accuracy. Analytical replicates were compared to evaluate analytical precision. The compositing duplicates were used to assess the efficiency of homogenizing sediment samples.

2.3.1 Conventional Sediment Measurements

Conventional sediment measurements consist of grain size, total organic carbon (TOC), total volatile solids (TVS), oil and grease and total petroleum hydrocarbons (TPH), and percent solids. The procedures for each of these analyses are discussed in the following paragraphs.

Grain size analysis was conducted by Soil Technology, Inc., of Bainbridge Island, Washington. Sixteen grain size fractions were determined by a combination of sieve and pipet techniques from the Puget Sound Estuary Program (PSEP) Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1986). These methods are consistent with ASTM D421 (ASTM 1978) and D422 (ASTM 1972). Table 2.3 presents the fractions measured.

Approximately 25 g of wet sediment from each sample was analyzed for total solids while another 10-g 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-µm (4.0 phi) sieve into a 1-L graduated cylinder. The coarse fraction was dried, weighed, and shaken through a nest of sieves to yield the required seven coarse subfractions. Any material still passing the final 63.5-µm sieve was added to the previous fines in the 1-L graduated cylinder. The silt/clay fractions were then subdivided using a pipet technique based on Stoke's Law of differential settling velocities for different sized particles.

TABLE 2.2. Analytical Chemistry Requirements for Oakland Harbor Phase III 38-Foot Project Tissue Samples

Parameters	Detection Limits[a] (mg/kg dry wt)	Number of Samples	Range of Recovery (%)	Relative Precision (%)
Metals				
Ag	1.0	112	75 - 125	15
As	1.0	112	75 - 120	15
Cd	0.1	112	NA[b]	15
Cr	1.0	112	85 - 115	15
Cu	1.0	112	NA	15
Hg	0.02	112	75 - 125	15
Ni	1.0	112	NA	15
Pb	1.0	112	75 - 125	15
Se	0.1	112	75 - 115	15
Zn	1.0	112	NA	15
Organic Compounds				
Butyltins	0.01	140	40 - 120	20
PCBs [c]	0.02	140	50 - 150	20
PAHs [d]	0.02	140	50 - 150	20
Pesticides [e]	0.002	140	50 - 150	20

(a) Target detection limits; all efforts were made to reach lowest practical detection limits.
(b) Not applicable.
(c) Reported as Aroclor equivalents 1242, 1248, 1254, and 1260 and total PCB; Analyzed using EPA Method 8080.
(d) All compounds on EPA Method 610 list. Analyzed using Method 8270 in Selective Ion Mode.
(e) All compounds on EPA Method 608 list. Analyzed using Method 8080.

The silt/clay fraction was disassociated by addition of a dispersant (sodium hexametaphosphate) into the distilled water sediment slurry contained in the 1-L graduated cylinders. At specified time intervals and specified depths below the surface, 20-mL aliquots were withdrawn from the graduated cylinder, delivered to a preweighed container, and dried at 90° ± 2°C to a constant weight. Duplicate analysis of seven samples was performed as a quality control measure. Other quality control measures, such as spikes, SRMs, or minimum detection limits, do not apply to grain size analysis.

TABLE 2.3. Grain Size Fractions Measured

Grain Size (µm)	Phi	Screen Number
3350	-2	6
2000	-1	10
1000	0	18
500	1.5	35
250	2	60
125	3	120
62.5	4	230
48	4.5	NA[a]
31.2	5	NA
23	5.5	NA
15.6	6	NA
7.8	7	NA
3.9	8	NA
1.9	9	NA
0.976	10	NA
0.4883	11	NA

(a) NA Not applicable.

Total organic carbon is the amount of non-volatile, partially volatile, volatile, and particulate organic carbon compounds in a sample. Analysis of TOC was performed by Global Geochemistry in Canoga Park, California. Each sediment sample was dried and ball milled to
a fine powder. Before combustion, inorganic carbon in the sample was removed by acidification. The TOC in sediment was then determined by measuring the carbon dioxide released during combustion of the sample (PSEP 1986; SW846 Method 9060, EPA 1986), reported as percent dry weight. Quality control measures included method blanks and analysis of compositing duplicates.

Total oil and grease includes vegetable oils, animal fats, soaps, waxes, and any other carbon-hydrogen material extractable by the solvent Freon. Total petroleum hydrocarbons comprise the nonpolar mineral fraction of total oil and grease that is not removed by silica gel absorption. These analyses were performed by Twin City Testing in St. Paul, Minnesota. Infrared spectrophotometry (IR) was used to determine concentrations of oil and grease (Method 413.2, EPA 1979) and petroleum hydrocarbons (Method 418.1, EPA 1979). A 20-g aliquot of sample was dried with an excess of anhydrous sodium sulfate, then extracted with Freon. For total oil and grease, sample extracts were scanned from 4000 to 600 cm^{-1} on an

infrared spectrophotometer and the peak height measured at 2930 cm^{-1}. This wavelength represents the $-CH_2$ configurations of hydrocarbons and was the standard used to determine oil and grease. For total petroleum hydrocarbons, silica gel was added to the extract to remove the more polar animal- and vegetable-based oils. The extract was then shaken and allowed to settle. An aliquot was then removed and scanned the same way as the oil and grease sample. The relationship of peak height to oil concentration was determined by regressing the peak height versus a known concentration of fuel oil.

Total volatile solids are a measure of the fraction of total solids that are lost on ignition at a higher temperature than that used to determine total solids. Total volatile solids are used as an estimate for the amount of organic matter in the total solids. Operationally, TVSs are defined by the combustion temperature, and do not always represent the total organic content of a sample because some of the more volatile organic material may be lost during drying and some inorganic material may also be lost during combustion. Analysis of TVS was performed by the MSL using the method defined in PSEP (1986). Following that method, the sample was freeze-dried to constant weight and ball milled to a fine powder. A 1-g portion was then removed, weighed, and combusted at 550°C. The sample was cooled in a desiccator and then reweighed. The amount of sample lost from the dried sediment during ignition was then defined as the volatile solids fraction.

Sediment samples used for determination of percent solids were prepared in one of two ways. The MSL and Twin Cities Testing performed a percent-solids analysis to determine a sample dry weight. Pre-weighed wet samples are either freeze-dried over a period of 4 days or dried in an oven at 110°C for at least 8 h and cooled in a desiccator. The ratio of dry weight to wet weight is multiplied by 100 to determine the percent solids.

2.3.2. Semivolatile Organic Compounds

The semivolatile organic compounds analyzed in sediments were the 16 PAHs listed in EPA Method 610. These compounds were extracted from sediments following EPA SW-846 Method 3540 (1986) using methylene chloride as the extraction solvent. A portion of the extract was used for PAH analysis by gas chromatography/mass spectroscopy in the Selective Ion Mode (GC/MS SIM) following EPA SW-846 Method 8270 (1986). Tissue extracts were run through gel permeation chromatography (GPC) prior to analysis to remove potential interferences. Analyses for PAHs in the sediments and *M. nasuta* tissues were performed by

Twin Cities Testing in St. Paul, Minnesota; the analysis for the *N. caecoides* tissues was performed by Alden Laboratories in Seattle, Washington.

Surrogate compounds were added to all samples prior to extraction. Matrix spike/matrix spike duplicates were conducted to assess accuracy and precision of the measurement. National Research Council of Canada (NRCC) SRM HS-5, a sediment sample with known PAH concentrations, was also analyzed for all PAH compounds.

2.3.3 Chlorinated Pesticides and PCBs

Chlorinated pesticides and PCBs in sediments and tissues were quantified by gas chromatography/electron capture detection (GC/ECD) following EPA SW-846 Method 8080 (1986). Analyses for PCB and pesticides in the sediments and *M. nasuta* tissues were performed by Twin Cities Testing in St. Paul, Minnesota; the analysis for the *N. caecoides* tissues was performed by Alden Laboratories in Seattle, Washington.

Chlorinated pesticides and PCBs were extracted simultaneously with the PAH compounds using EPA SW-846 Method 3540 (1986). The procedure involved a methylene chloride extraction using sonication extraction techniques. A portion of the methylene chloride extract was solvent exchanged to hexane, and interferences were removed by passing the extract through a column packed with 10 g of 7% deactivated alumina. Most samples required an additional cleanup treatment using GPC to remove other interferences. Analytical quantification was performed using GC/ECD analysis. The presence of detected pesticides and PCBs was confirmed by analysis on a second column. Dibutylchlorendate (DBC) was the surrogate compound added to each sample before extraction to assess the extraction efficiency.

A matrix spiking solution, consisting of either a subset of pesticides or one aroclor, was also added to the appropriate samples before extraction. Matrix spike/matrix spike duplicate analyses were conducted to assess accuracy and precision of the measurement. A method blank was analyzed with this set of samples as well. To assess accuracy, NRCC SRM HS-2 was analyzed for pesticides and PCBs with the sediment samples.

2.3.4 Metals

Ten metals were measured in sediments and tissues: silver (Ag), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), selenium

(Se), and zinc (Zn). Metals analyses for both sediment and tissues were performed by the MSL in Sequim, Washington. Samples of sediment, *M. nasuta* tissue, and *N. caecoides* tissue were analyzed using a combination of three different methods: 1) energy-diffusive x-ray fluorescence (XRF), following the method of Sanders (1987); 2) Zeeman graphite-furnace atomic absorption spectroscopy (GFAA), following EPA SW-846 Method 7000 (1986) and the method of Bloom and Crecelius (1984); and 3) cold-vapor atomic absorption spectroscopy (CVAA), according to EPA SW-846 Method 7471 (1986) and the method of Bloom and Crecelius (1983). The analytical methods for each sample matrix and corresponding metals for which each method was used are presented in Table 2.4.

To prepare sediment and tissues for analysis, samples were freeze-dried, then blended in a Spex mixer-mill. Approximately 5 g of mixed sample was ground in a ceramic ball mill. The XRF analysis was performed on a 0.5-g aliquot of dried, ground material pressed into a pellet with a diameter of 2 cm. For GFAA, and CVAA analyses, 0.2- to 0.5-g aliquots of dried homogenous sample went through an acid digestion process to separate and isolate the metals from the matrix.

Quality control measures for metals analyses included analysis of blanks (not applicable to XRF technique), duplicate analyses (XRF method) or triplicate analyses (GFAA method), and analysis of SRM (Sediment SRMs were BEST-1, BCSS, MESS-1, PACS-1, 1646; Tissue SRM was 1566a) samples.

2.3.5. Butyltins

Butyltin compounds in sediment and tissues were analyzed using gas chromatography/flame photometric detection (GC/FPD) following the methods of Unger et al. (1986). Butyltins in sediment and *M. nasuta* tissue were analyzed at MSL in Sequim, Washington, and butyltins in *N. caecoides* samples were analyzed at Battelle Ocean Sciences in Duxbury, Massachusetts.

Wet samples were extracted with methylene chloride and tropolone. Propyltin was added before extraction as a surrogate compound to assess extraction efficiency. The mono-, di-, and tributyltin compounds extracted from the sediment and tissues were derivatized to a less volatile, more thermally stable form (nonionic n-hexylor n-pentyl derivatives).

TABLE 2.4. Analytical Method and Corresponding Metal for Each Sample Matrix

Sediment			*N. caecoides* Tissue			*M. nasuta* Tissue		
XRF	GFAA	CVAA	XRF	GFAA	CVAA	XRF	GFAA	CVAA
As	Ag	Hg	As	Ag	Hg	As	Ag	Hg
Cr	Cd		Cu	Cd		Cu	Cd	
Cu	Se		Ni	Cr		Ni	Cr	
Ni			Zn	Pb		Se		
Pb			Se			Zn		
Zn						Pb		

The extracts were passed through a florisil liquid chromatography column for cleanup, and the butyltins were quantified by GC/FPD. Concentrations were reported in µg/kg dry weight of mono-, di-, tri- and tetra-butyltin species as tin. The recently certified reference material for butyltins, NRCC SRM PACS-1, was analyzed with the sediment. Matrix spikes, method blanks, and analytical duplicates were performed as a quality control measure.

2.4 TOXICOLOGICAL TESTING PROCEDURES

Bioassays using both the solid-phase and SPP tests were conducted at the MSL to assess the ecological effects of aquatic disposal of dredged material from the Oakland Harbor Phase III 38-Foot Project area. The MSL facilities provided the required conditions for flow-through solid-phase tests, static solid-phase tests, and static SPP tests. Laboratory equipment providing these testing conditions included a controlled-temperature environment, flow-through seawater supply, lighting control, and air supply.

The solid-phase tests, also called benthic bioassays, were used to assess the acute toxicity and bioaccumulation potential of dredged material after it settles at an aquatic disposal site. Four species of marine organisms were exposed to composited sediment from the Oakland Harbor sampling sites, reference area sediment, and control sediment. These acute toxicity tests consisted of 1) a 10-day solid-phase flow-through acute toxicity test using *N. caecoides* and *M. nasuta* ; 2) a 10-day solid-phase flow-through test using the *C. stigmaeus*; and 3) a 10-day solid-phase static test using *R. abronius*.

The bioaccumulation test was a 28-day exposure of *N. caecoides* and *M. nasuta* within the test sediment. The purpose of the 28-day bioaccumulation test was to assess the potential for bioaccumulation of contaminants from the sediment into the tissues of the organisms. The test treatments and procedures were similar to the 10-day test except they

involved a longer exposure period, larger test population, and a depuration process for surviving *M. nasuta* and *N. caecoides*.

The SPP tests were used to assess the potential effects of discharging dredged material through the water column during disposal operations. The SPP tests evaluate effects caused by the physical presence of suspended particles and the toxicity of chemical contaminants associated with the particles or dissolved into the water after release. Three marine species were used in these tests: mysids (*H. sculpta*), juvenile sanddabs (*C. stigmaeus*), and oyster larvae (*C. gigas*). The SPP treatments were prepared as described in Section 2.2.4. For each SPP treatment, there were three replicates of each of the four SPP concentrations: 0% (sea water), 10%, 50%, and 100% SPP.

2.4.1 10-Day Solid-Phase Flow-Through Test with *N. caecoides* and *M. nasuta*

Prior to testing, *N. caecoides* were held in their native sediment in shallow pans covered with well-aerated 15°C seawater from a gravity-fed flow-through system. *M. nasuta* were held in large tanks of clean sediment with flow-through 15°C seawater. Temperature, pH, dissolved oxygen (DO), and salinity of water in each holding tank water were monitored daily. The organisms were not fed during the holding period.

The flow-through test with *M. nasuta* and *N. caecoides* was conducted in five, 10-gal aquaria for each sediment treatment that were placed in random positions on water tables. Figure 2.3 shows the system used for flow-through tests. Each aquarium was filled with approximately 8 L of sand-filtered seawater via the flow-through system. The test sediment was added to a depth of 3 cm by measuring out the required amount (3870 mL) in a clean glass container, and using seawater to wash and distribute the sediment evenly over the tank's bottom. The flow-through system was initiated, and aquaria were allowed to fill to a total volume of approximately 36 L. For approximately 4 h, suspended materials in the aquaria were allowed to settle and the flow-through system was adjusted and calibrated to deliver 125 ±10 mL/min of seawater flow to each aquarium. The system was allowed to run overnight before the organisms were added.

For the 10-day test, 20 *M. nasuta* and 20 *N. caecoides* were collected from the holding tanks and placed in each aquarium. The initiation time/date and the initials of the analyst who added the organisms to each tank were noted on each aquarium. Water quality parameters of salinity, temperature, DO, and pH were measured daily in at least one replicate of each

treatment and recorded on water quality data sheets. (Water quality data are provided in Appendixes D-J). The water quality parameters and ranges established for the tests were

Dissolved Oxygen	≥4.0 mg/L
pH	ambient ±0.5 units
Salinity	ambient ±2.0‰
Temperature	15.0°C ±2.0°C
Flow Rates	125 ±10 mL/min.

If daily water quality parameters exceeded these ranges, adjustments were made to the system. The number of dead organisms present was monitored daily. Dead organisms were removed but not replaced. If any dead *N. caecoides* were removed, the specimen was identified as to whether it was a whole animal or a head or tail portion. Daily observations of test animal behavior were made and recorded on data forms for each test. The number of *M. nasuta* on the sediment surface and the number of those with their siphons exposed were noted, as well as the number of *N. caecoides* on the sediment surface and the number of those with only their heads exposed.

At the end of the 10-day test, water quality measurements were taken in all tanks and the contents of each aquarium were gently passed through a 1.0-mm Nytex screen to recover the *N. caecoides* and *M. nasuta*. The organisms were placed in glass baking dishes labeled with the treatment number, and the number of dead and live of each species was counted. Acute toxicity was determined by observing whether the *N. caecoides* reacted to gentle probing. If there was no movement and the worm's coloring was pale to translucent, the organism was considered dead. Acute toxicity in the *M. nasuta* was determined by observing and counting dead individuals. Those non-responsive with gaping shells were considered dead. The mortality data were recorded on the termination forms. A 10% recount of the test organisms by a second analyst was performed as a quality control measure.

2.4.2 28-Day Solid-Phase Flow-Through Test with *N. caecoides* and *M. nasuta*

The procedure for conducting the 28-day solid-phase flow-through test with *N. caecoides* and *M. nasuta* was identical to that of the 10-day test with three exceptions: 1) the number of organisms was increased to 25 *M. nasuta* and 30 *N. caecoides* because more individuals were needed to yield enough tissue for chemical analysis; 2) the exposure period was increased from 10 to 28 days; and 3) the surviving test organisms were depurated for 48 h and then sampled for chemical analysis. The ranges for water quality parameters as well as

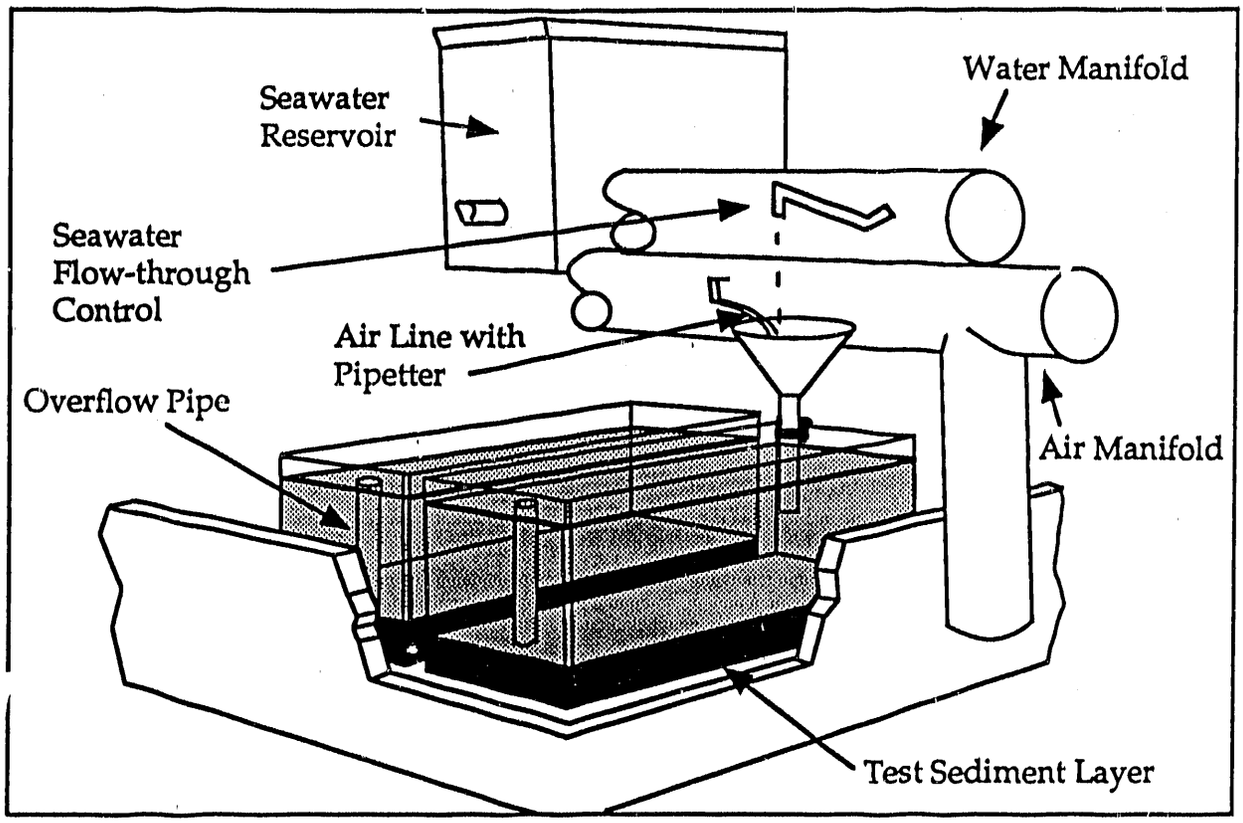


FIGURE 2.3. Flow-through Aquarium for *M. nasuta*, *N. caecoides*, and C. stigmaeus

the test conditions, such as temperature and flow rate, were the same in the 28-day test as for the 10-day test. Water quality parameters were measured and mortality of the test organisms was monitored at the same frequency for both tests.

When the 28-day test was terminated, the living *M. nasuta* and *N. caecoides* were collected for chemical evaluation of bioaccumulation. To ensure that tissue chemistry results would not be biased by contaminants associated with sediment grains in the digestive tract, the test organisms were allowed to depurate, or void the digestive tract, for 48 h following the 28-day exposure. The surviving *N. caecoides* from one test aquarium were placed in another flow-through 10-gal aquarium with approximately 2 in. of clean sediment from Sequim Bay in the bottom. Clean sediment was necessary for *N. caecoides* because they require sediment

to surround their tissues to survive. During the depuration period, the animals were not fed and the fecal material and debris were removed daily during water quality monitoring. The surviving *M. nasuta* were placed in a glass baking dish (without sediment), which was then placed in the depuration aquarium containing the *N. caecoides* from the same replicate. *M. nasuta* fecal material was siphoned from the baking dish daily during the depuration period. After 48 h of depuration, the *M. nasuta* shells were cleaned with a scrub brush, and the tissues were removed using titanium instruments and collected for chemical analysis. The *N. caecoides* were gently washed in clean seawater to remove external sediment grains and then put in containers for chemical analysis.

2.4.3 10-Day Solid-Phase Static Test with *R. abronius*

The *R. abronius* test was conducted in 1-qt mason jars (Figure 2.4). The test containers were placed on a water table according to randomization sheets and maintained at 15°C. After the test sediment was mixed, it was added to the jars to a depth of 2 cm, and then slowly filled with a 0.45-µm-filtered seawater to a volume of 750 mL. The jars were aerated and allowed to incubate for 24 h to stabilize temperature and pH to test conditions. Initial water quality parameters were measured in each container and recorded on water quality forms.

The 96 h reference toxicant test was conducted to establish the health and sensitivity of the test organisms. *R. abronius* were exposed to a seawater control plus four concentrations of cadmium chloride (0.5, 1.0, 2.0, and 4.0 mg/L as Cd), with three replicates of each concentration. The reference toxicant test was conducted in the same manner as the solid-phase test.

Twenty *R. abronius* were added to each mason jar. Animals were observed daily during the 4- and 10-day tests, and the number of animals floating on the surface, swimming in the jar, or settling on the sediment was recorded on observation forms. Animals that were floating on the surface were gently pushed below the water surface with a pipet tip and observed as they either buried or did not rebury into the sediment. Water temperature, salinity, pH, and DO were measured daily in one replicate of each exposure and concentration. All containers were measured for water quality at initiation and termination of the bioassay.

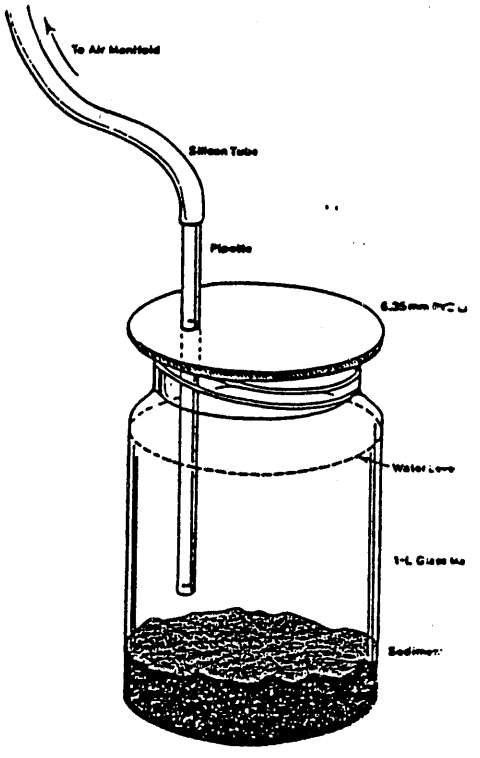


FIGURE 2.4. Static Amphipod Testing Jars

Acceptable water quality values and ranges were

Dissolved Oxygen	≥4.0 mg/L
pH	ambient ±0.5 units
Salinity	ambient ±2.0‰
Temperature	15°C ±2.0°C.

At the end of the test, the contents of each jar were placed in a 0.5-mm Nytex screen to collect the *R. abronius* and then placed in a glass dish labeled with the treatment number. The number of live or dead organisms in each dish was counted, and the presence or absence of body parts recovered at the end of the test was noted. The acute toxicity was observed by gently probing the animal and noting whether it reacted by moving its pleopods. The mortality data were recorded on termination forms. A 10% recount of the test organisms by a second analyst was performed as a quality control measure.

2.4.4 10-Day Solid-Phase Flow-Through Test with *C. stigmaeus*

Prior to testing, *C. stigmaeus* were held in large tanks with a 3-in. layer of sediment on the bottom for at least 5 but no longer than 11 days prior to test initiation. The tanks were filled and supplied by flow-through seawater at test temperature (15°C). The sanddabs were fed freeze-dried krill twice a day. Temperature, pH, DO, and salinity of the holding tank water were monitored daily.

For each sediment treatment composite, the solid-phase flow-through test for *C. stigmaeus* was conducted in 10-gal aquaria (5 replicates) randomly positioned on the water tables (Figure 2.3). Approximately 8 L of sand-filtered seawater was added to each aquarium via the flow-through seawater system. Test sediment was added to a depth of 3 cm by measuring out 3870 mL in a clean glass container and using the seawater in the aquarium to distribute the sediment evenly. Each aquarium was filled over a period of approximately 4 h, allowing suspended particles to settle.

Seawater was circulated overnight via the flow-through system at a flow rate of 125 ±10 mL/min. Initial water quality parameters and flow-through rates were measured on every test container. Ten *C. stigmaeus* were collected from the holding tanks and placed in each aquarium. Initiation date, time, and the analyst's initials were noted on the aquarium and on the data forms. The animals were checked after 2 h and dead or impaired organisms were removed and replaced. Organisms were considered impaired if they swam abnormally or were unable to orient themselves dorsal-ventrally. Biological observations and the number of live and dead in each test container were recorded daily. Water quality parameters and flow rates were measured daily in at least one replicate of each treatment and recorded on the water quality data sheets. Acceptable water quality parameters and ranges during the experiment were

Dissolved Oxygen	≥4.0 mg/L
pH	ambient ±0.5 units
Salinity	ambient ±2.0‰
Temperature	15°C ±2.0°C
Flow Rate	125 ±10 mL/min.

If daily water quality parameters exceeded these ranges, adjustments were made to the system. During the test, all dead fish were removed and placed in individually labeled 50-mL centrifuge tubes and stored in the freezer. At the termination of the test, water quality

parameters were measured on all replicates and the number of living and dead *C. stigmaeus* was counted and recorded on the termination form. Live fish from each treatment were placed in a clean, labeled glass jar and preserved in Davidson's solution for histopathological analysis, if required.

2.4.5 96-h Suspended-Particulate-Phase Static Test with *C. stigmaeus*

The test chambers for the SPP test with *C. stigmaeus* were 10-gal aquaria that were randomly positioned on the water tables, with 20 to 24 aquaria per table. Test temperature was maintained by a circulating water bath on the water table. Aeration was provided through a glass pipet connected by silastic tubing to an overhead air manifold. Aquaria were labeled with a treatment code, concentration, and replicate number. The volume of test material in each aquarium was 16 L. To obtain the 100% SPP treatment, 16 L of 100% SPP was added directly to the aquarium; the 0% SPP treatment was 16 L of 0.45-µm-filtered Sequim Bay seawater. To prepare 16 L of each of the 10% and 50% SPP concentrations, appropriate volumes of 100% SPP and 0.45-µm-filtered Sequim Bay dilution water were mixed directly in the test aquaria.

Once all concentrations of an SPP treatment were prepared and all test containers were filled, aeration was started and initial water quality parameters were measured in all replicates. *C. stigmaeus* were then removed from the holding tanks using a net and added to each test container. Ten *C. stigmaeus* were placed in each container so that the test population for each concentration of SPP was 30 individuals (120 individuals per SPP treatment). Initiation time and date were documented on test containers and data record forms.

C. stigmaeus were not fed during the 96-h exposure. After initiation, DO, pH, salinity, and temperature were measured daily in at least one replicate. Acceptable ranges for the water quality parameters during the experiment were

Dissolved oxygen	>4.0 mg/L
pH	ambient ±0.5 units
Salinity	ambient ±2.0‰
Temperature	15.0°C±2.0°C.

Observations of *C. stigmaeus* activity and behavior in each test container were made at test initiation and at 4, 24, 48, and 72 h. A clean probe was used to determine the condition of any resting *C. stigmaeus*. An organism was considered dead if it did not respond to gentle

probing. Dead organisms were removed and preserved in Davidson's solution for potential histopathological analysis.

Before termination of the test at 96 h, water quality parameters were measured in all replicates. At 96 h, the number of live and dead organisms was counted in each test container. A second analyst recounted at least 10% of the test organisms being terminated as a quality control measure. Additionally, fish from SPP treatments where there appeared to be a toxicological effect on test organisms (either through mortality or behavioral abnormalities) were also preserved for histopathological analysis.

2.4.6 96-h Suspended-Particulate-Phase Static Test with *H. sculpta*

Prior to testing, *H. sculpta* were held for at least 48 h in flow-through aquaria maintained at test temperature (15°C). *H. sculpta* were fed finely ground, flaked fish food twice a day, and water quality parameters in the holding tanks were monitored daily.

The test containers for the *H. sculpta* test were 2-L glass baking dishes placed in random positions on water tables. Test temperature was maintained by immersing these containers in a circulating water bath. Aeration was provided through a pipet connected by silastic tubing to an overhead air manifold. Appropriate volumes of 100% SPP and 0.45-µm-filtered Sequim Bay dilution water were added to clean glass 1-gal jars to make 0%, 10%, 50%, and 100% SPP concentrations for the *H. sculpta* test. A total of 3000 mL was prepared for each dilution to allow 1000 mL in each of three replicate test chambers. The test containers were labeled with a treatment code, concentration, and replicate number.

As soon as containers were in place, gentle aeration was started to each one, and water quality measured in all replicates. *H. sculpta* were then removed from the holding tanks using a wide-bore pipette. Ten individuals were added to each container so that the test population for each concentration was 30 individuals per SPP concentration or 120 individuals per treatment. The test initiation time and date were documented on data forms.

After test initiation, water quality parameters were measured daily in at least one replicate. Acceptable ranges for the water quality parameters during the experiment were

Dissolved oxygen	> 4.0 mg/L
pH	ambient ±0.5 units
Salinity	ambient ±2.0‰
Temperature	15.0°C ± 2.0°C.

Observations of test organisms were made at test initiation and at 4, 24, 48, and 72 h, using a light table to enhance visibility of the *H. sculpta*. During the 96-h exposure, *H. sculpta* were fed small amounts of ground flaked fish food at 4, 24, 48, and 72 h. Excess food was removed with a small pipet before daily observations, using extra caution not to disturb test animals. Molted exoskeletons and any particulates from the SPP solution that had precipitated out were also removed.

Before termination of the test at 96 h, water quality parameters were measured in all replicates. At 96 h, the number of live and dead animals was counted in each test container. An organism was considered dead if it did not respond to gentle probing. A second analyst recounted surviving test organisms in at least 10% of the test containers as a quality control measure.

A 96-h reference toxicant test was also conducted to establish the health and expected response of the test organisms. *H. sculpta* were exposed to a seawater control plus four concentrations of zinc chloride (0.25, 0.50, 1.0, and 2.0 mg/L as Zn). There were three replicates of each treatment. The reference toxicant test was conducted in the same manner as the SPP tests.

2.4.7 48-h Suspended-Particulate-Phase Static Test with Larval *C. gigas*

Prior to testing, adult *C. gigas* were held in flow-through tanks at ambient temperature until several days before the test, when they were transferred to 12°C filtered seawater and fed twice daily with algal paste. The test chambers for the bivalve larvae test were 1-qt glass mason jars. The dilutions of SPP for the bivalve test (0%, 10%, 50%, and 100%) were prepared directly in labeled test containers. The dilution water consisted of Strait of Juan de Fuca seawater (26 ‰) filtered at 20 µm. The final volume of test material in each container was 750 mL. Test chambers containing test material were placed in random positions on a water table and gentle aeration was started. Initial water quality parameters were measured in all replicates once the containers had reached test temperature (20°±1°C).

Adult *C. gigas* were induced to spawn by placing individuals in 20°C seawater for 2 h, then removing them from water and allowing them to dry for approximately 20 min. They were then returned to 20°C water that was quickly warmed to 25°C. Sperm from up to three males was pooled and debris was removed by screening through 35-µm mesh. The sperm was then introduced to containers of egg suspension for fertilization. The egg sperm suspensions were

mixed frequently using a perforated plunger over a period of 90 to 140 min, after which development of the embryos was checked. Three egg suspensions with a high percentage of embryo development were pooled into a common stock for use in the test. The pooled egg suspension was screened through 75-µm mesh to remove debris, and then retained on a 20-µm screen to rinse away excess sperm. Finally, the eggs were rinsed from the 20-µm screen into a clean container and diluted with seawater.

To estimate fertilization success and embryo density, a 1-mL sample was removed from the container (after thorough mixing) and diluted to 100 mL with seawater. Three, 1-mL samples were removed from this 100:1 suspension, and the number of developing embryos and non-fertilized eggs were scored using a Sedgewick-Rafter counting chamber on a compound microscope at low magnification. The mean number of embryos from the replicate counts was multiplied by 100 (to correct for the dilution factor) to estimate the density of embryos in the egg stock. The resulting density of 21,800 embryos/mL was used to calculate the amount of stock to add to each test container as well as to calculate percent fertilization.

To initiate the test, 1.0 mL of bivalve embryo stock solution was pipetted into each test container to yield a stocking density of 29 embryos/mL in the containers of test material. A perforated plunger was used to thoroughly mix the contents of the stock container before removing each aliquot with the pipettor. The test initiation date and time were recorded on data record forms. To obtain the actual embryo stocking density, 10-mL subsamples were removed from 14 control containers (two replicates per treatment control) 1 h after test initiation, and after mixing the contents of the container with the perforated plunger. Each subsample was placed in a labeled vial, fixed with 1 mL of 5% formalin, and scored for the number of fertilized eggs.

Water quality parameters were measured in one replicate of each dilution 24 h after test initiation. Acceptable ranges for water quality parameters during the experiment were

Dissolved oxygen	>4.0 mg/L
pH	ambient ±0.5 units
Salinity	ambient ±2.0‰
Temperature	20.0°C ± 1.0°C.

The bivalve test was terminated after 48 to 72 h, when development of D-shaped larvae predominated in control containers. Final water quality measurements were recorded for all replicates. Then, the contents of each chamber were homogenized with the perforated

plunger, and a 10-mL sample was removed with a calibrated pipettor and placed in a labeled vial containing 1 mL of 5% formalin. Samples were scored for the appearance of normal D-shaped larvae, abnormally developed larvae, blastula-stage larvae, and total number of larvae. At least 10% of the counts were confirmed by a second analyst.

A 48-h reference toxicant test was also conducted to establish the health and expected response of the test organisms. *C. gigas* larvae were exposed to a seawater control plus four concentrations of copper sulfate (1, 4, 16, and 64 µg/L as Cu). There were two replicates of each treatment. The reference toxicant test was set up and conducted in the same manner as the SPP tests.

2.5 DATA ANALYSIS AND INTERPRETATION

Several statistical analyses were conducted to determine the magnitude and significance of toxicity and bioaccumulation in test treatments relative to reference treatments. The statistical analyses were performed according to the recommendations of the 1991 Implementation Manual (EPA/USACE 1991). Test design and specific statistical analysis procedures are discussed in the following sections.

2.5.1 Randomization

All solid-phase and SPP toxicity tests were designed as completely random tests. Organisms were randomly allocated to treatments, and treatments were randomly positioned on water tables. A random number table for this purpose was generated for each toxicity test, using the discrete uniform random number generator in the LOTUS 123 spreadsheet. For the SPP tests, *C. stigmaeus* and *H. sculpta* individuals, and *C. gigas* larvae were randomly allocated to SPP replicates for all concentrations. Special care was taken with *C. stigmaeus* individuals in order to eliminate bias caused by variable mobility of the fish (otherwise, easily caught fish would be used earlier than more mobile fish).

2.5.2 Statistical Analysis of Solid-Phase Toxicity Tests

Solid-phase toxicity of all sediment treatments was compared by analysis of variance (ANOVA) tests on the arcsine square-root of the proportion of organisms surviving in the test. The arcsine square-root transformation stabilizes the within-class variances to meet the

assumptions of the ANOVA. As required by the 1991 Implementation Manual, statistical analysis is conducted to determine the strength of the evidence for concluding that the dredged material samples (test treatments) are significantly more toxic to marine species than the reference sediment sample. This objective is accomplished through the use of a procedure known as Dunnett's Test. This test evaluates whether acute toxicity observed in a given test treatment is significantly greater than that observed in the reference at $\alpha = 0.05$. Toxicity of a test treatment was considered significantly different from a reference treatment if it was statistically different in Dunnett's Test and if the survival in the treatment was ≥10% lower than the control treatment for the test organism (≥20% lower than control for *R. abronius*).

2.5.3 Statistical Analysis of SPP Tests

Two statistical tests are presented in the 1991 Implementation Manual (EPA/USACE 1991) for the interpretation of SPP tests. The first test is a two-sided t-test between survival in dilution water (0% SPP) replicates and survival in the 100% SPP replicates. This test is performed only when survival in the 100% SPP is less than control (0% SPP) survival and when control survival is greater than 90% (indicating test validity). Prior to conducting the t-test, angular transformation (arcsine of the square root) of the proportion surviving in test replicates is performed to reduce possible heterogeneity of variance between control and 100% SPP mean survivals. The second test required by the 1991 Draft Implementation Manual is an LC50 calculation, the concentration of SPP that is lethal to 50% of the individuals tested. The LC50 values for these tests were calculated using the Trimmed Spearman Karber method (Finney 1971). The Spearman Karber estimator is appropriate only if there is increasing mortality with increasing concentration and if 50% or greater mortality is observed in test solutions when normalized to control survival. If 50% mortality does not occur in the 100% SPP dilutions for any treatments, then LC50 values are reported as >100% SPP. The same method was used to calculate EC50 values (the concentration where 50% of the test organisms show a certain effect) for the bivalve SPP test and LC50 values for all reference toxicant tests.

2.5.4 Statistical Analysis of Bioaccumulation

Bioaccumulation tests conducted under 1991 Implementation Manual guidelines are intended to determine whether organism exposure to dredged material (test treatments) is likely to cause an elevation of contaminants in its body. The 1991 Implementation Manual requires the statistical comparison of contaminants in tissues exposed to dredged material

samples (test treatments) to tissues exposed to the reference sediment. Statistical comparison determines whether any dredged sediment (test treatment) has a larger effect on the organisms than the reference sediment. The USACE requested statistical analysis on dry weight concentrations of all chemical compounds, and in addition, analysis on wet weight concentrations of PAHs, pesticides, PCBs, and butyltins. When a compound was not detected, the detection limit value was used in statistical analysis. Where analytical duplicates were included in the analysis of variance, they did not influence the results of the statistical analyses. In metals analyses of *N. caecoides* tissues, low tissue mass reduced sample replication from five to three. As directed by the Implementation Manual, statistical analysis was performed using the multiple comparison Dunnett's Test at $\alpha = 0.05$ on the natural-logarithm transformation of tissue contaminant concentrations.

2.6 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The quality assurance/quality control (QA/QC) procedures followed for these studies were consistent with the Implementation Manuals (EPA/USACE 1977 and 1991) and the EPA protocols (PSEP 1986). The procedures followed were documented by Pacific Northwest Laboratory's (PNL) Quality Engineering Division as a QA Plan. A member of PNL's quality engineering staff was present during each phase of these studies to ensure that accepted procedures were followed. The PNL Laboratory Record Books (LRBs) were assigned to each portion of the study and served as records of day-to-day activities during the research. All entries in the LRBs were signed, dated, and reviewed by both the project manager and the quality assurance engineer. The following discussion summarizes QA/QC procedures followed for the three main portions of this study: sediment sampling, biological testing, and chemical testing. Quality Assurance/Quality Control Observations may be found in Ward et al. (1991).

2.6.1 Sample Tracking and Storage

All sediment samples were accompanied by chain-of-custody forms from the time of collection to receipt at MSL. After sample selection and compositing, a new set of custody forms was initiated for the sediment subsamples requiring chemical analyses. These accompanied the samples to the appropriate laboratory where the forms were signed and returned to the MSL project manager. Custody forms were also initiated for all tissue samples upon completion of the biological testing. These forms accompanied the samples to the appropriate laboratory for chemical analyses.

All sediment collected for these studies was stored in glass, Lexan containers, or steel drums lined with 9-C-4-A-phenolic epoxy, a non-contaminating coating. Sediment cores and grab samples were stored at 4°±2°C prior to biological testing. Subsamples for chemical analyses were obtained prior to biological testing. These subsamples were stored frozen until chemical analyses were performed.

Tissue samples were frozen immediately upon completion of the bioaccumulation tests. Samples for organic analyses were stored in precleaned glass jars with Teflon-lined lids and samples for metals analyses were stored in precleaned plastic jars.

2.6.2 Sediment and Tissue Chemistry Quality Control Procedures

Chemical testing procedures require that specific QA/QC protocols be followed. QA/QC guidelines specific to this project are provided in the *Quality Assurance Plan (QAP) for the Ecological Evaluation of Proposed Discharge of Dredged Material From Oakland Harbor.* These guidelines include the following:

- analysis of a method blank with each batch of samples
- replicate analysis on at least 5% of the samples (triplicate analyses where possible) to assess analytical precision
- analysis of matrix spikes on 10% of the samples (where applicable) with appropriate compounds to assess accuracy
- analysis of SRMs at a frequency of 5%, if available for the analytes of interest and sample matrix
- archival of all instrument printouts (e.g., raw data and chromatograms from AA and GC analyses) for future review
- second column confirmation for PCB and pesticide analyses.

In actual practice, some of the specific guidelines listed in the QAP for analytical precision and accuracy were modified to apply to the most current methods employed by laboratories. The guidelines for detection limits, range of recovery, and relative precision are listed in Table 2.1 for sediments and in Table 2.2 for tissues.

Measurements of accuracy can be determined by analyzing matrix spikes of known concentrations, as well as SRMs that have been certified for the presence of specific parameters. Matrix spikes were analyzed for most metals and for organic parameters, including oil and grease, petroleum hydrocarbons, PCBs, pesticides, and PAHs. Spikes generally are made up of a subset of the analytes of interest. Spike recoveries were calculated based on the difference between the amount spiked and the amount recovered in

the sample, taking into account the amounts already present in the spiked sample. Spikes were added to samples analyzed for metals and organic compounds. Spikes for organic compounds were analyzed in duplicate at a frequency of 5%. Surrogate compounds were added in known amounts to samples analyzed for PCBs, pesticides, PAHs, and butyltins. Surrogate compounds are added to samples prior to extraction, and their recoveries are a measurement of the efficiency or procedural accuracy of the analysis. Analytical accuracy is also measured through the analysis of SRMs. Sediment SRMs were analyzed for metals and for organic compounds. Tissue SRMs were analyzed for metals. SRMs are not associated with analysis of TOC, oil and grease and petroleum hydrocarbons, TVS, and grain size.

Measurements of precision were obtained through replicate analysis of selected sediment treatments. Analysis of replicates shows how precise or repeatable a result is. The measurement of precision is the industrial statistic "I" and relative percent difference (RPD) for duplicate analyses, and the relative standard deviation (RSD) for triplicate analyses. The "I" statistic is defined as the absolute value of the difference between duplicate measurements, divided by the sum of the duplicates. The RPD is defined as the absolute value of the difference between two duplicate measurements, divided by the mean of the duplicates, multiplied by 100. The RSD is defined as the sample standard deviation divided by the mean, multiplied by 100.

All instrument printouts and other raw data generated using MSL analytical instruments are filed at MSL for future reference. Procedures and related data were written into the appropriate LRB. Raw data generated by offsite analytical facilities are retained at those facilities, but can be made available for inspection.

For PCBs and pesticides, all Gas Chromatograph (GC) analyses required qualitative and quantitative confirmation using a second column which is different from the one used in the initial GC analyses.

2.6.3 Toxicological Testing Quality Control Procedures

Test organisms were handled carefully during collection and transfer to test containers. Organisms shipped to MSL were gradually equilibrated to ambient surroundings, and kept in their native sediment whenever possible. Animals were fed, if necessary, before biological testing. Information on the collecting and handling of each test species is included in Section 2.2.3.

Selection of species was consistent with the 1991 Implementation Manual and involved the use of juvenile forms, burrowing invertebrates, deposit feeding organisms, and a larval (planktonic) form. Representatives of all test organisms were taxonomically identified by qualified experts at MSL before use in bioassays.

During all bioassay tests, water quality parameters were measured to ensure that acceptable experimental conditions were maintained. These conditions included a stable temperature (±2.0°C and ±1°C for oysters), DO limit of 4.0 or 6.0 mg/L (depending on the test), and 14 h of light per day. Salinity was allowed to vary ±2.0‰, and pH was allowed to vary ±0.5 units within each test container during the bioassay period. These limits and values are consistent with those outlined in the 1991 Implementation Manual. Water quality instruments were calibrated according to the manufacturer's specification or PNL protocols.

3.0 RESULTS

This section includes a discussion of sediment sampling results and geologic descriptions, as well as detailed results of sediment chemistry, toxicological testing, and tissue chemistry. Complete appendixes containing all data for this report are presented in Ward et al. (1991).

3.1 SEDIMENT SAMPLING RESULTS

Sediment sampling for Oakland Harbor Phase III 38-Foot Project took place between September 18 and 21, 1990. All sediment samples were collected following the procedures described in Section 2.1. Sediment core samples were collected at 29 of the anticipated 32 stations in Oakland Inner Harbor designated as I-C3 through I-C35. One 4-in. core and one 12-in. core was collected at each station from mudline to -39 ft MLLW as indicated in Tables 3.1 and 3.2. Each of the 4-in. cores was geologically described and composited for chemical evaluation and grain size analyses. Sediment obtained using the 12-in. core was composited and tested for biological responses (toxicity and bioaccumulation) as well as receiving chemical evaluations and grain size analyses. Table 3.3 shows the six composites and their respective sediment treatments.

Sediment samples were collected from eight locations in the Alcatraz Island Environs reference area, referred to as R-AM, and composited to obtain a representative sample of the reference site (Figure 3.1).

Control sediment for use in solid-phase toxicity tests was collected from Sequim Bay, Washington (Figure 3.2); West Beach, Whidbey Island, Washington (Figure 3.3); and Tomales Bay, California (Figure 3.4) as described in Section 2.1.3. Sequim Bay control sediment (C-SB) was used as an experimental grain size control in all toxicity tests and the native control for *M. nasuta*. West Beach control sediment (C-WB) is the native sediment for the amphipod *R. abronius*; Tomales Bay control sediment (C-NE) is the native sediment for *N. caecoides* and *C. stigmaeus*.

3.2 GEOLOGICAL DESCRIPTIONS

The following is a description of the geology of the Oakland Harbor Phase III 38-Foot Project area based on sediment characterization of 29 core samples collected in September

TABLE 3.1. Sampling Information for the 4-in. Core from Oakland Harbor Phase III 38-ft Project Compared to R-AM

Station	Replicate	Date	California State Plane Coordinates (Zone III) North (Y)	East (X)	Depth (-ft MLLW)	Core Required -39 ft MLLW (ft)	Core Collected (ft)
I-C3	1	09-21-90	478,893	1,469,593	37.2	1.8	2.1
I-C4[a]	NA[b]	09-21-90	478,100	1,471,436	36.5	2.5	None
I-C19	1	09-21-90	479,381	1,465,766	37.0	2.0	4.5
I-C20[c]	NA	09-21-90	479,192	1,466,712	38.6	0.4	None
I-C21	1	09-21-90	478,081	1,470,189	34.5	4.5	5.0
I-C5	1	09-21-90	476,668	1,474,656	36.2	2.8	4.0
I-C22	1	09-21-90	477,315	1,472,570	35.9	3.1	3.6
I-C23	1	09-21-90	476,845	1,474,152	37.0	2.0	4.4
I-C24	1	09-21-90	476,507	1,475,135	36.7	2.3	3.3
I-C25	1	09-21-90	476,358	1,475,571	36.8	2.2	2.7
I-C26	1	09-21-90	476,220	1,476,089	36.8	2.2	3.2
I-C27	1	09-21-90	476,108	1,476,747	37.0	2.0	3.1
I-C6[c]	NA	09-21-90	475,927	1,477,733	37.0	2.0	None
I-C3	1	09-21-90	475,480	1,481,316	37.9	1.1	2.2
I-C8	2	09-21-90	475,480	1,481,316	37.9	1.1	2.3
I-C28	1	09-21-90	475,139	1,479,530	34.9	4.1	4.1
I-C29	1	09-21-90	475,091	1,480,365	36.5	2.5	3.2
I-C30	1	09-21-90	475,170	1,480,995	36.5	2.5	2.8
I-C9	1	09-20-90	475,676	1,482,362	36.3	2.7	3.0
I-C10	1	09-20-90	475,765	1,482,876	36.5	2.5	3.8
I-C11	1	09-20-90	475,862	1,483,334	34.3	4.7	4.9
I-C12	1	09-20-90	475,890	1,483,804	38.3	0.7	3.1
I-C12	2	09-20-90	475,890	1,483,804	38.3	0.7	3.2
I-C31	1	09-20-90	475,858	1,481,878	34.0	5.0	5.9
I-C32	1	09-20-90	475,925	1,482,226	37.9	1.1	1.1
I-C32	2	09-20-90	475,925	1,482,226	37.9	1.1	1.8
I-C33	1	09-20-90	475,656	1,483,139	37.5	1.5	2.7
I-C33	2	09-20-90	475,656	1,483,139	37.5	1.5	2.8
I-C34	1	09-20-90	475,696	1,483,700	37.9	1.1	2.1
I-C34	2	09-20-90	475,696	1,483,700	37.9	1.1	2.5
I-C13	1	09-19-90	475,922	1,484,268	36.8	2.2	4.4
I-C14	1	09-19-90	475,889	1,485,017	36.3	2.7	4.3
I-C15	1	09-19-90	475,717	1,485,702	34.9	4.1	4.8
I-C18	1	09-19-90	475,618	1,486,541	37.9	1.1	1.5
I-C18	2	09-19-90	475,618	1,486,541	37.9	1.1	2.0

TABLE 3.1. (contd)

Station	Replicate	Date	California State Plane Coordinates (Zone III) North (Y)	East (X)	Depth (-ft MLLW)	Core Required -39 ft MLLW (ft)	Core Collected (ft)
I-C16	1	09-19-90	475,929	1,485,724	35.9	3.1	3.6
I-C17	1	09-19-90	476,063	1,485,718	38.0	1.0	4.0
I-C17	2	09-19-90	476,063	1,485,718	38.0	1.0	4.0
I-C35	1	09-19-90	476,185	1,485,744	31.0	8.0	10.0

(a) Access to station I-C4 was denied by the U.S. Navy while Alameda airstrip was in service. Station coordinates, depth and core required pertain to the planned sampling location.
(b) NA Not applicable.
(c) Station I-C6 and I-C20 were abandoned because depth was greater than -39 ft MLLW within a radius of 50 ft from the planned location. Station coordinates, depth and core required pertain to the planned sampling location.

1990. Sediment cores were described according to ASTM Procedure D2488-84: "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)" (ASTM 1984). Sediment characteristics that were evaluated include dilatancy, toughness and plasticity of silt/clay, sediment type (i.e., engineering classification), color, consistency (i.e., firmness), cementation, sedimentary structure, reaction with hydrochloric acid, maximum particle size, and odor. In addition, any other features such as the presence of root traces, mollusk shells, and/or related detritus were noted. A detailed description of the materials and methods used for describing the cores, copies of the core data logs, and a key to the abbreviations used are presented in Appendix B of Ward et al. (1991).

The geologic units comprising the Phase III 38-Foot Project area are Older Bay Mud (OBM) and Younger Bay Mud (YBM) (USACE 1975).

3.2.1 Older Bay Mud

The OBM is distinguished by its firm-to-hard consistency and its color, which often consists of various shades of red, yellow, and brown. These colors indicate an oxidizing environment. Deposits with grain sizes ranging from loose sands to hard, stiff silty clays can be found in the OBM. Merritt Sands are occasionally found in OBM and are characterized by highly compacted sediment with sand-sized particles throughout. The vertical position within the sediment column and the weathered and bleached appearance of the OBM suggests that this sediment is much older than the relatively recent estuarine sediments belonging to the YBM.

TABLE 3.2. Sampling Information for the 12-in. Core from Oakland Harbor Phase III -38-ft Project Compared to R-AM

Station	Replicate	Date	California State Plane Coordinates (Zone III) North (Y)	East (X)	Depth (-ft MLLW)	Core Required -39 ft MLLW (ft)	Core Collected (ft)	Mudline to -38 ft MLLW Contribution to Comp[a] (gal)	(comp)
I-C3	1	09-21-90	478,893	1,469,593	37.2	1.8	6.8	9 to	Comp I
I-C4[b]	NA[c]	09-21-90	478,100	1,471,438	37.0	2.0	None	0 to	Comp I
I-C19	1	09-21-90	479,381	1,465,766	37.0	2.0	4.5	5 to	Comp I
I-C19	2	09-21-90	479,381	1,465,766	37.0	2.0	5.5	9 to	Comp I
I-C21	1	09-21-90	478,081	1,470,189	34.5	4.5	7.5	9 to	Comp I
I-C5	1	09-21-90	476,668	1,474,656	36.2	2.8	8.9	7.5 to	Comp II
I-C22	1	09-21-90	477,315	1,472,570	35.9	3.1	7.3	5 to	Comp II
I-C23	1	09-21-90	476,845	1,474,152	37.0	2.0	4.0	5 to	Comp II
I-C24	1	09-21-90	476,507	1,475,135	36.7	2.3	3.2	5 to	Comp II
I-C25	1	09-21-90	476,358	1,475,571	36.8	2.2	7.4	5 to	Comp II
I-C26	1	09-21-90	476,220	1,476,089	36.8	2.2	4.5	4 to	Comp II
I-C27	1	09-21-90	476,108	1,476,747	37.0	2.0	5.5	7 to	Comp II
I-C6[d]	NA	09-21-90	475,927	1,477,733	37.0	2.0	None	0 to	Comp III
I-C8	1	09-21-90	475,480	1,481,316	37.9	1.1	7.5	3 to	Comp III
I-C28	1	09-21-90	475,139	1,479,530	34.9	4.1	8.2	15 to	Comp III
I-C29	1	09-21-90	475,091	1,480,365	36.5	2.5	9.2	8 to	Comp III
I-C30	1	09-21-90	475,170	1,480,995	36.5	2.5	4.9	5 to	Comp III
I-C9	1	09-20-90	475,676	1,482,362	36.3	2.7	7.9	6 to	Comp IV
I-C10	1	09-20-90	475,765	1,482,876	36.5	2.5	7.7	6 to	Comp IV
I-C11	1	09-20-90	475,862	1,483,334	34.3	4.7	5.0	5 to	Comp IV
I-C12	1	09-20-90	475,890	1,483,804	38.3	0.7	7.1	2.5 to	Comp IV
I-C31	1	09-20-90	475,858	1,481,878	34.0	5.0	5.9	7.5 to	Comp IV
I-C32	1	09-20-90	475,925	1,482,226	37.9	1.1	5.5	2.5 to	Comp IV
I-C33	1	09-20-90	475,656	1,483,139	37.5	1.5	4.7	1.5 to	Comp IV
I-C34	1	09-20-90	475,696	1,483,700	37.9	1.1	4.1	1.5 to	Comp IV

TABLE 3.2. (contd)

Station	Replicate	Date	California State Plane Coordinates (Zone III) North (Y)	East (X)	Depth (-ft MLLW)	Core Required -39 ft MLLW (ft)	Core Collected (ft)	Mudline to -38 ft MLLW Contribution to Comp[a] (gal)	(comp)
I-C13	1	09-19-90	475,922	1,484,268	36.8	2.2	4.5	6 to	Comp V
I-C14	1	09-19-90	475,889	1,485,017	36.3	2.7	8.7	9 to	Comp V
I-C15	1	09-19-90	475,717	1,485,702	34.9	4.1	7.8	15 to	Comp V
I-C18	2	09-19-90	475,618	1,486,541	37.9	1.1	6.8	1.5 to	Comp V
I-C18	1	09-19-90	475,618	1,486,541	37.9	1.1	8.4	1.5 to	Comp V
I-C16	1	09-19-90	475,929	1,485,724	35.9	3.1	7.2	9 to	Comp VI
I-C17	1	09-19-90	476,063	1,485,718	38.0	1.0	7.7	4 to	Comp VI
I-C35	1	09-19-90	476,185	1,485,744	31.0	8.0	11.7	20 to	Comp VI

(a) Approximately equivalent fraction (i.e., 1/3) of mudline to -39 ft segment of each core taken for composites.
(b) Access to Station I-C4 was denied by the U.S. Navy while Alameda airstrip was in service. Station coordinates, depth, and core required pertain to the planned sampling location.
(c) NA Not applicable.
(d) Station I-C6 was abandoned because depth was greater than -39 ft MLLW within a circular radius of 50 ft from the planned location. Station coordinates, depth, and core required pertain to the planned sampling location.

TABLE 3.3. The Six Composites Showing Their Respective Sediment Treatments

COMP I	COMP IV
I-C3	I-C9
I-C19	I-C10
I-C21	I-C11
	I-C12
COMP II	I-C31
I-C5	I-C32
I-C22	I-C33
I-C23	I-C34
I-C24	
I-C25	COMP V
I-C26	I-C13
I-C27	I-C14
	I-C15
COMP III	I-C18
I-C8	
I-C28	COMP VI
I-C29	I-C16
I-C30	I-C17
	I-C35

Table 3.4 gives the mudline depth, thickness of YBM and OBM, and a brief physical description of each sediment sample. This table shows that OBM was not present in core samples from stations contributing to COMP I and was in only one sample that contributed to COMP II. The OBM represented approximately 50% of the sediment from core samples contributing to COMPs III, IV, V, and VI. As shown in Table 3.4, sediment samples that contributed to COMPs III, IV, V, and VI contained both YBM and OBM sections. The OBM sections were composed of gravelly or silty sands; the YBM sections were composed of clay and sand.

3.2.2 Younger Bay Mud

The YBM consists of mostly soft, dark-colored sediments deposited in an estuarine environment. This layer consists mostly of silty clays with portions of fine sand. The YBM colors ranged from dark olive gray to black and had an odor of rotten eggs (i.e., hydrogen sulfide), which is an indicator of chemically reducing conditions. The YBM generally has a very soft consistency and is distinguished from the OBM by a sudden characteristic change in consistency. Sediment samples that contributed to COMP I and COMP II (except I-C27) were entirely YBM (Table 3.4). These samples were located in the upper 2 to 5 ft of sediment from

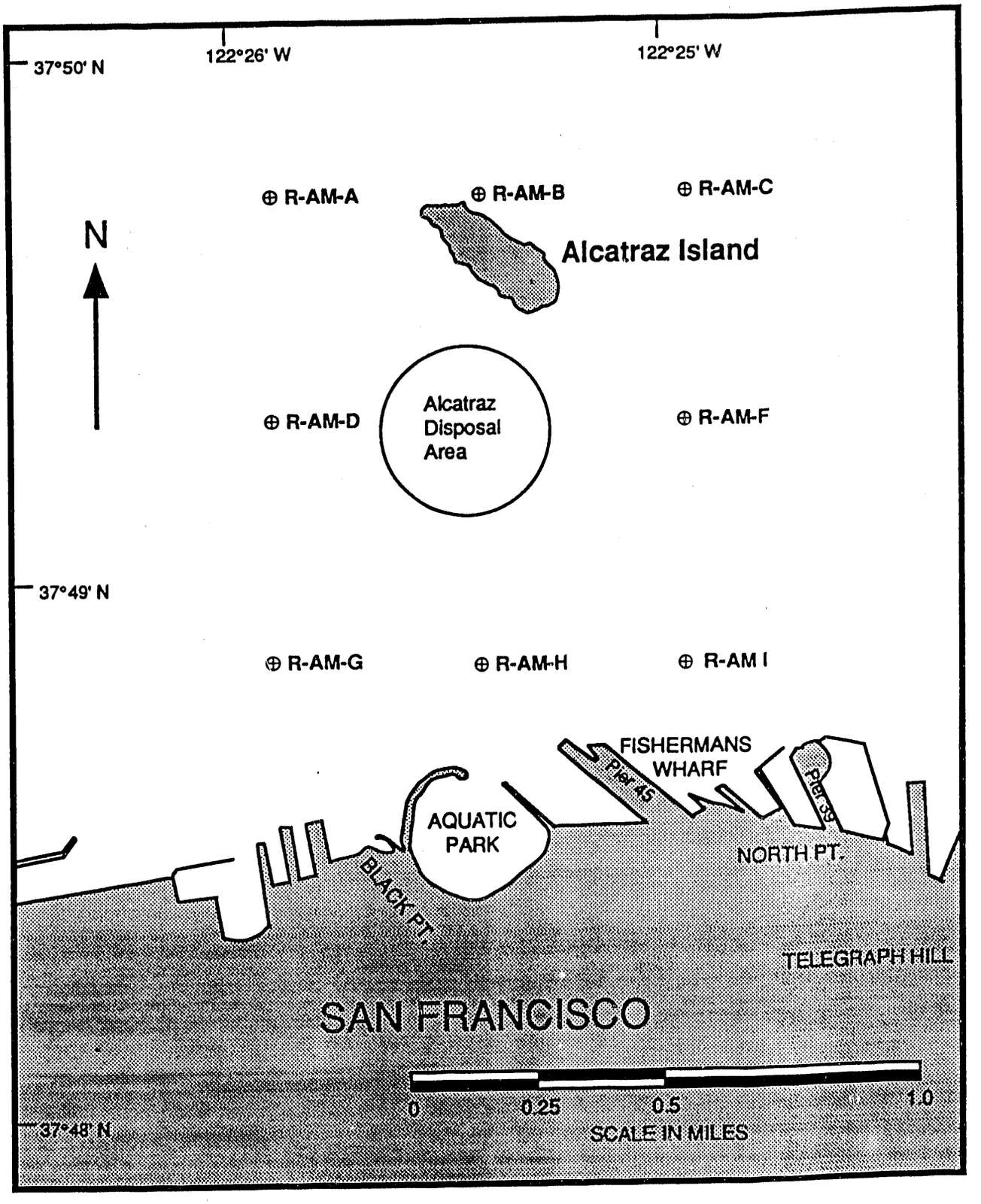


FIGURE 3.1. Reference Sediment Sampling Site Near Alcatraz Island Environs (R-AM)

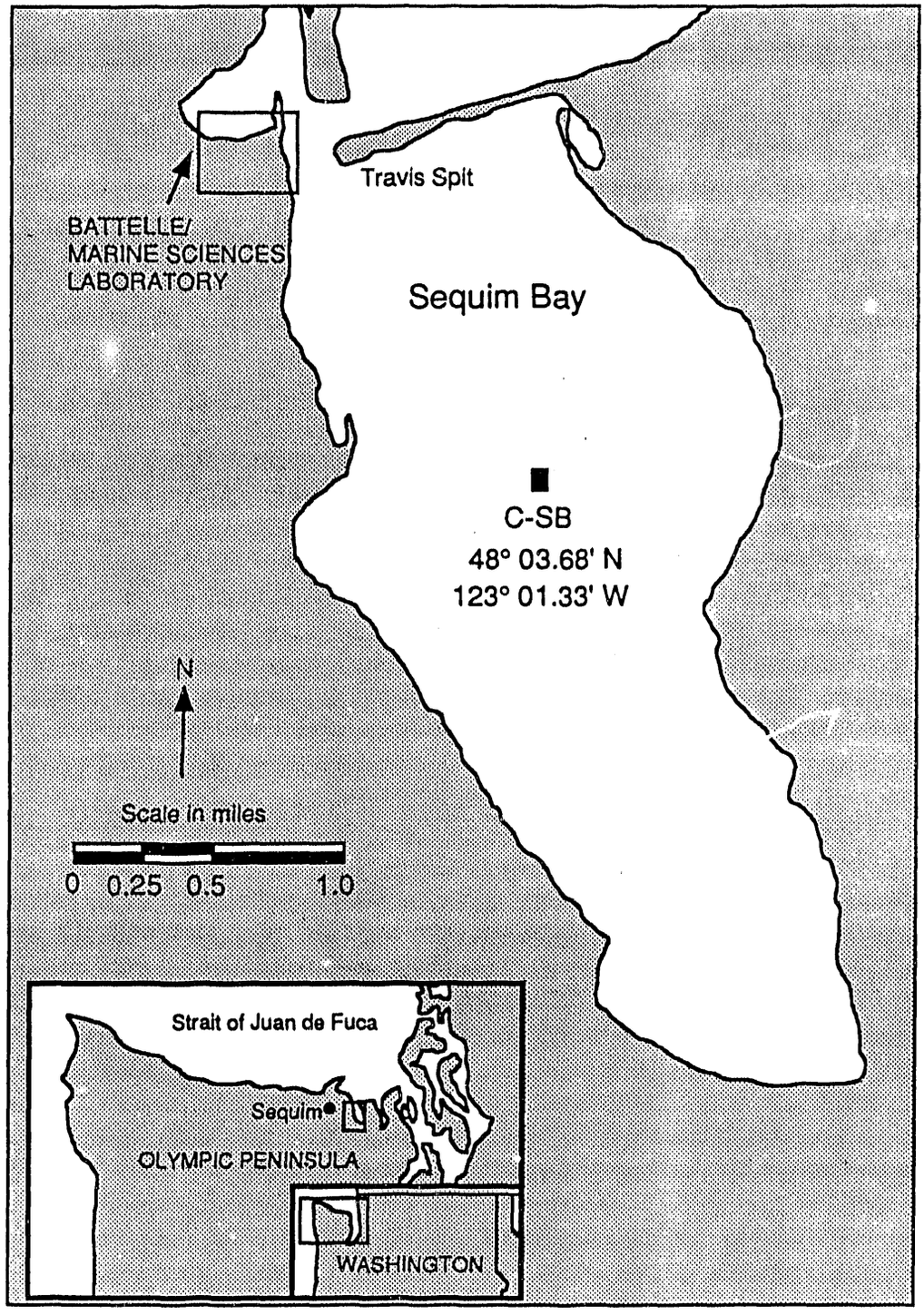


FIGURE 3.2. Location of Sequim Bay, Washington, Control Station (C-SB)

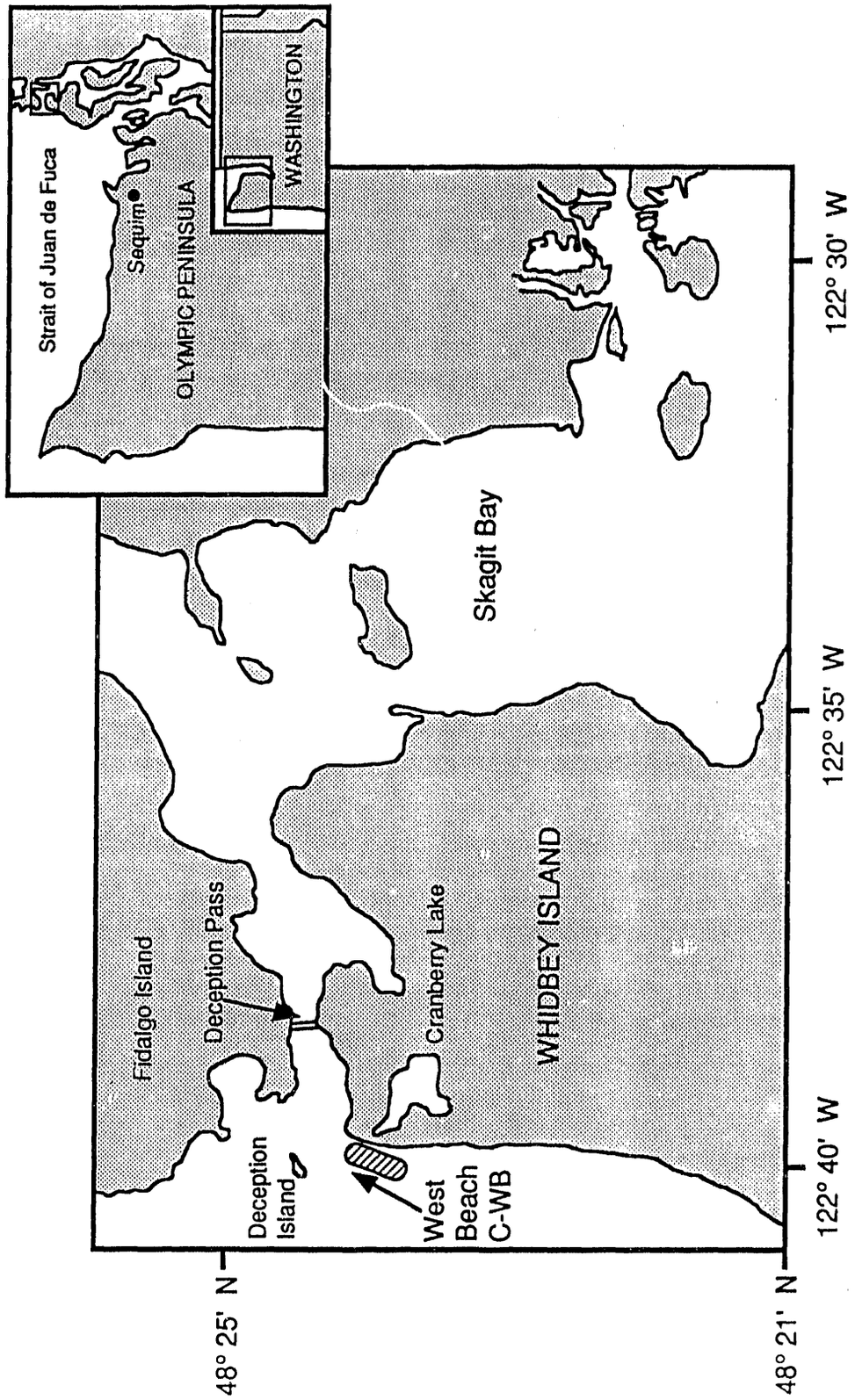


FIGURE 3.3. Location of West Beach, Whidbey Island, Washington, Control Station (C-WB)

FIGURE 3.3. Location of West Beach, Whidbey Island, Washington, Control Station (C-WB)

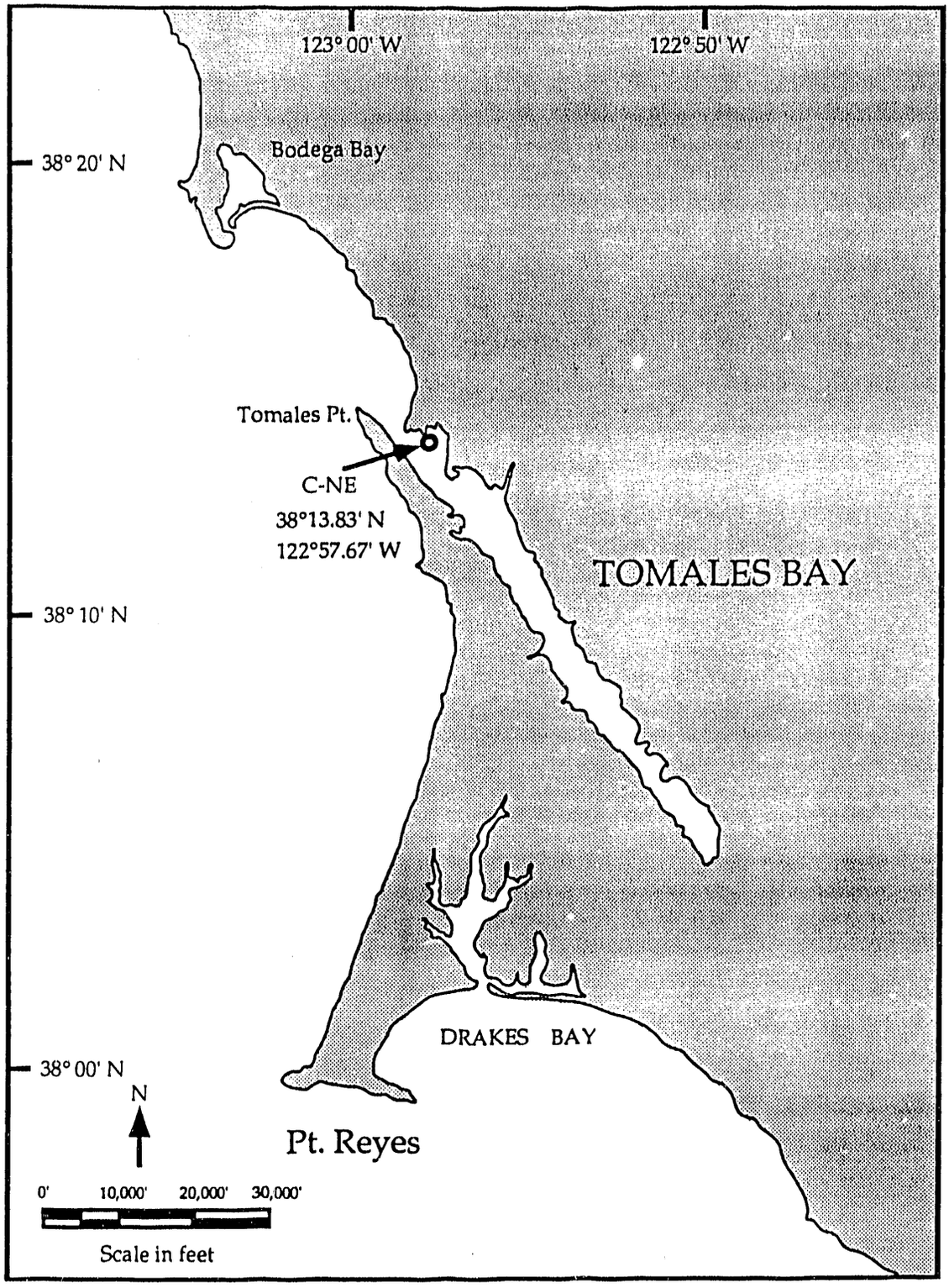


FIGURE 3.4. Location of Dillon Beach/Tomales Bay, California, Control Station (C-NE)

TABLE 3.4. Summary of Geological Descriptions

Sediment Treatment	Mudline -ft MLLW	Sediment Thickness, ft YBM[a]	OBM[b]	Physical Description (to -38 ft)
COMP I				
I-C3	37.2	2.2	0.0	Clay with sand; gravelly sands
I-C19	37.0	4.6	0.0	Silty clays with sand
I-C21	34.5	5.0	0.0	Clay with sand and gravelly sand
COMP II				
I-C5	36.2	4.0	0.0	Clay with sand; gradual darkening
I-C22	35.9	3.7	0.0	Clay with sand
I-C23	37.0	4.4	0.0	Clay with sand
I-C24	36.7	3.5	0.0	Clay with sand
I-C25	36.8	3.2	0.0	Clay with sand
I-C26	36.8	3.3	0.0	Clay with sand
I-C27	37.0	1.6	1.3	YBM-Clay with sand; OBM-sands
COMP III				
I-C8	37.2	0.8	1.6	YBM-silts and fine sands; OBM-gravelly sands
I-C28	34.9	3.0	1.5	YBM-clay with sand; OBM-gravelly sands
I-C29	36.5	3.1	0.0	YBM-clay with sand
I-C30	36.5	1.9	0.6	YBM-clay with sand; OBM-sands
COMP IV				
I-C9	36.3	3.0	0.0	Clay with sand
I-C10	36.5	2.0	1.3	YBM-clay with sand; OBM-gravelly sands
I-C11	34.3	1.9	2.8	YBM-clay with sand; OBM-merrit sands
I-C12	38.3	2.1	1.1	YBM-clay with sand; OBM-silty sands
I-C31	34.0	3.0	2.4	YBM-clay with sand; OBM-gravelly sands
I-C32	37.9	1.6	0.0	Clay with sand
I-C33	37.5	1.5	1.2	YBM-clayey sands; OBM-gravelly sands
I-C34	37.9	1.5	1.0	YBM-clays; OBM-gravelly sands
COMP V				
I-C13	36.8	1.3	2.0	YBM-clay with sand; OBM-gravelly sands
I-C14	36.3	2.0	1.6	YBM-clay with sand; OBM-gravelly/silty sands
I-C15	34.9	2.1	2.1	YBM-clay with sand; OBM-clay
I-C18	37.9	1.1	1.0	YBM-clay with sand; OBM-silty sands
COMP VI				
I-C16	35.9	1.7	1.7	YBM-clay with sand; OBM-clay
I-C17	38.0	1.5	1.7	YBM-clay with sand; OBM-clay with sand
I-C35	31.0	6.0	2.8	YBM-clay with sand; OBM-gravelly/silty sands

(a) YBM - Younger Bay Mud
(b) OBM - Older Bay Mud

the outer and middle areas of Oakland Inner Harbor (Figure 1.1). The YBM unit from cores in COMPs III, IV, V, and VI was generally within the upper 3.0 ft of the sediment column and overlayed the OBM.

3.3 SEDIMENT CHEMISTRY

The analytical chemistry results of the 4-in. sediment cores, the six composite samples, the reference sediment (R-AM), and the three control sediments are presented in terms of dry weight in the following sections. Complete sediment chemistry results, quality control data, and quality control summaries can be found in Appendix C of Ward et al. (1991).

3.3.1 Sediment Conventional Measurements

Sediment conventional measurements are grain size, TOC, TVS, oil and grease, and TPH. Grain size, TOC, and TVS are expressed as percent dry weight of the sample. Oil and grease and TPH concentrations are expressed as mg/kg dry weight. A summary of sediment conventional measurements is presented in Table 3.5.

The grain size results presented in Figure 3.5, show that Oakland Harbor sediments are composed of a mixture of sediment grain sizes within each COMP. The respective subsamples within COMP I show a predominantly coarse-grained sediment distribution (between 35% and 70% sand or coarser), while the composite sample had approximately equal percentages of sand, silt and clay. COMP II and its respective stations showed a significant amount of fine-grained sediments with less than 10% consisting of sand or gravel except for Station I-C27, which had approximately equal distributions of sand, silt, and clay fractions. COMP III and Station I-C29 contained approximately equal distributions of sand, silt, and clay fractions while I-C8, I-C28, I-C28 dup, and I-C30 are composed primarily of sandy sediments. COMP IV and its respective stations are divided with five samples containing predominantly coarse-grained sediments (COMP IV, I-C10, I-C11, I-C31, and I-C33) and four stations containing predominantly fine-grained sediments (I-C9, I-C12, I-C32, and I-C34). COMP V and its respective stations are composed primarily of coarse-grained sediments. COMP VI and its respective stations are essentially fine-grained sediments with the exception of the sandy Station I-C16. The control sediments C-NE and C-WB have a 95% or greater coarse grain size, while C-SB contains 20% coarse-grained sediment and 80% fine-grained sediment. The reference sediment R-AM is composed of 98% coarse-grained sediment (not shown in Figure 3.5).

TABLE 3.5. Conventional Sediment Measurements Results (grain size, TOC, and TVS in percent dry weight; Oil and Grease and TPH in mg/kg dry weight)

Sediment Treatment	Gravel >2000 µm	Sand 62.5-2000 µm	Silt 3.9-62.5 µm	Clay <3.9 µm	TOC	TVS	Oil and Grease	TPH
COMP I	0	32	32	36	0.88	7.01	105	87
COMP I dup	0	31	32	37	0.36	7.94	89	75
I-C3	0	49	22	29	0.61	5.60	48	37
I-C19	21	13	29	37	0.61	8.75	18	17
I-C21	0	68	15	17	0.32	3.52	47	18
COMP II	0	8	44	48	1.14	8.77	69	59
I-C5	0	7	43	50	1.13	9.48	111	68
I-C22	0	11	43	46	1.05	9.30	78	58
I-C23	0	9	46	45	1.12	8.96	79	43
I-C24	0	8	45	47	1.05	9.02	77	40
I-C25	0	6	43	51	1.19	8.90	146	121
I-C25 top 12"	0	10	53	37	1.35	10.60	128	81
I-C26	0	8	45	47	1.13	9.06	16	62
I-C27	0	32	33	35	0.81	5.69	57	29
COMP III	0	38	29	33	0.90	5.95	202	167
I-C8	0	70	15	15	0.21	2.63	33	12
I-C28	0	51	23	26	0.56	4.94	125	97
I-C29	0	29	31	40	1.01	6.25	245	181
I-C30	0	55	19	26	0.60	4.67	14	0.8 U[a]
COMP IV	0	53	19	28	0.61	5.06	74	49
I-C9	0	26	31	43	1.03	7.50	175	142
I-C10	0	79	8	13	0.22	2.63	21	18
I-C11	0	76	10	14	0.24	2.76	49	36
I-C12	0	14	34	52	1.15	8.67	100	93
I-C31	0	63	14	23	0.45	4.38	53	47
I-C32	0	5	38	57	1.31	10.01	158	124
I-C33	0	65	14	21	0.43	3.74	57	42
I-C34	0	26	28	46	0.99	9.42	90	48
COMP V	0	65	18	17	0.22	2.99	58	36
I-C13	0	71	11	18	0.34	3.49	66	59
I-C14	0	56	17	27	0.51	4.40	82	65

TABLE 3.5. (contd)

Sediment Treatment	Gravel >2000 µm	Sand 62.5-2000 µm	Silt 3.9-62.5 µm	Clay <3.9 µm	TOC	TVS	Oil and Grease	TPH
I-C15	1	62	20	17	0.20	2.84	29	20
I-C18	1	52	24	23	0.44	3.75	135	102
COMP VI	0	41	32	27	0.36	3.96	58	51
I-C16	0	72	11	17	0.31	3.24	56	46
I-C17	0	17	32	51	1.25	8.46	188	145
I-C35	0	30	32	38	0.76	5.96	142	112
R-AC	0	15	40	45	0.94	8.61	92	78
R-AM	4	94	1	1	0.07	2.13	13	0.6 U
C-NE	0	95	1	4	0.07	1.43	15	2
C-SB	0	20	50	30	2.03	10.71	76	67
C-WB	0	98	1	1	0.11	1.19	21	9

(a) U Undetected above detection limit.

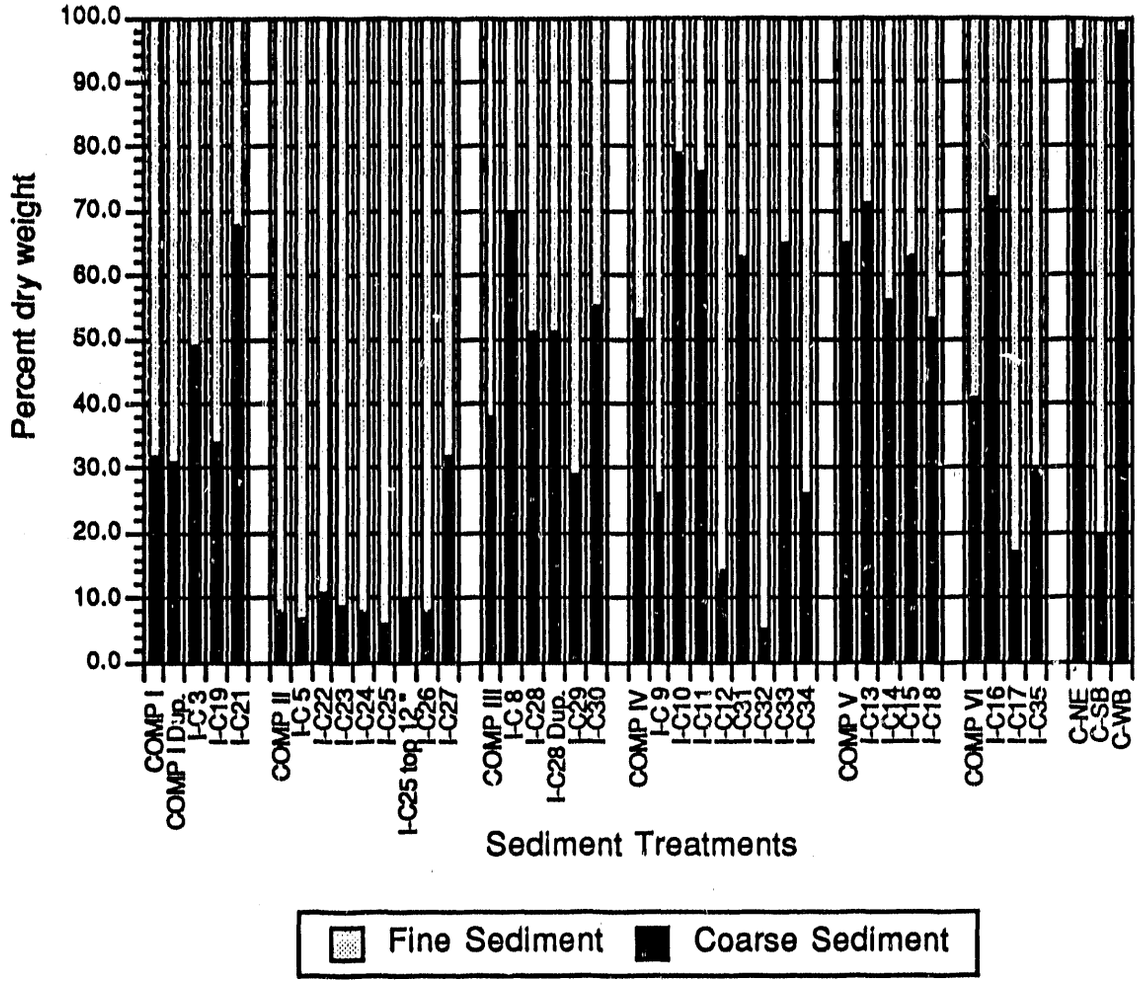


FIGURE 3.5. Grain Size Distribution in Sediment Treatments

The concentrations of TOC (Figure 3.6) in control sediments spanned the range of all test sediments with values ranging from 0.07% in the control sediment C-NE and the reference sediment R-AM to 2.03% in the control sediment C-SB. The COMPs, their respective stations, and the control sediments, all had TOC concentrations that were equal to or greater than the concentrations found in R-AM. In general, higher TOC values were found in the fine-grained sediment. Stations with more than 50% fine-grained sediment also had more than 0.50% TOC as shown in Figure 3.7. All the controls, reference R-AM, and sediment treatments follow this correlation, with the exception of C-SB, where 80% fine-grained sediment contained approximately twice as much TOC (2.03%) as indicated in the regression. The reference sediment R-AM, had only a 2% fine-grained sediment and 0.07% TOC, so this data point also fell outside of the linear regression with higher TOC values than predicted.

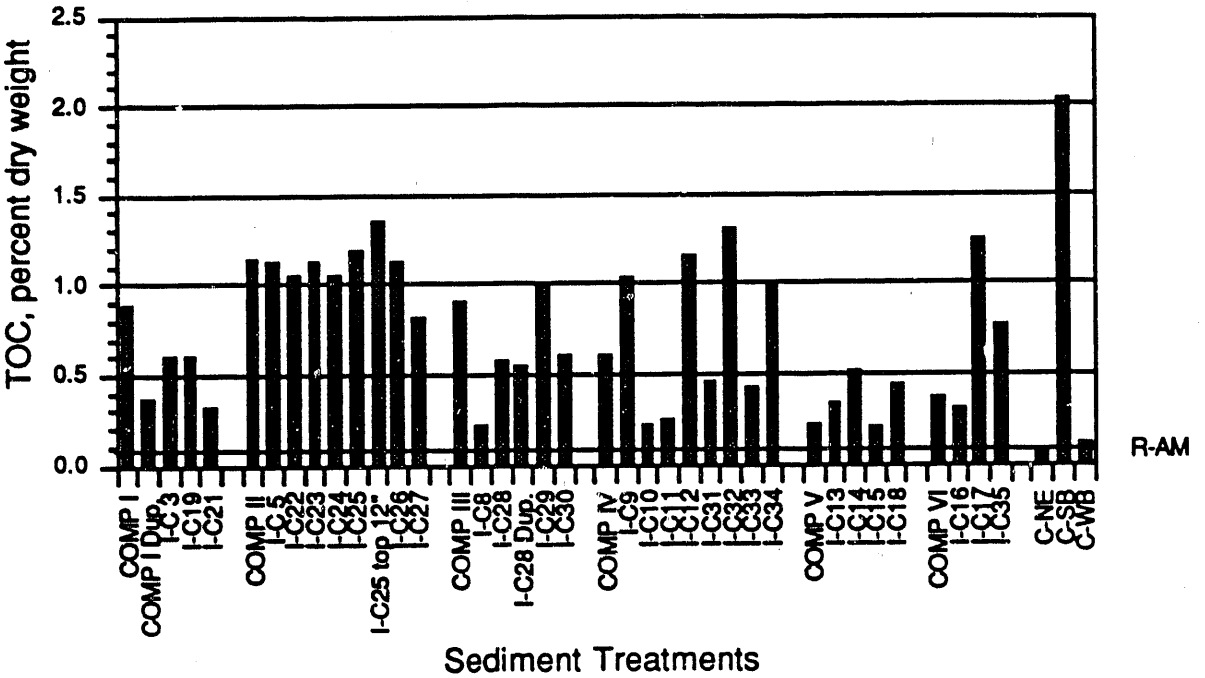


FIGURE 3.6. Concentrations of TOC in Sediment Treatments

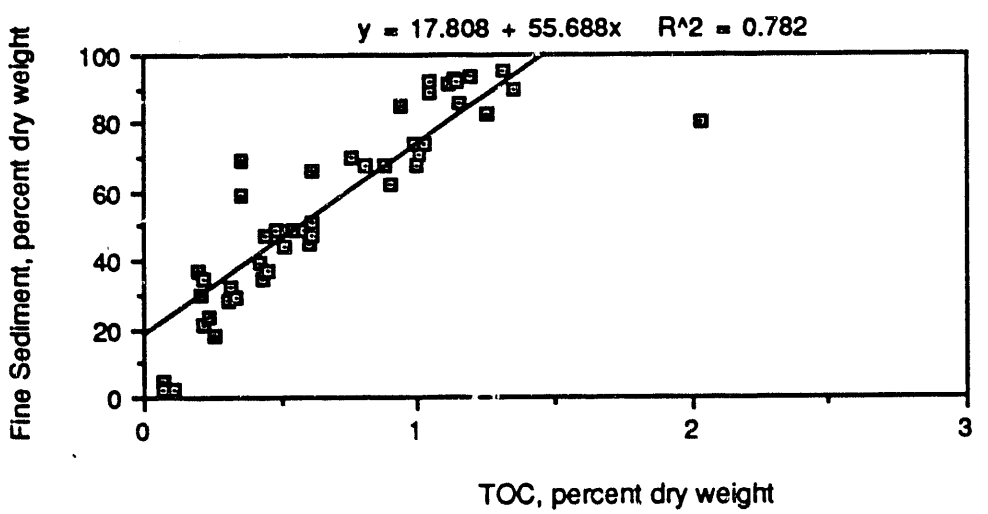


FIGURE 3.7. Linear Regression of TOC and Fine-Grain Size

The concentrations of TVS in control sediments encompassed the entire range from 1.19% in C-WB to 10.71% in C-SB (Figure 3.8). All COMPs and their respective stations had greater concentrations of TVS than the reference sediment R-AM. The control sediments C-NE and C-WB were the only stations that had TVS concentrations that were lower than R-AM. Similar to TOC, TVS concentrations were higher in stations containing fine-grained sediments as shown in Figure 3.9.

Figure 3.10 shows a linear regression representing the relationship between TOC and TVS. These two parameters are positively correlated with C-SB falling outside of the regression with more TOC than predicted based on TVS concentrations.

Oil and grease and TPH concentrations are presented in Figures 3.11 and 12. Oil and grease concentrations ranged from 14 mg/kg in I-C30 to 245 mg/kg in I-C29. Concentrations of TPH ranged from undetected at 0.6 mg/kg in R-AM to 181 mg/kg in I-C29. The reference sediment R-AM had an oil and grease value of 13 mg/kg dry weight and an undetected TPH value of 0.6 mg/kg dry weight. All COMPs, their respective stations, and the control sediments, had higher concentrations of oil and grease and TPH than the reference R-AM. Treatments with the highest concentrations of oil and grease also had the highest concentrations of TPH as shown in Figure 3.13. The exception to this correlation is I-C26, which contained 16 mg/kg of oil and grease and 62 mg/kg of TPH. Station I-C26 is aberrant because it contained high concentrations of oil and grease relative to the TPH concentration than predicted.

3.3.2 Polynuclear Aromatic Hydrocarbons

Total PAH consists of low molecular weight PAHs (LPAH) and high molecular weight PAHs (HPAH). The Inner Oakland Harbor sediments are predominantly HPAH (Figure 3.14). Total PAH concentrations ranged from 12 µg/kg dry weight in sediment from C-NE to 31,880 µg/kg dry weight in the top 12 in. of Station I-C35. All COMPs and their respective stations had total PAH concentrations that exceeded the total PAH found in the reference R-AM. Figure 3.15 compares total LPAH to total HPAH in a linear regression. Generally, the sediment samples that contained greater than 50% fine-grained material also had the highest concentrations of LPAH and HPAH. The top 12 in. of sediment treatment I-C35 (LPAH 464 µg/kg and HPAH 31,879.75 µg/kg) as well as station I-C17 (LPAH 648 µg/kg and HPAH 7284 µg/kg) were exceptions to the correlation.

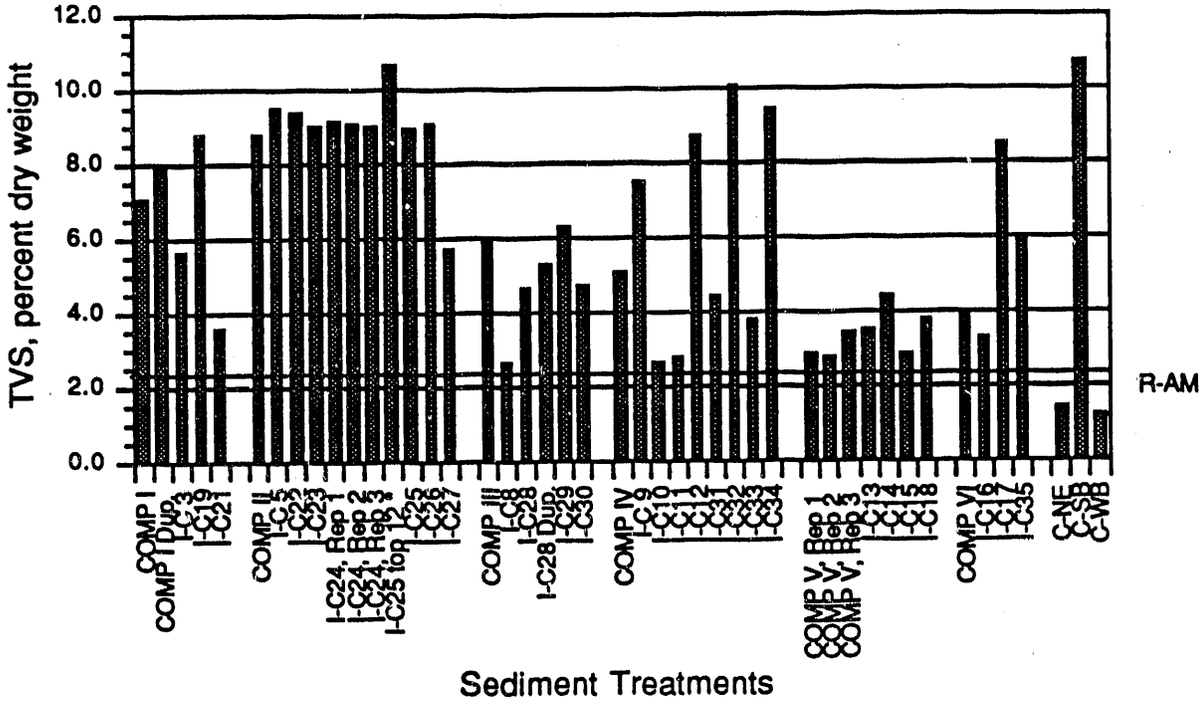


FIGURE 3.8. Concentrations of TVS in Sediment Treatments

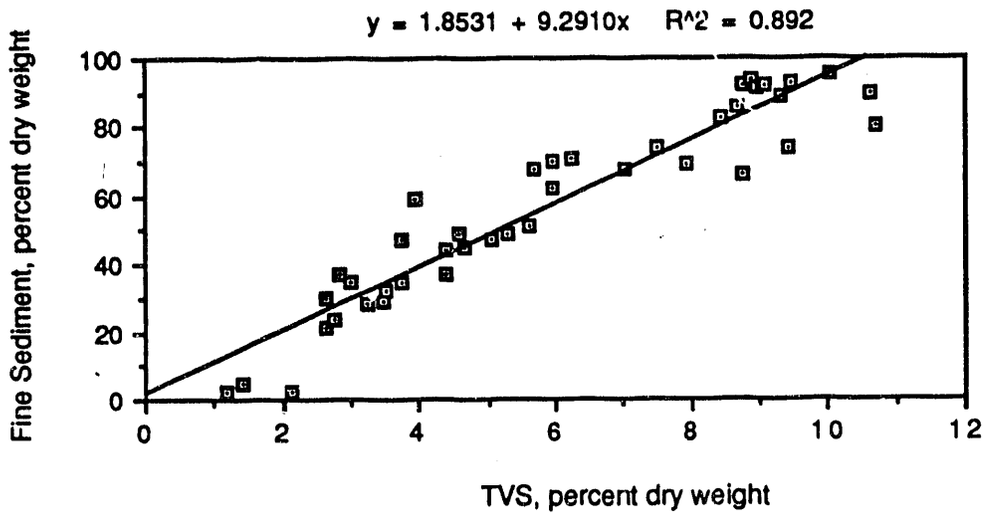


FIGURE 3.9. Linear Regression of TVS and Fine-Grain Size

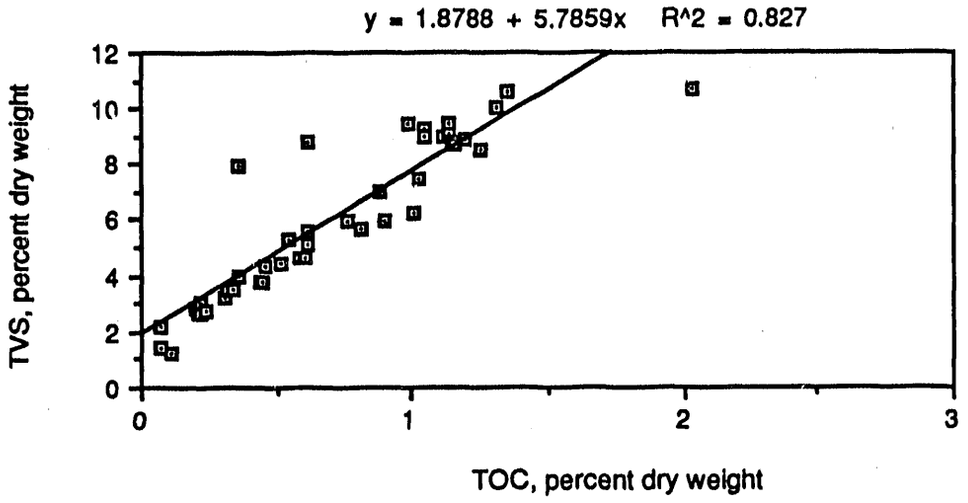


FIGURE 3.10. Linear Regression of TOC and TVS

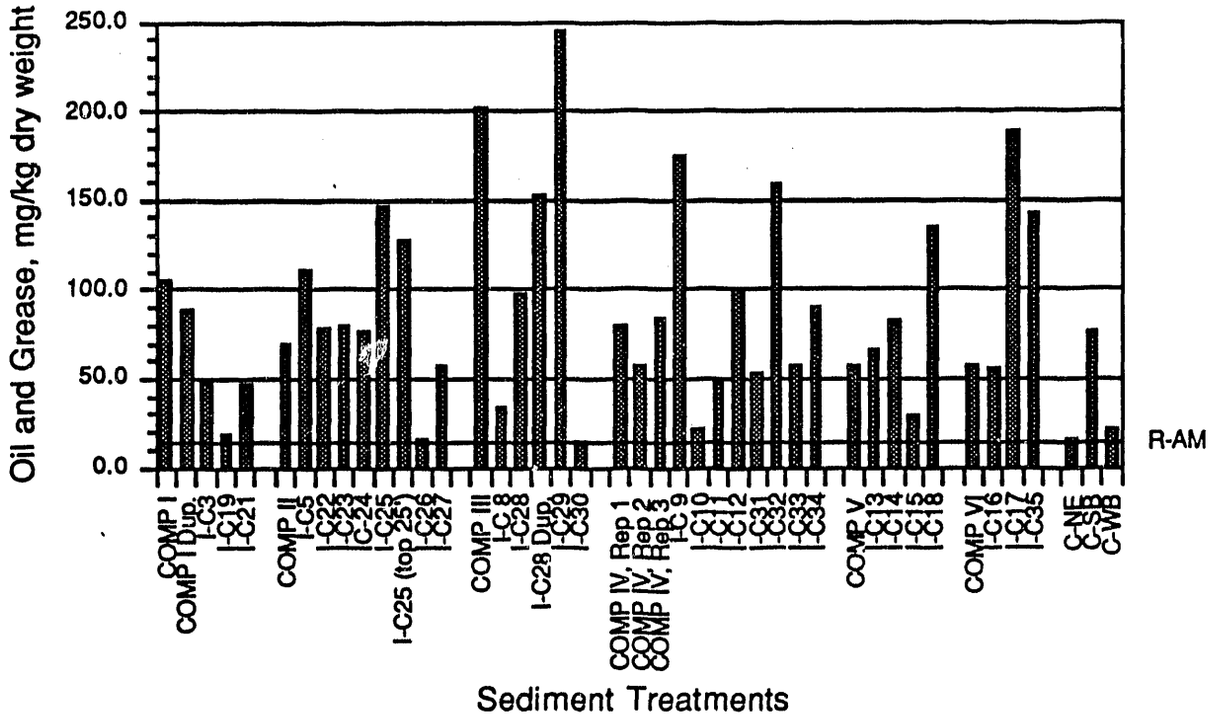


FIGURE 3.11. Concentrations of Oil and Grease in Sediment Treatments

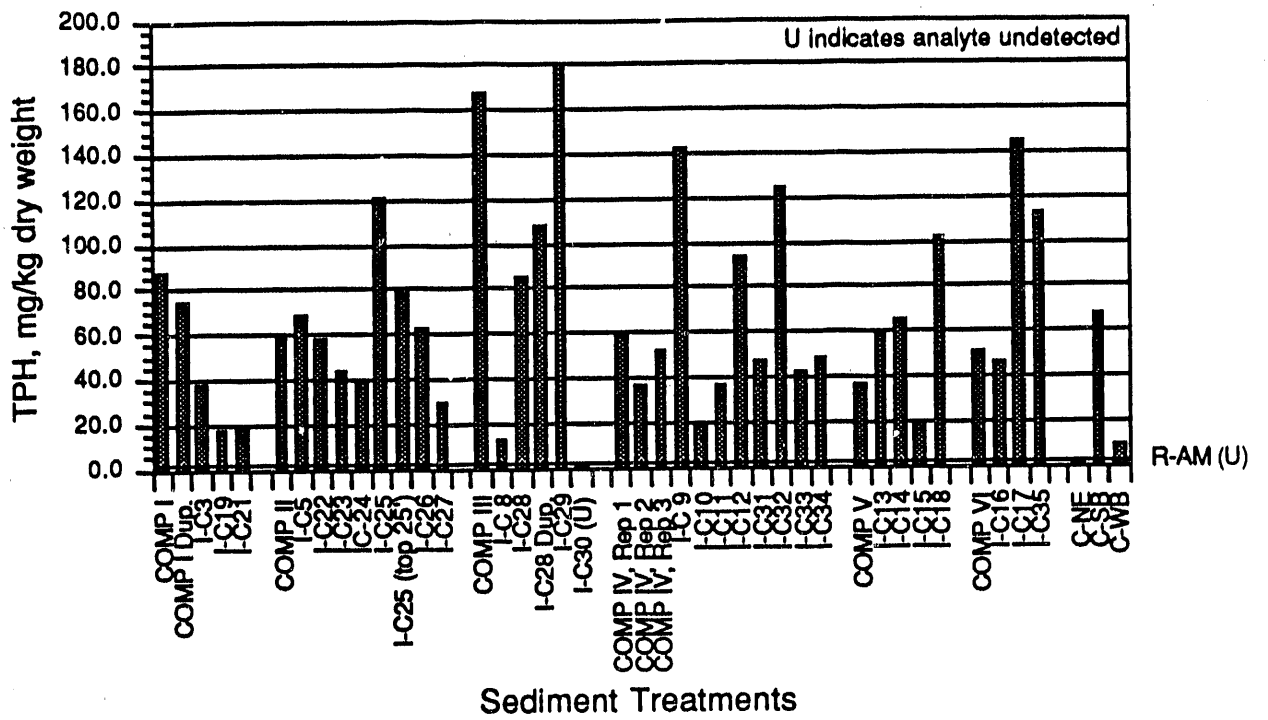


FIGURE 3.12. Concentrations of TPH in Sediment Treatments

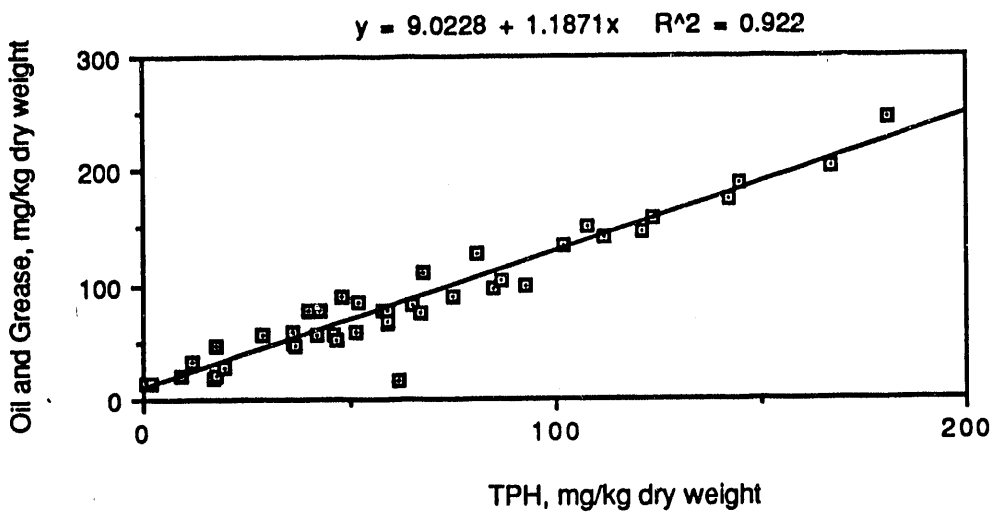


FIGURE 3.13. Linear Regression Between TPH and Oil and Grease

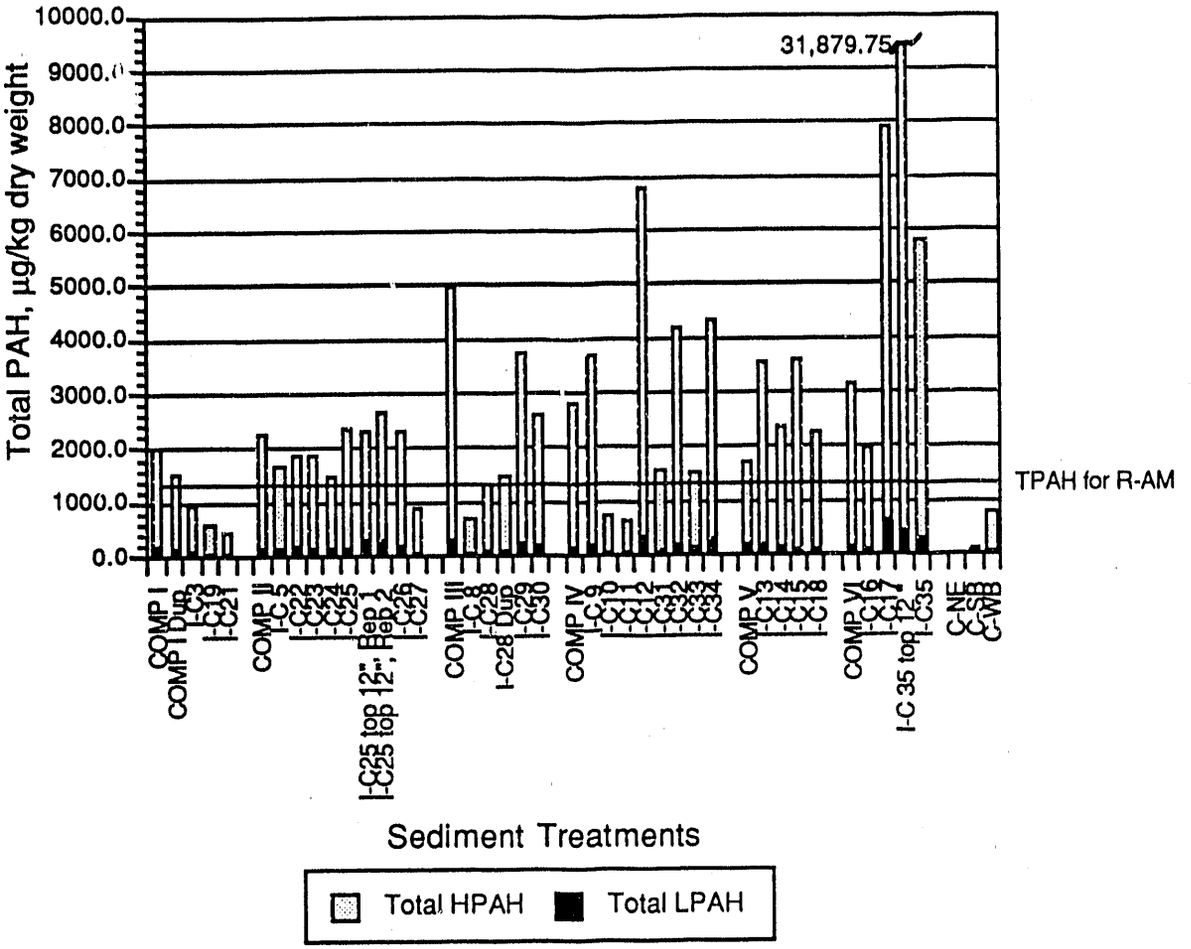


FIGURE 3.14. Concentrations of Total PAH in Sediment Treatments (Treatment I-C12 top 12 in. had a concentration of 31,879.75 µg/kg, which is above the vertical axis of the figure).

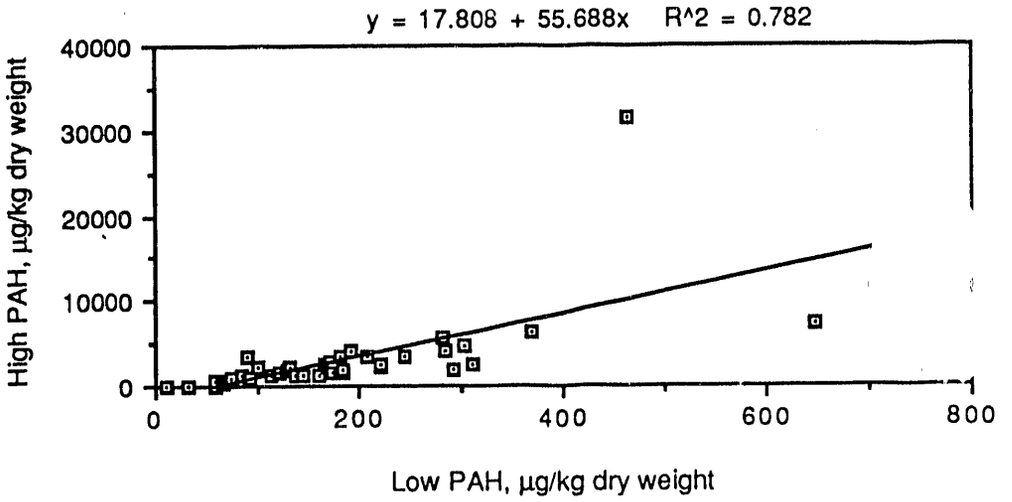


FIGURE 3.15. Linear Regression of LPAH to HPAH

3.3.3 Chlorinated Pesticides and Polychlorinated Biphenyls

Seven pesticide compounds had at least one detected value in the Oakland Harbor sediment. Pesticide compounds 4,4'-DDD, 4,4'-DDE, and Dieldrin are shown in Figures 3.16 through 3.18. The "B" flags in the graphs indicate that the pesticide was found in the blank associated with the sample. Because the amount in the blanks was less than twice the method detection limit, the sample concentrations were not blank-corrected. Some sediment treatments had higher undetected pesticide values than sediment treatments with detected pesticide values. This is due to the variance in the method detection limits for each pesticide. All three of these pesticide compounds were undetected in the reference sediment R-AM. Aroclor-1254 was the only PCB that had values above the detection limit (Figure 3.19). Detected concentrations of Aroclor-1254 ranged from 64 µg/kg in I-C10 to 410 µg/kg in I-C17. There were seven stations that had elevated detection limits ("UE" flag) because of chromatographic interference and there was a significant difference in quantitation between first and second columns. The reference sediment R-AM had an undetected value of 24 µg/kg of Aroclor-1254. All COMPs, their respective sediment treatments, and the control sediments had concentrations of Aroclor-1254 that were elevated above R-AM.

3.3.4 Metals

Ten metals were measured in the Oakland Harbor reference and control sediments. These metals concentrations are measured in mg/kg (ppm) dry weight. The six metals (As, Cr, Cu, Ni, Pb, and Zn) analyzed by the XRF method (Section 2.3.4) were analyzed in duplicate, while the remaining metals were analyzed in triplicate. All ten metals are ubiquitous in the natural environment; therefore, the metal concentration for each treatment, including the reference sediment R-AM and three control sediments, are compared to a typical shale soil sediment (Krauskopf 1967).

Concentrations of Ag (Figure 3.20) ranged from 0.03 mg/kg dry weight in control sediment C-WB to 0.87 mg/kg dry weight in station I-C29, a 29-fold range. All COMPs, their respective stations, and the control sediments had Ag concentrations above R-AM. All sediment treatments, with the exception of two test treatments and two control sediments, had Ag concentrations greater than that of typical shale soil (0.1 mg/kg dry weight) (Krauskopf 1967).

Concentrations of As (Figure 3.21) ranged from 2.94 mg/kg dry weight in C-WB to 12.1 mg/kg dry weight in I-C26, a 4.1-fold difference. The reference sediment R-AM had As

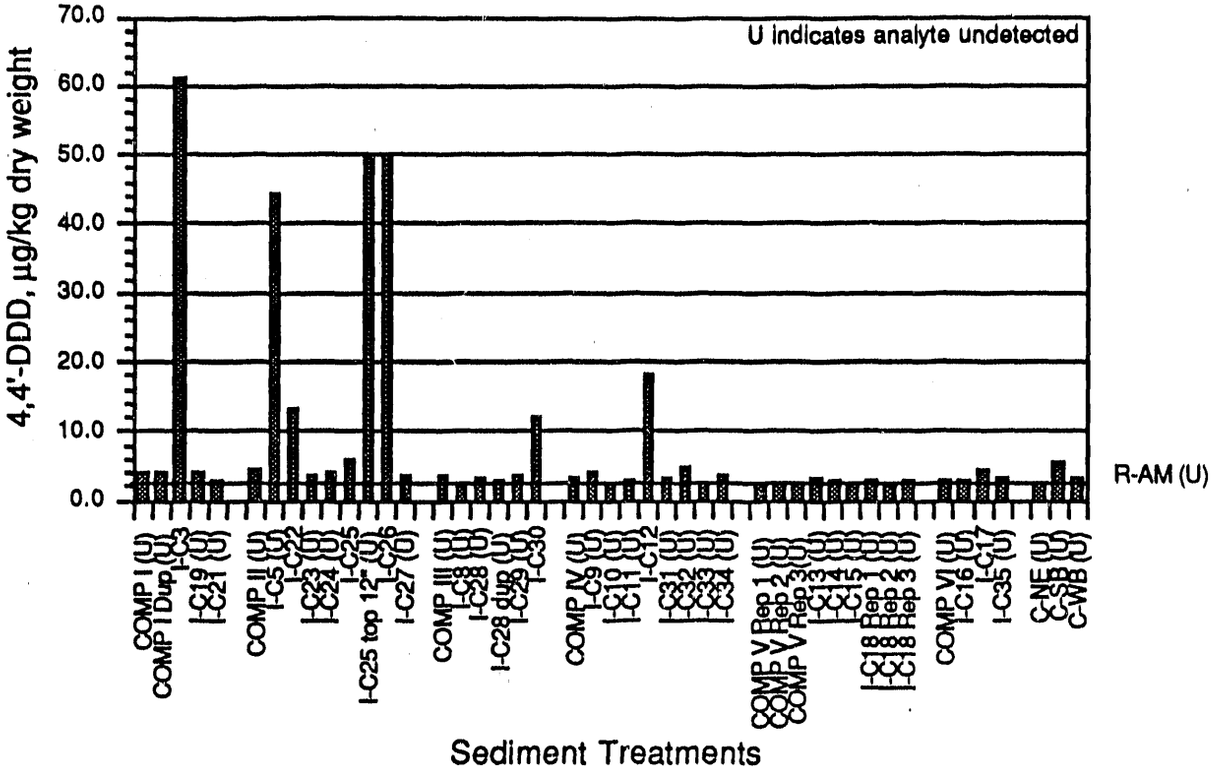


FIGURE 3.16. Concentrations of 4,4'-DDD in Sediment Treatments

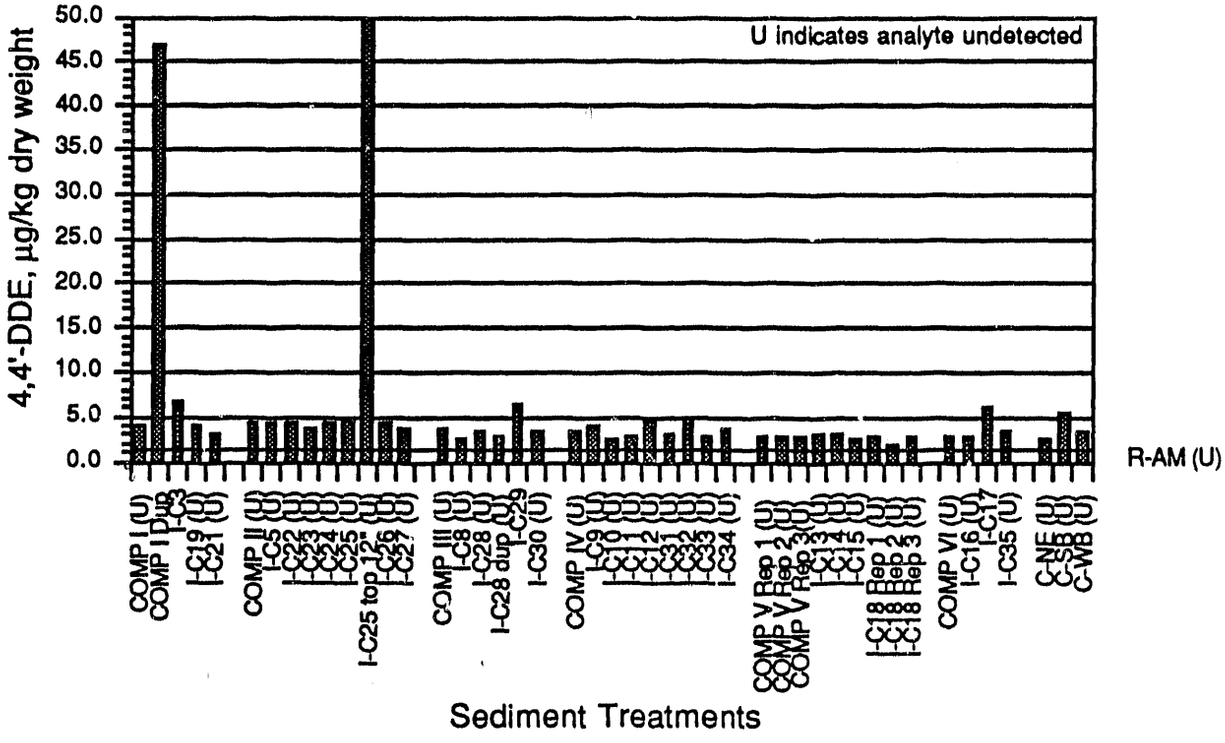


FIGURE 3.17. Concentrations of 4,4'-DDE in Sediment Treatments

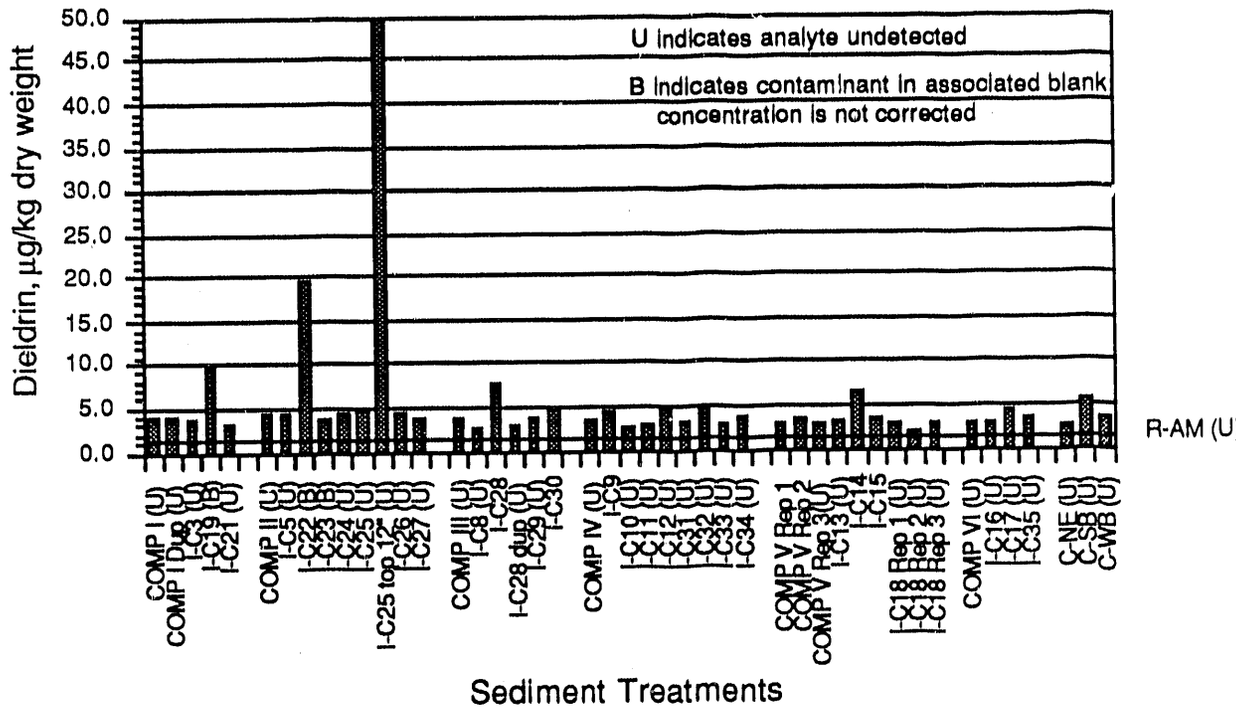


FIGURE 3.18. Concentrations of Dieldrin in Sediment Treatments

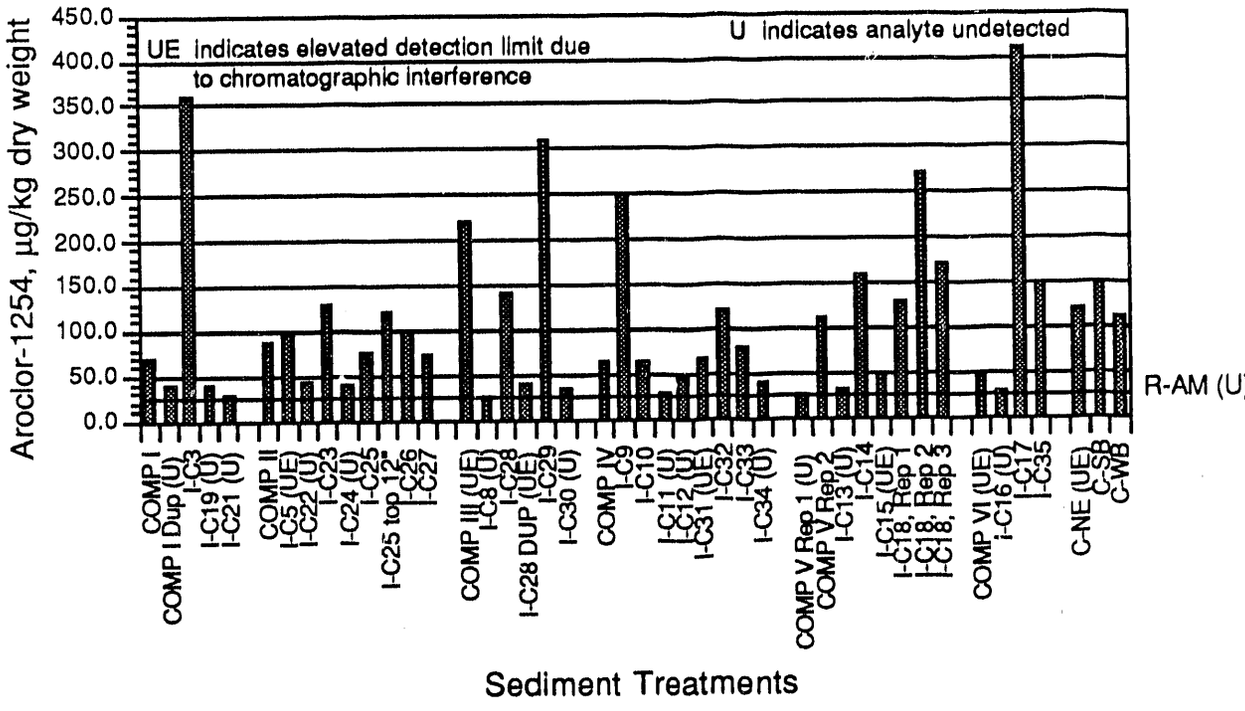


FIGURE 3.19. Concentrations of Aroclor-1254 in Sediment Treatments

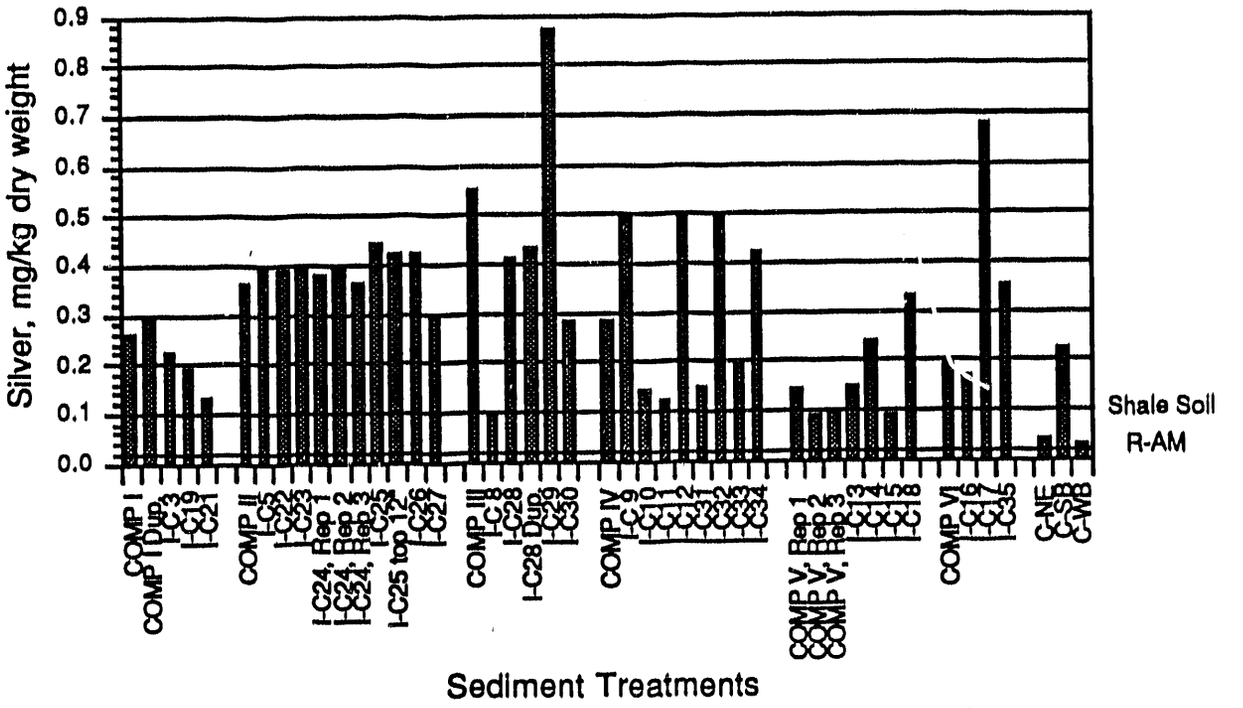


FIGURE 3.20. Concentrations of Silver in Sediment Treatments

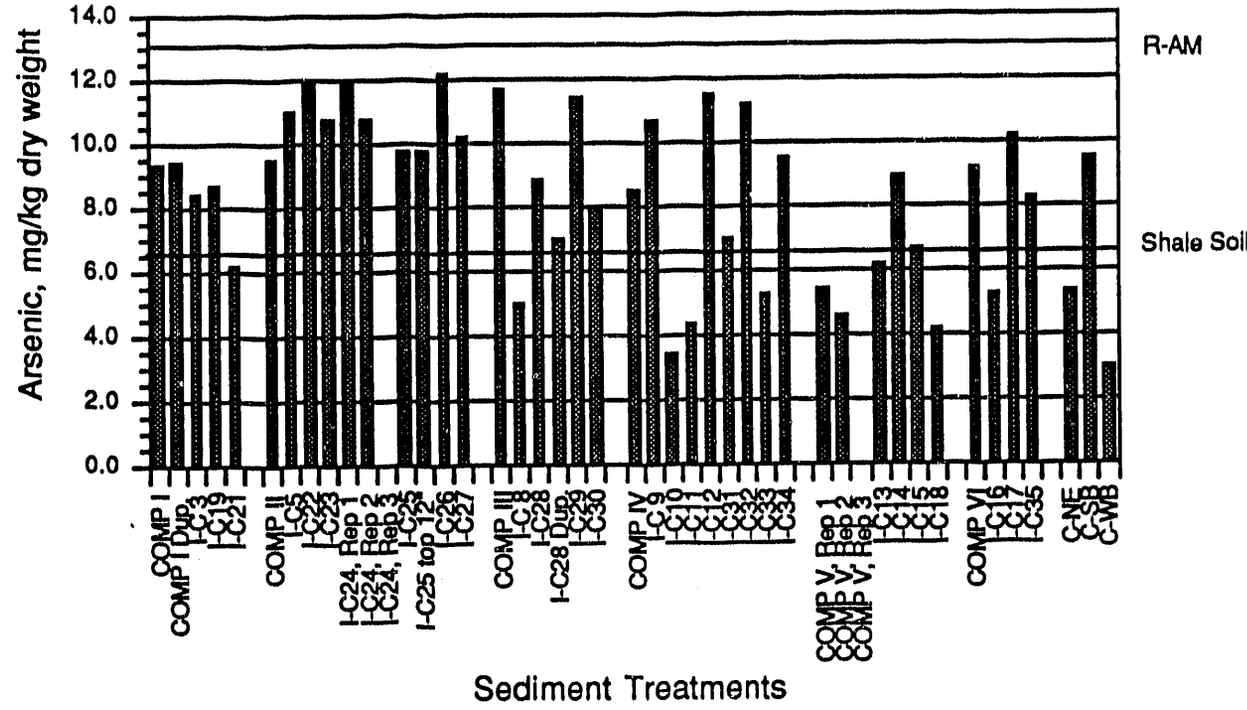


FIGURE 3.21. Concentrations of Arsenic in Sediment Treatments

concentrations above all sediment treatments (including the control sediments). All sediment treatments, with the exception of ten test treatments and two control sediments, had As concentrations greater than that of typical shale soil (6.6 mg/kg dry weight).

Concentrations of Cd (Figure 3.22) ranged from 0.03 mg/kg dry weight in C-NE to 0.99 mg/kg dry weight in I-C29, a 33-fold difference. Only COMP III had Cd concentrations above R-AM. COMPs I and II and their respective stations all had Cd concentrations below R-AM. Stations I-C28, I-C28 dup, and I-C29 in COMP III; stations I-C9, I-C12, I-C31, I-C32, and I-C34 in COMP IV; Station I-C18 in COMP V; Station I-C17 in COMP VI, and the control sediment C-SB, had Cd concentrations above R-AM. Thirteen sediment treatments had Cd concentrations greater than that of typical shale soil (0.3 mg/kg dry weight).

Concentrations of Cr (Figure 3.23) ranged from 81 mg/kg dry weight in C-NE to 955 mg/kg dry weight in I-C11, an 11.8-fold difference. All of the COMPs and their respective stations as well as C-WB had Cr concentrations exceeding the concentrations found in R-AM. Chromium concentrations in typical shale soil is 100 mg/kg dry weight. All of the sediments, except C-NE, contained Cr concentrations above 100 mg/kg.

Concentrations of Cu (Figure 3.24) ranged from 8.0 mg/kg dry weight in C-NE to 174.3 mg/kg dry weight in COMP I dup, a 21.8-fold difference. All COMPs, their respective stations, and C-SB had Cu concentrations above R-AM. Control sediments C-NE and C-WB had Cu concentrations below R-AM. Thirteen sediment treatments had concentrations of Cu above the typical shale soil concentration of 57 mg/kg.

Concentrations of Hg (Figure 3.25) ranged from 0.009 mg/kg dry weight in C-WB to 1.280 mg/kg dry weight in I-C29, a 142-fold difference. All COMPs, their respective stations, and the control sediments (except C-WB), had Hg concentrations exceeding the concentrations found in R-AM. Ten Oakland Harbor sediment treatments had concentrations of Hg that exceeded the typical shale soil concentrations of Hg (0.4 mg/kg).

Concentrations of Ni (Figure 3.26) in sediment treatments ranged from 22.7 mg/kg in C-NE to 113.8 mg/kg in I-C12, a 5-fold difference. All COMPs, their respective stations, and the control sediments (except C-NE), had Ni concentrations above R-AM. Sixteen sediment treatments exceeded the typical shale soil Ni concentration of 95 mg/kg dry weight.

Concentrations of Pb (Figure 3.27) in sediment treatments ranged from 3.5 mg/kg in C-NE to 79.3 mg/kg in I-C17, a 22.7-fold difference. All COMPs, their respective sediment

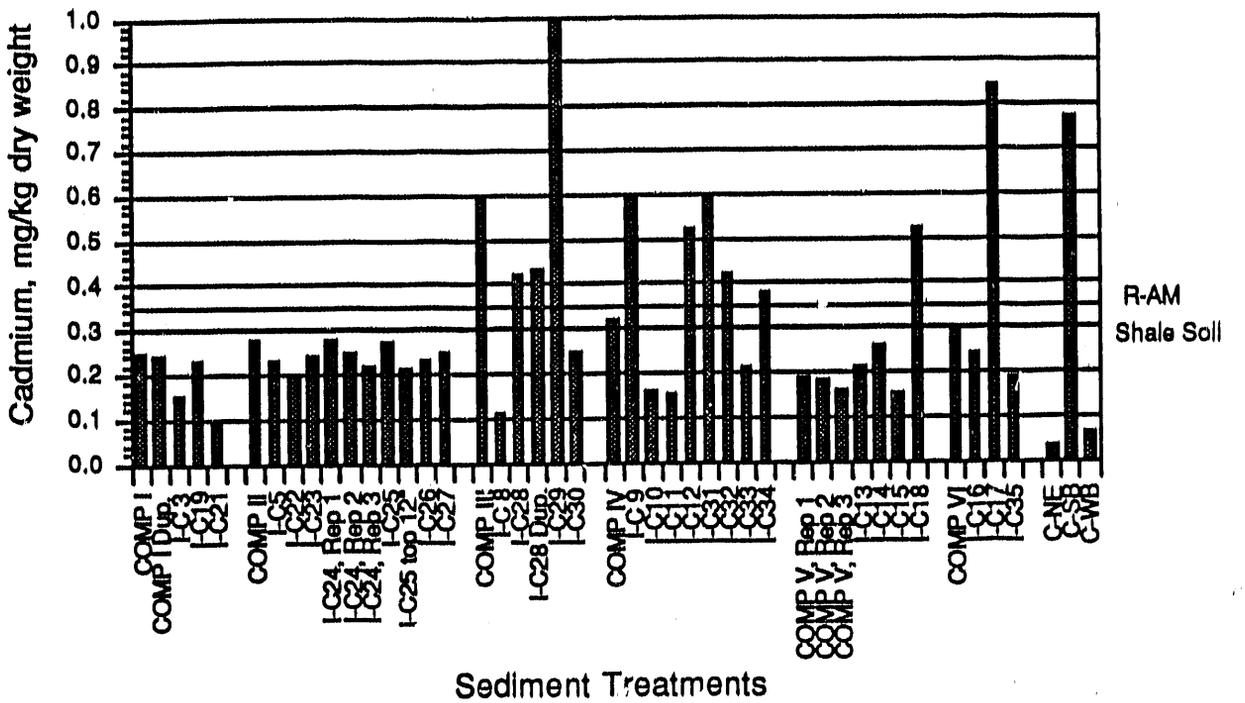


FIGURE 3.22. Concentrations of Cadmium in Sediment Treatments

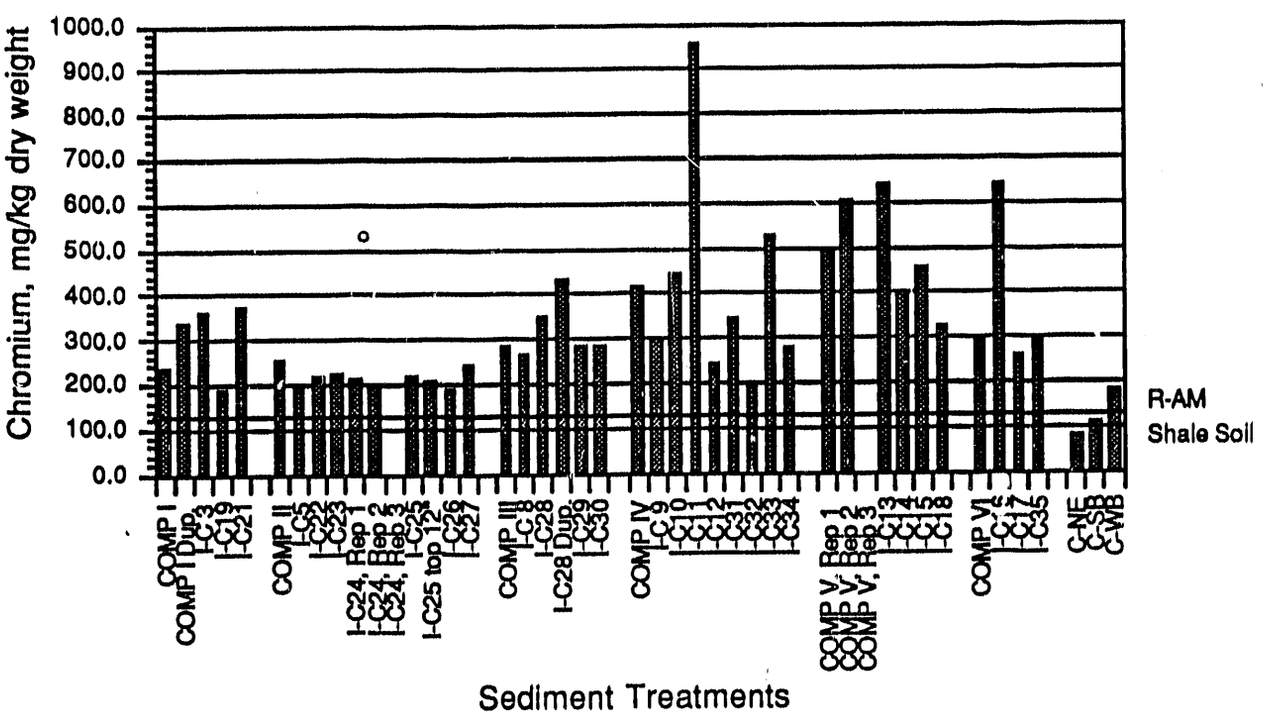


FIGURE 3.23. Concentrations of Chromium in Sediment Treatments

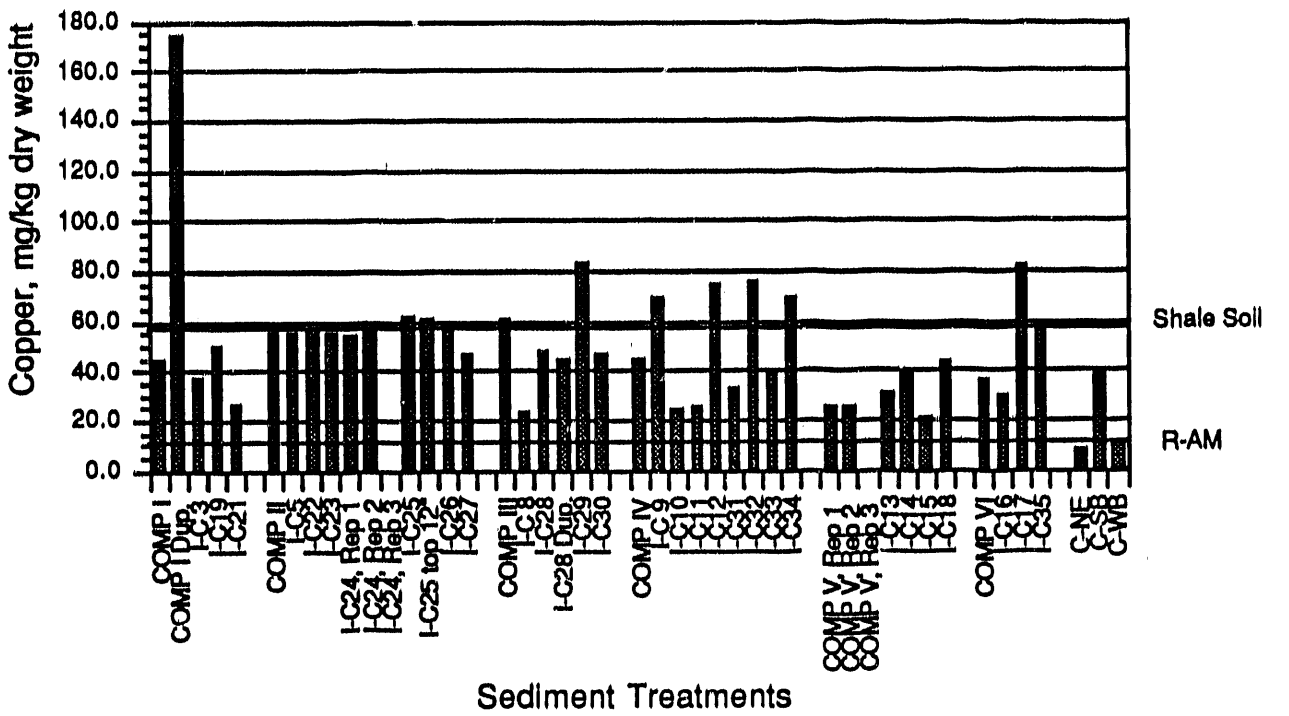


FIGURE 3.24. Concentrations of Copper in Sediment Treatments

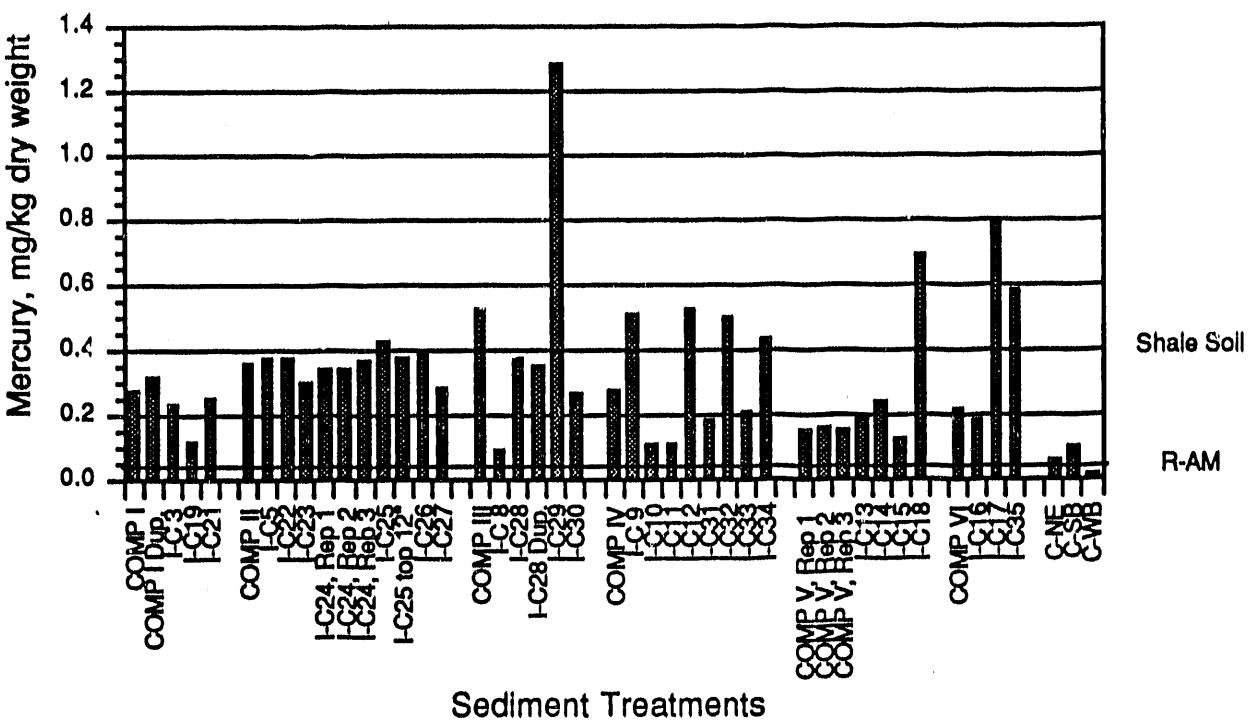


FIGURE 3.25. Concentrations of Mercury in Sediment Treatments

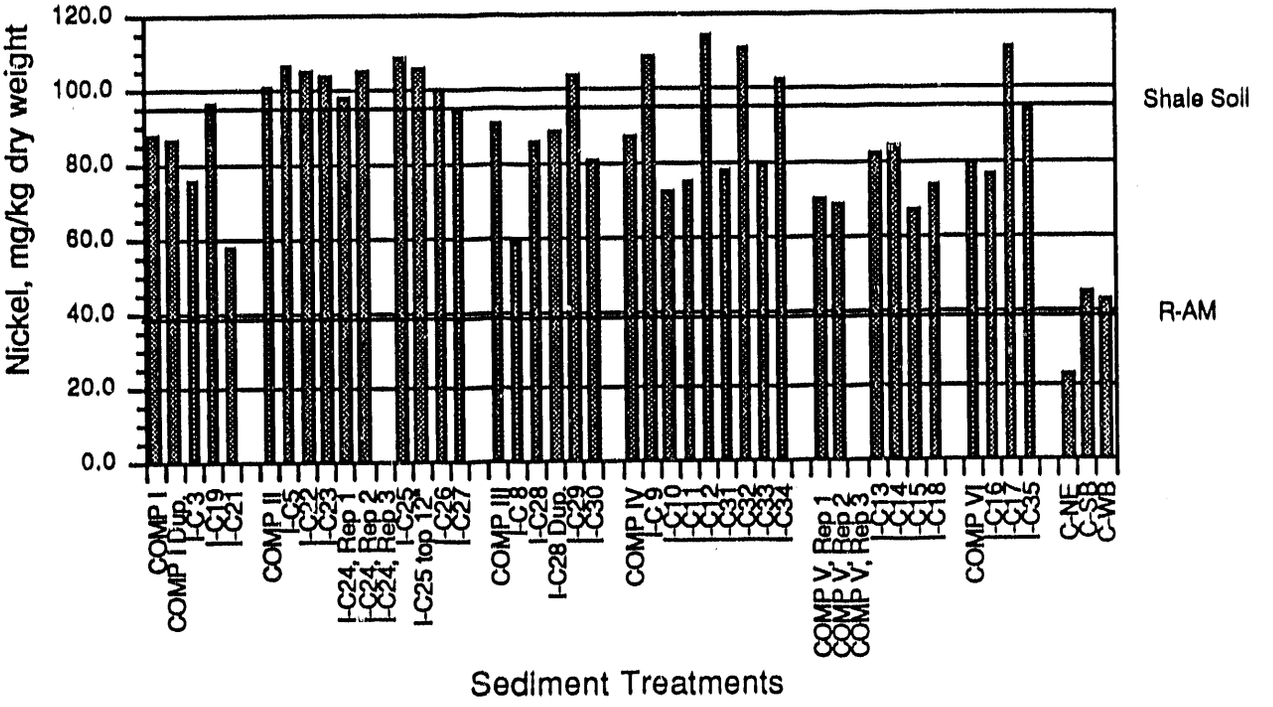


FIGURE 3.26. Concentrations of Nickel in Sediment Treatments

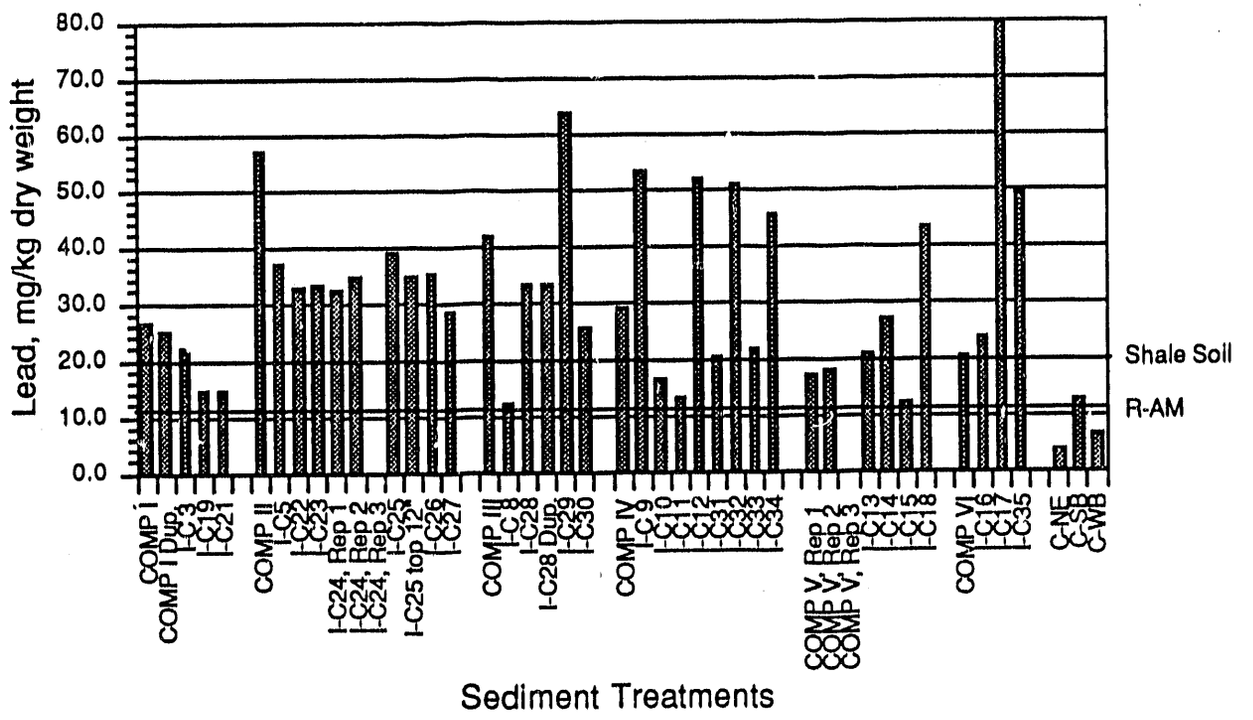


FIGURE 3.27. Concentrations of Lead in Sediment Treatments

treatments and C-SB had Pb concentrations exceeding the levels found in R-AM. All but 11 sediment treatments had Pb concentrations exceeding the typical shale soil concentration of 20 mg/kg.

Concentrations of Se (Figure 3.28) were undetected above a value of 0.08 mg/kg in twelve sediment treatments (including the reference sediment R-AM). Of the detected values, Se concentrations ranged from 0.08 mg/kg dry weight in I-C21 to 0.76 mg/kg in C-SB. All COMPs and their respective sediment treatments had Se concentrations at or above the Se concentrations found in the reference sediment R-AM. Only control sediment C-SB had a Se concentration that exceeds the typical shale soil concentration of 0.6 mg/kg dry weight.

Concentrations of Zn (Figure 3.29) ranged from 22.0 mg/kg dry weight in C-NE to 216.0 mg/kg in I-C29, a 9.8-fold difference. All COMPs, their respective sediment treatments, and the control sediments (except C-NE) had Zn concentrations above those found in the reference sediment R-AM. Nine sediment treatments had Zn concentrations below the shale soil concentration of 80 mg/kg dry weight.

3.3.5 Butyltins

Monobutyltin (MBT) concentrations ranged from undetected in six sediment treatments to 5.8 µg/kg dry weight in I-C29 (Figure 3.30). All the control sediments had MBT concentrations that were undetected above the method detection limit. All COMPs and their respective stations had concentrations of MBT that were at or above the concentrations in the reference R-AM. Dibutyltin (DBT) concentrations ranged from undetected in C-NE to 40.1 µg/kg in I-C17 (Figure 3.31). All COMPs, their respective stations, and control sediments (except C-NE) had DBT concentrations exceeding the concentrations found in R-AM. Tributyltin (TBT) concentrations in the sediment treatments ranged from 0.7 µg/kg in C-WB to 44.5 µg/kg in I-C17 (Figure 3.32). All of the COMPS and their respective sediment treatments had TBT concentrations at or above the levels found in R-AM.

3.4 TOXICOLOGICAL TESTING RESULTS

Solid-phase toxicity tests were conducted to evaluate the six composite sediments (COMPs I through VI) relative to the reference sediment R-AM. Control sediments were used to validate the tests through examination of test organism survival. The solid-phase toxicity tests that were conducted with these sediments were the 10-day flow-through solid-phase test

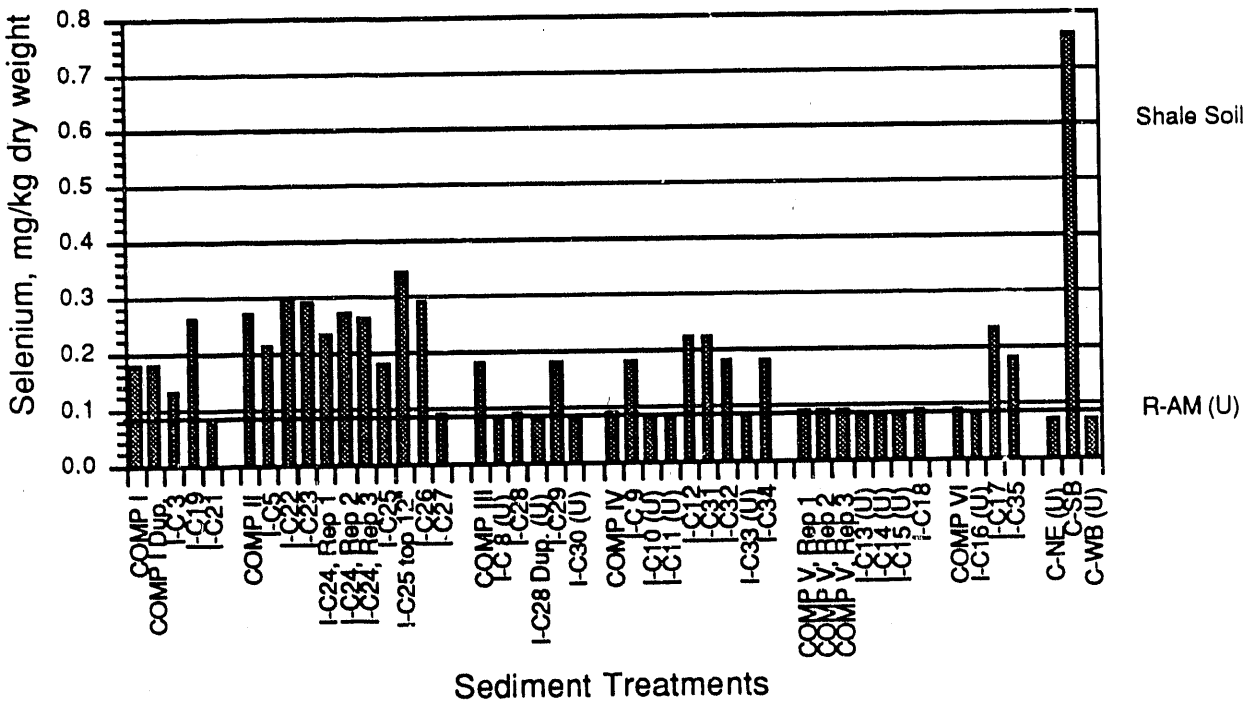


FIGURE 3.28. Concentrations of Selenium in Sediment Treatments

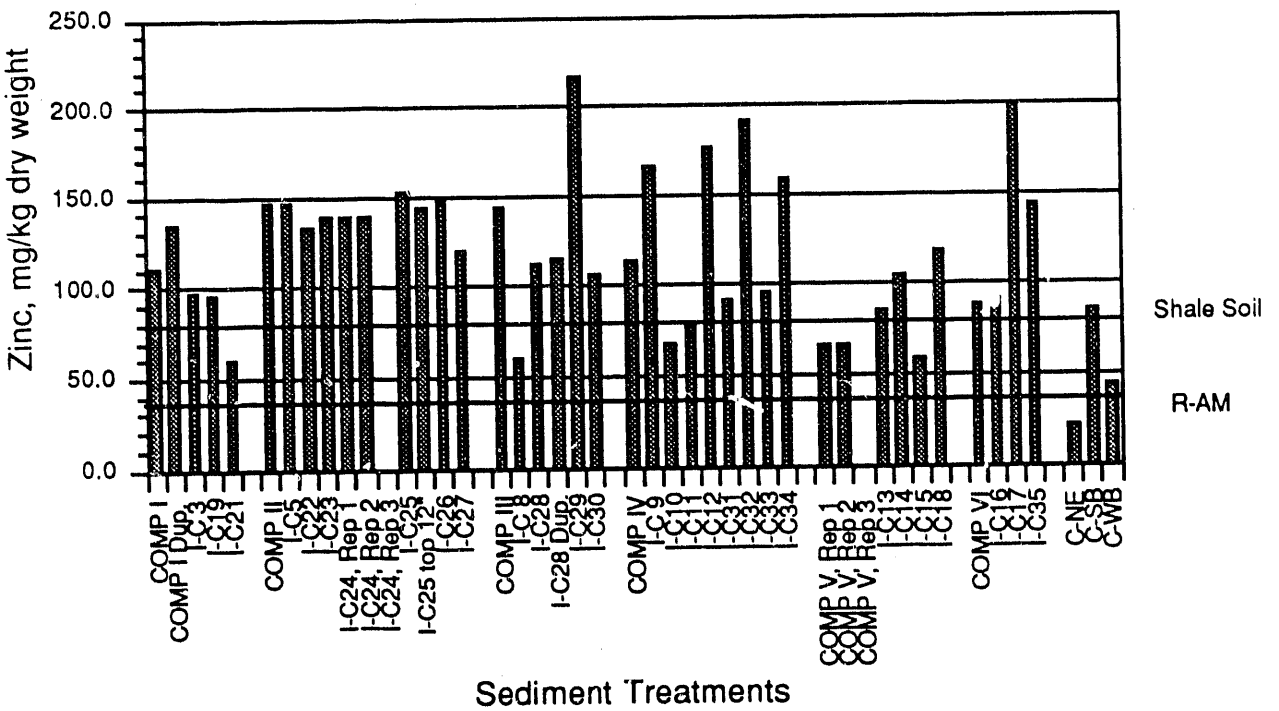


FIGURE 3.29. Concentrations of Zinc in Sediment Treatments

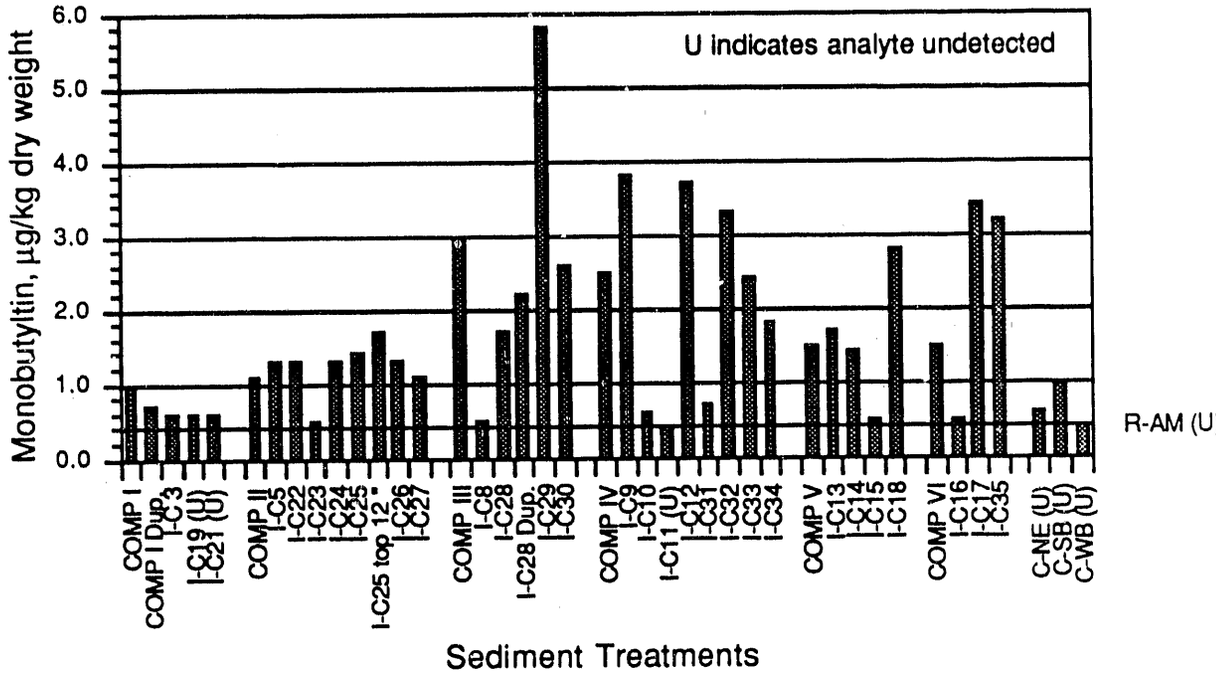


FIGURE 3.30. Concentrations of Monobutyltin in Sediment Treatments

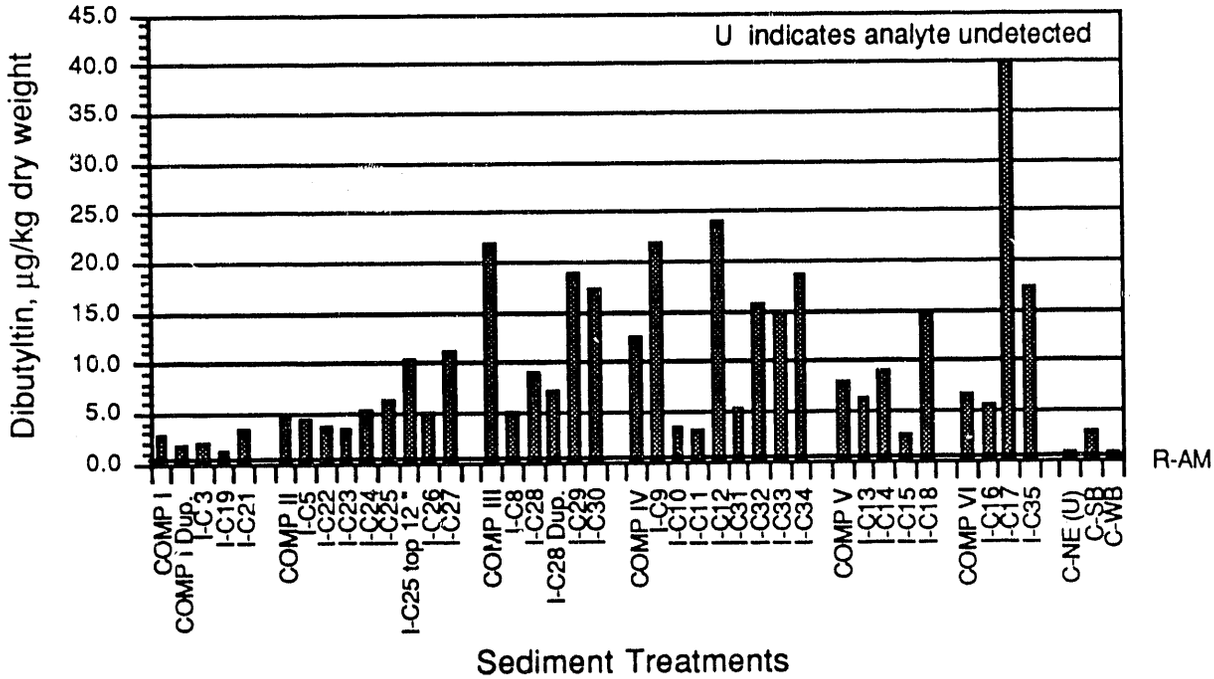


FIGURE 3.31. Concentrations of Dibutyltin in Sediment Treatments

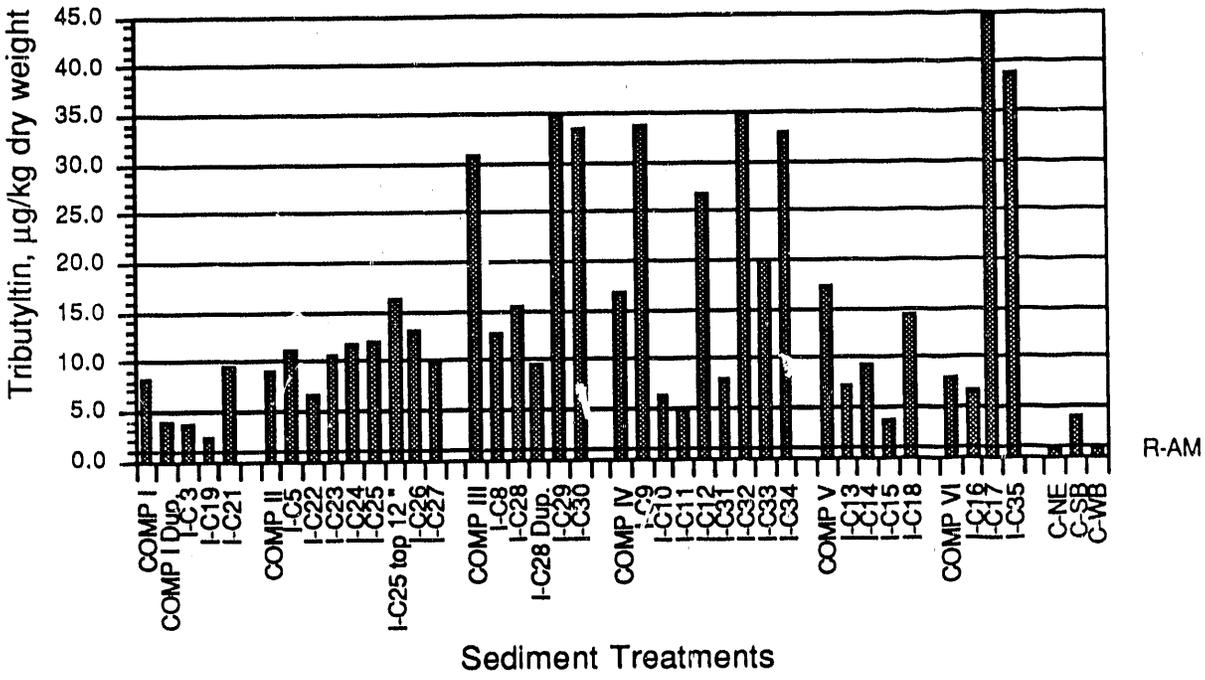


FIGURE 3.32. Concentrations of Tributyltin in Sediment Treatments

with the polychaete *N. caecoides* and the bentnose clam *M. nasuta*, a 28-day flow-through solid-phase test with *N. caecoides* and *M. nasuta* (bioaccumulation exposure), a 10-day static solid-phase test with the amphipod *R. abronius*, and a 10-day flow-through solid-phase test with juvenile speckled sanddab *C. stigmaeus*. The tests were validated by 90% or better survival of test organisms in native control sediment. After the tests were inspected for validity, the data were evaluated by ANOVA and Dunnett's Test to determine if significant differences occurred between treatments at $\alpha = 0.05$ (Section 2.5.2). At the request of USACE, ANOVA and Dunnett's Test were performed on the six composite sediments and compared to R-AM. These tests were performed according to the procedures described in the 1991 Implementation Manual.

Suspended-particulate-phase tests were conducted using three species of sensitive marine organisms: the mysid shrimp *H. sculpta*, juvenile speckled sanddab *C. stigmaeus*, and larvae of the oyster *C. gigas*. These tests were conducted with the same six sediment composites that were used in the solid-phase toxicity tests. Four concentrations were tested: 0% (seawater), 10%, 50%, and 100% SPP. The SPP preparation is described in Section 2.2.3 and the toxicological testing procedures are discussed in Section 2.4.2. For each SPP

test, control survival and water quality results were evaluated for validity of the test. Survival values for the 0% (control) and 100% SPP treatments were then statistically compared with a two-sample t-test. If the result was significant ($\alpha = 0.05$), and at least 50% reduction in survival relative to control was noted, LC50 and EC50 (where appropriate) estimates were made using a trimmed Spearman-Karber method.

3.4.1 10-Day Flow-Through Solid-Phase Test with *M. nasuta* and *N. caecoides*

The tests are validated for the *M. nasuta* solid-phase test by 100% survival in the native control sediment C-SB, and 98% survival in the native control sediment C-NE-A for the *N. caecoides* test.

Mean survival of *M. nasuta* was 98% or greater in the eight sediment treatments tested. The ANOVA and Dunnett's Test on the arcsine square-root transformations of proportion surviving identified no significant differences between the six COMPS and R-AM (Table 3.6 and 3.7). There was no substantial difference in mean percent survival in R-AM relative to the control C-SB.

Mean survival of *N. caecoides* ranged from 62% in COMP VI to 98% in the control sediment C-NE-A. The Dunnett Test on arcsine square-root transformation of proportion surviving (Table 3.8) identified a significant difference between COMP VI and R-AM; however, ANOVA (Table 3.9) identified no significant differences between the six COMPs and R-AM. All the composite sediments had greater than 10% increased mortality than was found in the control (C-NE).

3.4.2 28-Day Flow-Through Solid-Phase Test with *M. nasuta* and *N. caecoides*

The results of the *M. nasuta* and *N. caecoides* 28-day toxicological tests are presented in Volume 1, Appendix F of Ward et al. (1991). The tests are validated for both species by *M. nasuta* survival of 94% in the control sediment C-SB, and 96% survival of *N. caecoides* in the control sediment C-NE-A. The purpose of these 28-day solid-phase tests is to provide bio-accumulation data and not acute toxicity data.

TABLE 3.6. Results of the 10-Day Flow-Through Solid-Phase Test with *M. nasuta* Compared to R-AM

Sediment Treatment	Mean Percent Survival	Statistical Significance
COMP I	100	NS(a)
COMP II	100	NS
COMP III	100	NS
COMP IV	100	NS
COMP V	98	NS
COMP VI	98	NS
R-AM	100	NS
C-SB	100	NA(b)

(a) NS Non-significant toxicity compared to R-AM ($\alpha = 0.05$).
(b) NA Not applicable because control is not included in the statistical comparison.

TABLE 3.7. ANOVA Results for the 10-Day Flow-Through Solid-Phase Test with *M. nasuta* When Compared to R-AM

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Between Groups	0.044	6	0.007	1.438	0.2356(a)
Within Groups	0.144	28	0.005		

(a) Significance Level: $p \leq 0.05$.

TABLE 3.8. Results of the 10-Day Flow-Through Solid-Phase Test with *N. caecoides* Compared to R-AM

Sediment Treatment	Mean Percent Survival	Statistical Significance
COMP I	74	NS(a)
COMP II	77	NS
COMP III	69	NS
COMP IV	70	NS
COMP V	72	NS
COMP VI	62	S(b)
R-AM	92	NS
C-NE-A	98	NA(c)

(a) NS Non-significant toxicity compared to R-AM ($\alpha = 0.05$).
(b) S Significant toxicity compared to R-AM ($\alpha = 0.05$).
(c) NA Not applicable because control is not included in the statistical comparison.

TABLE 3.9. ANOVA Results for the 10-Day Flow-Through Solid-Phase Test with *N. caecoides* Compared to R-AM

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Between Groups	0.432	6	0.072	1.720	0.1533[a]
Within Groups	1.173	28	0.042		

(a) Significance Level: $p \leq 0.05$

3.4.3 10-Day Static Solid-Phase Test with *R. abronius*

Results of the 10-day R. *abronius* test were validated by a 98% mean survival in the control sediment treatment C-WB. Mean percent survival for the 10-day *R. abronius* test ranged from 58% in COMP V to 98% in C-WB. The ANOVA and Dunnett's Test results (Tables 3.10 and 3.11) show that there was a significant difference between COMP V and the reference sediment R-AM. The reference sediment R-AM had 12% lower survival compared to the control C-WB.

The results of the *R. abronius* reference toxicant test using a Cd standard were analyzed using the Spearman-Karber method (Section 2.5.3). The LC50 was estimated to be 1.8 mg/L, meaning that a 50% decrease in survival could be expected at that concentration of Cd. This LC50 is higher than those estimated during Oakland Harbor Phase III A (1.22 mg/L Cd) and Oakland Harbor Phase III B (0.83 mg/L Cd), indicating that the *R. abronius* used for 38-ft Project testing was less sensitive to Cd than those used in Phase III A and III B.

3.4.4 10-Day Flow-Through Solid-Phase Test with *C. stigmaeus*

The 10-Day *C. stigmaeus* solid-phase test was validated by 93% survival in the control sediment treatment C-NE. The mean survival of *C. stigmaeus* was 90% or greater in all eight sediment treatments. Statistical analyses using ANOVA and Dunnett's Test (Tables 3.12 and 3.13) show that there was no significant difference between the six COMPs and the reference sediment R-AM. There was not a substantial difference in mean percent survival in R-AM relative to the control C-NE.

TABLE 3.10. Results of the 10-Day Solid-Phase Test with *R. abronius* Compared to R-AM

Sediment Treatment	Mean Percent Survival	Statistical Significance
COMP I	77	NS(a)
COMP II	83	NS
COMP III	83	NS
COMP IV	82	NS
COMP V	58	S(b)
COMP VI	72	NS
R-AM	86	NS
C-WB	98	NA(c)

(a) NS Non-significant toxicity compared to R-AM ($\alpha = 0.05$).
(b) S Significant toxicity compared to R-AM ($\alpha = 0.05$).
(c) NA Not applicable because control is not included in the statistical comparison.

TABLE 3.11. ANOVA Results for the 10-Day Solid-Phase Test with *R. abronius* Compared to R-AM

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Between Groups	0.456	6	0.076	2.765	0.0307(a)
Within Groups	0.770	28	0.028		

(a) Significance Level: $p \leq 0.05$

TABLE 3.12. Results of the 10-Day Solid-Phase Test with *C. stigmaeus* Compared to R-AM

Sediment Treatment	Mean Percent Survival	Statistical Significance
COMP I	92	NS(a)
COMP II	90	NS
COMP III	96	NS
COMP IV	92	NS
COMP V	94	NS
COMP VI	92	NS
R-AM	96	NS
C-NE	93	NA(b)

(a) NS Non-significant toxicity compared to R-AM ($\alpha = 0.05$).
(b) NA Not applicable because control is not included in the statistical comparison.

TABLE 3.13. ANOVA Results for the 10-Day Solid-Phase Test with *C. stigmaeus* Compared to R-AM

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Between Groups	0.067	6	0.011	0.236	0.9610[a]
Within Groups	1.318	28	0.047		

(a) Significance Level: $p \leq 0.05$

3.4.5 96-Hour Static Suspended-Particulate-Phase Test with *C. stigmaeus*

The 96-h *C. stigmaeus* SPP test was validated by greater than 90% mean survival in the control (0% SPP) concentration as shown in Table 3.14. A mean survival of 90% or greater was observed in all SPP treatments at all concentrations. The t-test results that compare control treatments to 100% SPP for each treatment (Table 3.15) show that there were no significant differences within treatments. Because mean survival was greater than 50% for each COMP relative to the seawater control, LC50 values are not calculated.

3.4.6 96-Hour Static Suspended-Particulate-Phase Test with *H. sculpta*

The 96-h *H. sculpta* SPP test was validated by greater than 90% mean survival in the control (0% SPP) treatments. Mean survival ranged from 50% to 97% in the six COMPs. Table 3.16 shows that all treatments except COMP II produced statistically significant differences in survival between the control and 100% SPP dilutions. T-test and LC50 results are also presented in Table 3.17. Survival in the 100% SPP remained at or above 50%, so LC50 values were not calculated.

The *H. sculpta* reference toxicant test using a zinc chloride ($ZnCl_2$) was analyzed using the trimmed Spearman-Karber method (Section 2.5.3). The LC50 was estimated to be 0.65 mg/L of Zn, meaning that a 50% decrease in survival could be expected at this concentration. This LC50 value is within the range of values obtained from reference toxicant tests in other programs at MSL.

3.4.7 48-Hour Static Suspended-Particulate-Phase Test with Larval *C. gigas*

The 48-h *C. gigas* SPP test was validated by greater than 85% mean survival in the control treatment (0% SPP). Table 3.18 presents the results of the mean percent survival and

TABLE 3.14. Results of the 96-Hour Static Suspended-Particulate-Phase Test with *C. stigmaeus*

Sediment Treatment	% SPP Concentration	Mean Percent Survival
COMP I	0	100
COMP I	10	90
COMP I	50	100
COMP I	100	100
COMP II	0	100
COMP II	10	100
COMP II	50	100
COMP II	100	100
COMP III	0	100
COMP III	10	100
COMP III	50	100
COMP III	100	100
COMP IV	0	100
COMP IV	10	100
COMP IV	50	97
COMP IV	100	100
COMP V	0	100
COMP V	10	93
COMP V	50	97
COMP V	100	100
COMP VI	0	100
COMP VI	10	100
COMP VI	50	100
COMP VI	100	100
R-AM	0	97
R-AM	10	97
R-AM	50	100
R-AM	100	100

TABLE 3.15. T-Test and LC50 Determination for the 96-Hour Static Suspended-Particulate-Phase Test with *C. stigmaeus*

Sediment Treatment	Table t-value	d.f.	Calculated t-value	Significance[a]	LC50 as Percent SPP
COMP I	N/A[b]	N/A	N/A	N/A	>100
COMP II	N/A	N/A	N/A	N/A	>100
COMP III	N/A	N/A	N/A	N/A	>100
COMP IV	N/A	N/A	N/A	N/A	>100
COMP V	N/A	N/A	N/A	N/A	>100
COMP VI	N/A	N/A	N/A	N/A	>100
R-AM	2.776	4	-1.0000	N/S[c]	>100

(a) Test of significant difference ($\alpha = 0.05$) for two sample t-test comparison of 0% and 100% SPP concentrations
(b) NA Statistical test could not be performed due to zero variance in survival in 0% and 100% SPP concentrations
(c) NS Non-significant at $\alpha = 0.05$

the mean percent normal development for all treatments. The mean percent survival ranged from 72% to 95% in the six COMPs. The mean percent of normal larvae development was generally close to the percent survival. Table 3.19 presents the results of the t-test, which compares the 0% and 100% survivals for each treatment. The results indicate that COMP III, V, and R-AM produced statistically significant differences in survival between the 0% and 100% SPP concentrations. COMPs I, II, IV, and VI had no significant differences in survival between the 0% and 100% SPP concentrations. Because survival was no lower than 67% in the 100% SPP treatments, LC50 values were not calculated.

A reference toxicant test was also conducted using the larvae from *C. gigas*. An LC50 value of 25 µg/L of Cu reduced the percent survival of larvae to 50% compared to controls, as calculated by the trimmed Spearman-Karber method.

3.5 TISSUE BIOACCUMULATION

Contaminants of concern were measured in the tissues of *M. nasuta* and *N. caecoides* after the 28-day exposure to test, reference, and control sediment treatments. These contaminants were PAHs, pesticides, PCBs, metals, and butyltins. The tissue chemistry results and the statistical analyses performed using Dunnett's Test for comparison of all means are summarized in the following sections. At the request of USACE-WES, the PAH, pesticides, PCBs, and butyltin compounds were analyzed in both wet and dry weight (dry

TABLE 3.16. Results of the 96-Hour Static Suspended-Particulate-Phase Test with *H. sculpta*

Sediment Treatment	% SPP Concentration	Mean Percent Survival
COMP I	0	93
COMP I	10	83
COMP I	50	77
COMP I	100	67
COMP II	0	90
COMP II	10	97
COMP II	50	80
COMP II	100	73
COMP III	0	97
COMP III	10	87
COMP III	50	70
COMP III	100	60
COMP IV	0	93
COMP IV	10	80
COMP IV	50	70
COMP IV	100	53
COMP V	0	93
COMP V	10	93
COMP V	50	80
COMP V	100	73
COMP VI	0	93
COMP VI	10	87
COMP VI	50	83
COMP VI	100	73
R-AM	0	90
R-AM	10	80
R-AM	50	63
R-AM	100	50

TABLE 3.17. T-Test and LC50 Determination for the 96-Hour Static Suspended-Particulate-Phase Test with *H. sculpta*

Sediment Treatment	Table t-value	d.f.	Calculated t-value	Significance[a]	LC50 as Percent SPP
COMP I	2.776	4	5.6569	S[b]	>100
COMP II	2.776	4	2.5000	NS[c]	>100
COMP III	2.776	4	5.5000	S	>100
COMP IV	2.776	4	8.4853	S	>100
COMP V	2.776	4	4.2426	S	>100
COMP VI	2.776	4	4.2426	S	>100
R-AM	2.776	4	4.8990	S	>100

(a) Test of significant difference ($\alpha = 0.05$) for two sample t-test comparison of 0% and 100% SPP concentrations.
(b) S Significant at $\alpha = 0.05$.
(c) NS Non-significant at $\alpha = 0.05$.

weight only for metals) and the detection limit was used for the compounds that were undetected. When a compound in test organism tissue is significantly elevated compared to tissues exposed to R-AM, the mean tissue concentration is documented. Complete *M. nasuta* and *N. caecoides* tissue chemistry data results are contained in Volume 2, Appendix K of Ward et al. (1991).

3.5.1 Polynuclear Aromatic Hydrocarbon Bioaccumulation in *M. nasuta*

The results of ANOVA and Dunnett's Test comparing mean tissue concentrations and statistical groupings for individual compounds are presented in Appendix A and Appendix B of this report.

Results of the Dunnett Test are summarized in Table 3.20 (wet weight) and Table 3.21 (dry weight). Table 3.20 (wet weight) shows that 10 of the 15 PAH compounds analyzed were elevated in *M. nasuta* tissues in at least one of the COMPs relative to the reference sediment R-AM. The results of the statistical analyses performed on the dry weight concentrations of PAHs are presented in Table 3.21. This dry weight analyses shows that the same 10 PAH compounds that had significant concentrations in wet weight *M. nasuta* tissue, are also significantly elevated in dry weight *M. nasuta* tissue. It also shows that COMPs III, IV, V, and VI have significantly elevated concentrations of individual PAHs when evaluated using either the wet or dry weight values.

TABLE 3.18. Results of the 48-Hour Static Suspended-Particulate-Phase Test with *C. gigas*

Sediment Treatment	% SPP Concentration	Mean Percent Survival	Mean Percent Normal
COMP I	0	86	86
COMP I	10	95	90
COMP I	50	89	89
COMP I	100	79	78
COMP II	0	88	87
COMP II	10	84	82
COMP II	50	87	86
COMP II	100	77	77
COMP III	0	85	85
COMP III	10	84	82
COMP III	50	87	86
COMP III	100	72	67
COMP IV	0	88	88
COMP IV	10	86	82
COMP IV	50	78	76
COMP IV	100	83	83
COMP V	0	95	90
COMP V	10	87	85
COMP V	50	85	80
COMP V	100	73	70
COMP VI	0	94	92
COMP VI	10	85	83
COMP VI	50	87	87
COMP VI	100	73	72
R-AM	0	92	92
R-AM	10	87	87
R-AM	50	76	76
R-AM	100	73	73

TABLE 3.19. T-Test and LC50 Determination for the 48-Hour Static Suspended-Particulate-Phase Test with *C. gigas*

Sediment Treatment	Table t-value	d.f.	Calculated t-value	Significance[a]	LC50 as Percent SPP
COMP I	2.776	4	1.7386	NS[b]	>100
COMP II	2.776	4	1.5967	NS	>100
COMP III	2.776	4	3.0963	S[c]	>100
COMP IV	2.776	4	1.4924	NS	>100
COMP V	2.776	4	3.5052	S	>100
COMP VI	2.776	4	2.4435	NS	>100
R-AM	2.776	4	3.3298	S	>100

(a) Test of significant difference ($\alpha = 0.05$) for two sample t-test comparison of 0% and 100% SPP concentrations.
(b) NS Non-significant at $\alpha = 0.05$.
(c) S Significant at $\alpha = 0.05$.

3.5.2 Pesticide and PCB Bioaccumulation in *M. nasuta*

Chlorinated pesticide analyses of *M. nasuta* tissue are presented in Table 3.22 (wet weight) and Table 3.23 (dry weight). Table 3.22 shows that six pesticides (Delta-BHC, Gamma-BHC, 4,4'-DDT, Endosulfan II, Endosulfan sulfate and Endrin) had significantly elevated concentrations in wet weight *M. nasuta* tissues from one of the COMPs relative to the reference sediment R-AM. The results of the statistical analyses performed on the dry weight concentrations of pesticides are presented in Table 3.23 . Analyses on dry weight *M. nasuta* tissues show that four pesticides (Beta-BHC, Delta-BHC, Gamma-BHC, and Endrin) had significantly elevated concentrations in dry weight *M. nasuta* tissues from one of the COMPs relative to R-AM. COMP VI had significant elevations of pesticides when evaluated under both wet and dry weight determinations while COMP II was added under dry weight only.

The statistical analyses of wet weight and dry weight concentrations of PCBs in the tissues of *M. nasuta* are presented in Tables 3.24 and 3.25. The wet and dry weight analyses showed that aroclor 1242, 1254, and 1260 had significantly elevated concentrations in *M. nasuta* tissues from at least one of the COMPs relative to the reference sediment R-AM. All the tissues exposed to R-AM (except Aroclor-1254 wet weight) contained mean tissue concentrations (wet and dry weight) of PCBs that were undetected below the detection limit in all replicates. Comps V and Vi had significantly elevated concentrations of PCBs when compared to R-AM.

TABLE 3.20. Significantly Elevated Mean Tissue Concentrations of PAHs in *M. nasuta* (µg/kg wet weight)

PARAMETER	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Naphthalene	6.38 U[a]	-[b]	-	-	-	-	-
Acenaphthylene	0.97 U	-	-	-	-	-	-
Acenaphthene	2.42 U	-	-	-	-	-	-
Fluorene	1.93 U	-	-	-	-	-	-
Phenanthrene	4.68 B[c]	-	-	-	-	-	10.10 B[d]
Anthracene	1.23	-	-	-	-	-	-
Fluoranthene	7.77 B	-	-	-	-	-	31.30 B
Pyrene	36.43 B	-	-	73.08	108.12	-	208.96
Benzo(a)anthracene	1.70	-	-	-	5.96	-	9.58
Chrysene	3.15	-	-	-	-	-	11.12
Benzofluoranthenes	13.48	-	-	34.64	-	40.88	53.20
Benzo(a)pyrene	3.45	-	-	22.64	12.32	23.24	31.26
Dibenzo(a,h)anthracene	0.88 U	-	-	-	5.24	6.66	-
Benzo(g,h,i)perylene	2.98	-	-	8.88	-	9.44	10.54
Indeno(1,2,3-c,d)pyrene	2.25	-	-	-	-	8.24	7.56

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.
(c) UB Undetected or blank contamination associated with all replicates.
(d) B Analyte detected in blanks at twice the detection limit for all replicates (reported concentration is not blank-corrected).

TABLE 3.21. Significantly Elevated Mean Tissue Concentrations of PAHs in *M. nasuta* (µg/kg dry weight)

PARAMETER	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Naphthalene	47.77 U[a]	-[b]	-	-	-	-	-
Acenaphthylene	7.14 U	-	-	-	-	-	-
Acenaphthene	17.92 U	-	-	-	-	-	-
Fluorene	14.35 U	-	-	-	-	-	-
Phenanthrene	34.06 B[c]	-	-	-	-	-	66.24 B
Anthracene	9.13	-	-	-	-	-	-
Fluoranthene	57.16 B	-	-	-	-	-	196.79 B
Pyrene	278.10 B	-	-	592.92	786.13	494.12	1300.32
Benzo(a)anthracene	12.45	-	-	56.97	43.47	43.85	53.10
Chrysene	23.32	-	-	46.89	-	-	72.49
Benzofluoranthenes	102.89	-	-	278.94	-	351.79	340.40
Benzo(a)pyrene	26.30	-	-	182.86	89.84	209.83	201.96
Dibenzo(a,h)anthracene	6.61 U	-	-	-	39.58	70.18	-
Benzo(g,h,i)perylene	22.74	-	-	68.87	-	83.90	65.41
Indeno(1,2,3-c,d)pyrene	16.93	-	-	-	-	87.51	46.00

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.
(c) Analyte detected in blanks at less than twice the detection limit for all replicates (reported concentration is not blank-corrected).

TABLE 3.22. Signficantly Elevated Mean Tissue Concentrations of Pesticides in *M. nasuta* (µg/kg wet weight)

PARAMETER	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aldrin	2.0 U[a]	-[b]	-	-	-	-	-
Alpha-BHC	2.0 U	-	-	-	-	-	-
Beta-BHC	2.0 U	-	-	-	-	-	-
Delta-BHC	2.0 U	-	-	-	-	-	4.88
Gamma-BHC	2.0 U	-	-	-	-	-	5.00
Alpha-Chlordane	2.0 U	-	-	-	-	-	-
Gamma-Chlordane	2.0 U	-	-	-	-	-	-
4,4'-DDD	2.0 U	-	-	-	-	-	-
4,4'-DDE	2.1	-	-	-	-	-	-
4,4'-DDT	2.0 U	-	-	-	-	-	5.48 U
Dieldrin	2.1 U	-	-	-	-	-	-
Endosulfan I	2.0 U	-	-	-	-	-	-
Endosulfan II	2.0 U	-	-	-	-	-	6.68 UB[c]
Endosulfan sulfate	2.1	-	-	-	-	-	3.22
Endrin	2.0 U	-	-	-	-	-	4.04 U
Endrin Ketone	2.0 U	-	-	-	-	-	-
Heptachlor	2.0 U	-	-	-	-	-	-
Heptachlor epoxide	2.0 U	-	-	-	-	-	-
Methoxychlor	10.0 U	-	-	-	-	-	-
Toxaphene	20.0 U	-	-	-	-	-	-

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.
(c) Undetected or blank contamination associated with all replicates.

3.5.3 Metals Bioaccumulation in *M. nasuta*

Statistical analyses of the metals found in *M. nasuta* tissues were performed in dry weight only. Table 3.26 shows the results of the Dunnett Test. Metals concentrations are presented in mg/kg dry weight. Five metals (Cd, Cr, Cu, Ni and Pb) had significantly elevated concentrations of metals in *M. nasuta* tissues exposed to the COMPs relative to tissues exposed to R-AM. Chromium was elevated within all COMPs; Ni in all but COMP IV; Pb in all but COMPs I and II; and Cu and Cd in COMPs I or 11, respectively.

3.5.4 Butyltin Bioaccumulation in *M. nasuta*

Results of the butyltin statistical analyses on wet and dry weight *M. nasuta* tissues, are presented in Tables 3.27 and 3.28. All three butyltins were significantly elevated in the same COMPs in wet and dry weight *M. nasuta* tissues exposed to the COMPs relative to tissues exposed to the reference sediment R-AM. COMPs I and VI had no significant elevations of butyltins compared to R-AM.

TABLE 3.23. Signficantly Elevated Mean Tissue Concentrations of Pesticides in *M. nasuta* (µg/kg dry weight)

PARAMETER	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aldrin	14.667 U[a]	-[b]	-	-	-	-	-
Alpha-BHC	14.667 U	-	-	-	-	-	-
Beta-BHC	14.667 U	-	55.60 U	-	-	-	-
Delta-BHC	14.667 U	-	-	-	-	-	28.40
Gamma-BHC	14.667 U	-	-	-	-	-	27.20
Alpha-Chlordane	14.667 U	-	-	-	-	-	-
Gamma-Chlordane	14.667 U	-	-	-	-	-	-
4,4'-DDD	14.667 U	-	-	-	-	-	-
4,4'-DDE	15.500	-	-	-	-	-	-
4,4'-DDT	14.667 U	-	-	-	-	-	-
Dieldrin	15.667 U	-	-	-	-	-	-
Endosulfan I	14.667 U	-	-	-	-	-	-
Endosulfan II	14.667 U	-	-	-	-	-	-
Endosulfan sulfate	15.167	-	-	-	-	-	-
Endrin	14.667 U	-	-	-	-	-	24.60 U
Endrin Ketone	14.667 U	-	-	-	-	-	-
Heptachlor	14.667 U	-	-	-	-	-	-
Heptachlor epoxide	14.667 U	-	-	-	-	-	-
Methoxychlor	74.667 U	-	-	-	-	-	-
Toxaphene	149.167 U	-	-	-	-	-	-

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.

3.5.5 Polynuclear Aromatic Hydrocarbon Bioaccumulation in *N. caecoides*

Results of ANOVA and Dunnett's Test comparing mean tissue concentrations and statistical groupings for individual compounds are presented in Appendix C and Appendix D of this report.

The results of the Dunnett Test are summarized in Table 3.29 (wet weight) and Table 3.30 (dry weight). Table 3.29 shows that eight PAH compounds, naphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, and benzo(b)fluoranthene, were elevated in *N. caecoides* tissues from at least one of the COMPs relative to the reference sediment R-AM. Analysis of dry weight *N. caecoides* tissues (Table 3.30) shows that six PAH compounds, phenanthrene, anthracene, fluoranthene, pyrene, chrysene, and benzo(b)-fluoranthene, were significantly elevated in the *N. caecoides* tissues from at least one of the COMPs relative to R-AM. COMPs I through VI showed significant elevations relative to one or more of PAH concentrations at R-AM for both wet and dry weight determinations.

TABLE 3.24. Significantly Elevated Mean Tissue Concentrations of PCBs in *M.nasuta* (µg/kg wet weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aroclor 1016	20.0 U[a]	-[b]	-	-	-	-	-
Aroclor 1221	20.0 U	-	-	-	-	-	-
Aroclor 1232	20.0 U	-	-	-	-	-	-
Aroclor 1242	20.0 U	-	-	-	-	-	156.0
Aroclor 1248	20.0 U	-	-	-	-	-	-
Aroclor 1254	33.0	-	-	-	-	-	186.0
Aroclor 1260	20.0 U	-	-	-	-	52.3	-

(a) U indicates analyte undetected in all replicates
(b) Not significantly elevated relative to R-AM

TABLE 3.25. Significantly Elevated Mean Tissue Concentrations of PCBs in *M. nasuta* (µg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aroclor 1016	149.167 U[a]	-[b]	-	-	-	-	-
Aroclor 1221	149.167 U	-	-	-	-	-	-
Aroclor 1232	149.167 U	-	-	-	-	-	-
Aroclor 1242	149.167 U	-	-	-	-	-	870.0
Aroclor 1248	149.167 U	-	-	-	-	-	-
Aroclor 1254	249.167	-	-	-	-	-	1015.80
Aroclor 1260	149.167 U	-	-	-	-	434.71	-

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.

3.5.6 Pesticide and PCB Bioaccumulation in *N. caecoides*

Chlorinated pesticide analyses of *N. caecoides* tissue are presented in Table 3.31 (wet weight) and Table 3.32 (dry weight). There were no significant differences in pesticide levels observed in the tissues exposed to the six COMPs relative to the reference sediment R-AM. The *N. caecoides* tissues exposed to R-AM had mean tissue concentrations that were less than or equal to the method detection limit.

The statistical analyses of wet weight and dry weight concentrations of PCBs in the tissues of *N. caecoides*, are presented in Tables 3.33 and 3.34. Both the wet and dry weight analyses showed that *N. caecoides* tissues exposed to sediment from COMP III had Aroclor-1254 concentrations that were significantly elevated relative to the reference sediment R-AM. All of the tissues exposed to R-AM contained undetected mean tissue concentrations of PCBs.

3.5.7 Metals Bioaccumulation in *N. caecoides*

Statistical analyses of the metals found in *N. caecoides* tissues were performed in dry weight only. Table 3.35 shows the results of the Dunnett Test. Metals concentrations are presented in mg/kg dry weight. Six metals, As, Cd, Cr, Pb, Se, and Zn, had significantly elevated concentrations in *N. caecoides* tissues exposed to at least one COMP relative to the reference sediment R-AM. Arsenic was significantly elevated in all COMPs, Cr at COMPs IV, V, and VI; Pb at COMPs III, IV, and V; Zn at COMPs II and V; Cd at COMP V; and Se at COMP VI, relative to R-AM.

3.5.8 Butyltin Bioaccumulation in *N. caecoides*

Results of the butyltin statistical analyses on wet weight and dry weight *N. caecoides* tissues are presented in Tables 3.36 and 3.37. No butyltins were significantly elevated in either the wet or dry weight tissues when compared to the reference sediment R-AM.

TABLE 3.26. Signicantly Elevated Mean Tissue Concentrations of Metals in *M. nasuta* (mg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Silver	0.419	-(a)	-	-	-	-	-
Arsenic	25.686	-	-	-	-	-	-
Cadmium	0.316	-	0.448	-	-	-	-
Chromium	0.891	2.322	2.104	2.552	2.354	3.056	2.728
Copper	17.794	40.280	-	-	-	-	-
Mercury	0.147	-	-	-	-	-	-
Nickel	3.219	4.592	5.160	4.932	-	4.635	4.996
Lead	2.001	-	-	3.280	3.040	3.300	3.286
Selenium	1.590	-	-	-	-	-	-
Zinc	115.443	-	-	-	-	-	-

(a) Not significantly elevated relative to R-AM.

TABLE 3.27. Significantly Elevated Mean Tissue Concentrations of Butyltins in *M. nasuta* (µg/kg wet weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Tributyltin	2.2	-(a)	3.1	3.7	4.1	4.0	-
Dibutyltin	1.2	-	-	-	4.2	4.4	-
Monobutyltin	0.9 U(b)	-	-	1.5 U	-	-	-

(a) Not significantly elevated relative to R-AM
(b) U Undetected in all replicates; value is mean of detection limits.

TABLE 3.28. Significantly Elevated Mean Tissue Concentrations of Butyltins in *M. nasuta* (µg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Tributyltin	15.3	-(a)	24.2	26.4	27.3	27.2	-
Dibutyltin	8.5	-	-	-	27.6	29.3	-
Monobutyltin	6.4 U(b)	-	-	10.4 U	-	-	-

(a) Not significantly elevated relative to R-AM.
(b) U Undetected in all replicates; value is mean of detection limits.

TABLE 3.29. Significantly Elevated Mean Tissue Concentrations of PAHs in *N. caecoides* (µg/kg wet weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Naphthalene	44.6	-(a)	57.83	-	-	-	-
2-Methyl naphthalene	23.8	-	-	-	-	-	-
Acenaphthylene	10.0 U(b)	-	-	-	-	-	-
Acenaphthene	10.0 U	-	-	-	-	-	-
Fluorene	10.0 U	-	-	-	-	-	-
Phenanthrene	19.0	39.0	30.3	-	-	-	44.8
Anthracene	10.0 U	-	-	-	-	-	14.4
Fluoranthene	22.2	-	-	-	-	-	82.4
Pyrene	19.8	-	39.3	202.0	188.0	86.0	566.0
Benzo(a)anthracene	10.0 U	-	-	14.2	-	-	-
Chrysene	10.0 U	-	-	27.6	-	-	41.0
Benzo(b)fluoranthene	10.0 U	-	-	-	-	-	19.4
Benzo(k)fluoranthene	10.0 U	-	-	-	-	-	-
Benzo(a)pyrene	10.0 U	-	-	-	-	-	-
Dibenzo(a,h)anthracene	10.0 U	-	-	-	-	-	-
Benzo(g,h,i)perylene	10.0 U	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	10.0 U	-	-	-	-	-	-

(a) Not significantly elevated relative to R-AM.
(b) U indicates analyte undetected in all replicates.

TABLE 3.30. Significantly Elevated Mean Tissue Concentrations of PAHs in *N. caecoides* (µg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Naphthalene	288.034	-(a)	-	-	-	-	-
2-Methyl naphthalene	152.926	-	-	-	-	-	-
Acenaphthylene	63.796 U(b)	-	-	-	-	-	-
Acenaphthene	63.796 U	-	-	-	-	-	-
Fluorene	63.796 U	-	-	-	-	-	-
Phenanthrene	122.092	252.316	-	-	-	-	282.614
Anthracene	63.796 U	-	-	-	-	-	90.948
Fluoranthene	142.914	-	-	-	-	-	521.392
Pyrene	127.398	-	233.332	1162.768	1134.298	563.566	3572.370
Benzo(a)anthracene	63.796 U	-	-	-	-	-	-
Chrysene	63.796 U	-	-	160.088	-	-	257.986
Benzo(b)fluoranthene	63.796 U	-	-	-	-	-	120.584
Benzo(k)fluoranthene	63.796 U	-	-	-	-	-	-
Benzo(a)pyrene	63.796 U	-	-	-	-	-	-
Dibenzo(a,h)anthracene	63.796 U	-	-	-	-	-	-
Benzo(g,h,i)perylene	63.796 U	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	63.796 U	-	-	-	-	-	-

(a) Not significantly elevated relative to R-AM.
(b) U indicates analyte undetected in all replicates.

TABLE 3.31. Signficantly Elevated Mean Tissue Concentrations of Pesticides in *N. caecoides* (µg/kg wet weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aldrin	10.0 U(a)	-(b)	-	-	-	-	-
Alpha-BHC	10.0 U	-	-	-	-	-	-
Beta-BHC	10.0 U	-	-	-	-	-	-
Delta-BHC	10.0 U	-	-	-	-	-	-
Gamma-BHC	10.0 U	-	-	-	-	-	-
Chlordane	10.0 U	-	-	-	-	-	-
4,4'-DDD	10.0 U	-	-	-	-	-	-
4,4'-DDE	10.0 U	-	-	-	-	-	-
4,4'-DDT	10.0 U	-	-	-	-	-	-
Dieldrin	10.0 U	-	-	-	-	-	-
Endosulfan I	10.0 U	-	-	-	-	-	-
Endosulfan II	10.0 U	-	-	-	-	-	-
Endosulfan sulfate	10.0 U	-	-	-	-	-	-
Endrin	10.0 U	-	-	-	-	-	-
Endrin Aldehyde	10.0 U	-	-	-	-	-	-
Heptachlor	10.0 U	-	-	-	-	-	-
Heptachlor epoxide	10.0 U	-	-	-	-	-	-
Methoxychlor	11.0 U	-	-	-	-	-	-
Toxaphene	500.0 U	-	-	-	-	-	-

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.

TABLE 3.32. Signficantly Elevated Mean Tissue Concentrations of Pesticides in *N. caecoides* (µg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aldrin	63.796 U[a]	-[b]	-	-	-	-	-
Alpha-BHC	63.796 U	-	-	-	-	-	-
Beta-BHC	63.796 U	-	-	-	-	-	-
Delta-BHC	63.796 U	-	-	-	-	-	-
Gamma-BHC	63.796 U	-	-	-	-	-	-
Chlordane	63.796 U	-	-	-	-	-	-
4,4'-DDD	63.796 U	-	-	-	-	-	-
4,4'-DDE	63.796 U	-	-	-	-	-	-
4,4'-DDT	63.796 U	-	-	-	-	-	-
Dieldrin	63.796 U	-	-	-	-	-	-
Endosulfan I	63.796 U	-	-	-	-	-	-
Endosulfan II	63.796 U	-	-	-	-	-	-
Endosulfan sulfate	63.796 U	-	-	-	-	-	-
Endrin	63.796 U	-	-	-	-	-	-
Endrin Aldehyde	63.796 U	-	-	-	-	-	-
Heptachlor	63.796 U	-	-	-	-	-	-
Heptachlor epoxide	63.796 U	-	-	-	-	-	-
Methoxychlor	69.600 U	-	-	-	-	-	-
Toxaphene	3189.946 U	-	-	-	-	-	-

(a) U indicates analyte undetected in all replicates
(b) Not significantly elevated relative to R-AM

TABLE 3.33. Significantly Elevated Mean Tissue Concentrations of PCBs in *N. caecoides* (µg/kg wet weight)

PARAMETER	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aroclor 1016	100.0 U[a]	-[b]	-	-	-	-	-
Aroclor 1221	100.0 U	-	-	-	-	-	-
Aroclor 1232	100.0 U	-	-	-	-	-	-
Aroclor 1242	100.0 U	-	-	-	-	-	-
Aroclor 1248	100.0 U	-	-	-	-	-	-
Aroclor 1254	100.0 U	-	-	166.0	-	-	-
Aroclor 1260	100.0 U	-	-	-	-	-	-

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.

TABLE 3.34. Significantly Elevated Mean Tissue Concentrations of PCBs in *N. caecoides* (µg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Aroclor 1016	638.0 U[a]	-[b]	-	-	-	-	-
Aroclor 1221	638.0 U	-	-	-	-	-	-
Aroclor 1232	638.0 U	-	-	-	-	-	-
Aroclor 1242	638.0 U	-	-	-	-	-	-
Aroclor 1248	638.0 U	-	-	-	-	-	-
Aroclor 1254	638.0 U	-	-	950.4	-	-	-
Aroclor 1260	638.0 U	-	-	-	-	-	-

(a) U indicates analyte undetected in all replicates.
(b) Not significantly elevated relative to R-AM.

TABLE 3.35. Signicantly Elevated Mean Tissue Concentrations of Metals in *N. caecoides* (mg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Silver	0.063	-[a]	-	-	-	-	-
Arsenic	19.733	27.9	28.3	28.2	27.5	27.7	26.2
Cadmium	1.130	-	-	-	-	1.447	-
Chromium	0.300	-	-	-	0.470	0.437	0.430
Copper	25.667	-	-	-	-	-	-
Mercury	0.660	-	-	-	-	-	-
Nickel	3.100	-	-	-	-	-	-
Lead	0.783	-	-	1.020	1.027	0.963	-
Selenium	1.170	-	-	-	-	-	1.790
Zinc	188.800	-	203.0	-	-	210.667	-

(a) Not significantly elevated relative to R-AM.

TABLE 3.36. Significantly Elevated Mean Tissue Concentrations of Butyltins in *N. caecoides* (µg/kg wet weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Tributyltin	6.349 J[a]	-[b]	-	-	-	-	-
Dibutyltin	8.288 UJ[c]	-	-	-	-	-	-
Monobutyltin	9.070 UJ	-	-	-	-	-	-

(a) J Detected below method detection limit in all replicates; value is mean of detected values.
(b) Not significantly elevated relative to R-AM
(c) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.

TABLE 3.37. Significantly Elevated Mean Tissue Concentrations of Butyltins in *N. caecoides* (µg/kg dry weight)

Parameter	R-AM	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Tributyltin	41.4 J(a)	-(b)	-	-	-	-	-
Dibutyltin	53.4 UJ(c)	-	-	-	-	-	-
Monobutyltin	58.0 UJ	-	-	-	-	-	-

(a) J Detected below method detection limit in all replicates; value is mean of detected values.
(b) Not significantly elevated relative to R-AM
(c) UJ indicates undetected or detected below the method detection limit in all replicates; value is mean of detected values and detection limits

4.0 DISCUSSION AND CONCLUSIONS

4.1 GEOLOGICAL EVALUATIONS

Geological evaluations were performed on the individual sediment samples comprising each of the six composites (COMPs). Those evaluations provided an estimate of the amounts of Older Bay and Younger Bay Mud (OBM and YBM) and the dominant sediment type present in each of the COMPs. This summary information is presented in Table 4.1, which shows that the six COMPs represented depths ranging from -31.0 to -38.3 ft MLLW in the Inner Oakland Harbor. COMPs I and II were composed primarily of YBM in the form of clay which consists of some silts and sands. The remaining four COMPs (COMPs III, IV, V, and VI) were composed of both YBM and OBM, with YBM generally the dominant material. Sediment from these four COMPs were primarily sand. Gravel, silt, and clay were also present.

4.2 SEDIMENT CHEMISTRY

According to the 1991 Implementation Manual, sediment chemistry results are not intended to evaluate the suitability of sediments for open-ocean disposal but rather to provide a basis for determining the contaminants currently present in the sediment treatments (composites) that show signs of potential effects. Sediment chemistry results are to be used in conjunction with toxicity tests and bioaccumulation results in order to evaluate appropriate disposal options. This section compares chemical concentrations of sediment conventionals, metals, and organics to the reference R-AM.

TABLE 4.1. Summary of Geological Descriptions of Sediment

Treatment	MLLW Depth Range, ft	Material Characterization
COMP I	-34.5 to -37.2	YBM, clay with sand, silty clays
COMP II	-35.9 to -37.0	YBM, clay with sand
COMP III	-34.9 to -37.2	YBM, clay with sand, silts with fine sand
COMP IV	-34.0 to -38.3	YBM/OBM, clay with sand, gravelly sands
COMP V	-34.9 to -37.9	YBM/OBM, clay with sand, silty sands
COMP VI	-31.0 to -38.0	YBM/OBM, clay with sand

Table 4.2 summarizes all contaminants in the sediment treatments that exceeded the values observed in the reference R-AM. This table shows that contaminants of concern were elevated in the COMPs and the respective stations relative to the reference R-AM. The only exceptions to this were the metals As and Cd, which were generally not elevated. The three control treatments, C-NE, C-SB, and C-WB, produced the fewest number of elevated contaminant concentrations relative to R-AM. All COMPs had PAHs, PCBs, a variety of metals, and butyltin concentrations that were elevated relative to R-AM. Pesticide concentrations were elevated only in COMP V relative to R-AM.

4.3 TOXICOLOGY AND BIOACCUMULATION

Toxicology and bioaccumulation results are important in the characterization of sediment treatments (composites) representing proposed dredging sites. The COMPs that produced statistically significant acute toxicity or bioaccumulation of contaminants of concern relative to the reference R-AM are summarized in Table 4.3. By examining the results of the toxicity and bioaccumulation analyses, USACE will be able to determine which COMPs may be unsuitable for in-bay disposal relative to the reference site R-AM. There was no evidence of acute toxicity in the suspended-particulate-phase (water column) tests relative to R-AM. Table 4.3 shows that there was acute toxicity in the solid-phase tests of COMP V and COMP VI relative to R-AM. COMP V produced significant toxicity in the 10-day *R. abronius* test; COMP VI produced significant toxicity in the 10-day *N. caecoides* test.

The potential for bioaccumulation relative to R-AM, however, is evident by the total number of hits listed at the bottom of the table. For this discussion, a hit is defined as acute toxicity or a statistically significant elevation of bioaccumulation of LPAH, HPAH, a butyltin, or any of the 10 metals in tissues exposed to the COMPs relative to tissues exposed to R-AM. At the request of USACE, metals concentrations in the tissues of *M. nasuta* and *N. caecoides* were evaluated as dry weight only.

COMPs I and II showed no acute toxicity and only a few statistically significant differences in bioaccumulation that were due to slight elevations of metals. COMPs III and IV showed no acute toxicity and some statistically significant differences in bioaccumulation that were due to elevated levels of the PAH pyrene. COMPs V and VI showed acute toxicity and had the most statistically significant differences in tissue contaminant levels.

TABLE 4.2. Summary of Sediment Comparisons to R-AM

Stations	PAH		Pesticide	PCB	Metals										Butyltins		
	LPAH	HPAH		Aroclor-1254	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	TBT	DBT	MBT
COMP I	X(a)	X	—(b)	X	X	—	—	X	X	X	X	X	X	X	X	X	X
COMP I dup.	X	X	X	—	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C3	X	X	X	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C19	X	X	X	—	X	—	—	X	X	X	X	X	X	X	X	X	—
I-C21	X	X	—	—	X	—	—	X	X	X	X	X	X	X	X	X	—
COMP II	X	X	—	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C5	X	X	—	—	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C22	X	X	X	—	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C23	X	X	X	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C24	X	X	—	—	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C25	X	X	X	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C25 top 12"	X	X	—	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C26	X	X	X	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C27	X	X	—	X	X	—	—	X	X	X	X	X	X	X	X	X	X
COMP III	X	X	—	—	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C8	X	X	—	—	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C28	X	X	X	X	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C28 dup.	X	X	—	NA(c)	X	—	X	X	X	X	X	X	—	X	X	X	X
I-C29	X	X	X	—	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C30	X	X	X	—	X	—	—	X	X	X	X	X	—	X	X	X	X
COMP IV	X	X	—	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C9	X	X	X	X	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C10	X	X	—	X	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C11	X	X	—	—	X	—	—	X	X	X	X	X	—	X	X	X	—
I-C12	X	X	X	—	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C31	X	X	—	—	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C32	X	X	—	X	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C33	X	X	—	X	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C34	X	X	—	—	X	—	X	X	X	X	X	X	X	X	X	X	X

TABLE 4.2. (contd))

Stations	PAH		Pesticide	PCB	Metals										Butyltins		
	LPAH	HPAH		Aroclor-1254	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	TBT	DBT	MBT
COMP V	X	X	X	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C13	X	X	—	—	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C14	X	X	X	X	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C15	X	X	X	—	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C18	X	X	—	X	X	—	X	X	X	X	X	X	X	X	X	X	X
COMP VI	X	X	—	—	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C16	X	X	—	—	X	—	—	X	X	X	X	X	—	X	X	X	X
I-C17	X	X	X	X	X	—	X	X	X	X	X	X	X	X	X	X	X
I-C35	X	X	—	X	X	—	—	X	X	X	X	X	X	X	X	X	X
I-C35 top 12"	X	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C-NE	—	—	—	—	X	—	—	—	—	X	—	—	—	—	—	—	—
C-SB	—	—	—	X	X	—	X	—	X	X	X	X	X	X	X	X	—
C-WB	X	X	—	X	X	—	—	X	—	—	X	—	--	X	—	—	—

(a) X Elevation above the concentrations found in R-AM.
(b) --- No elevation above the concentrations found in R-AM.
(c) NA Not applicable; samples not analyzed for compounds.

TABLE 4.3. Summary of Statistical Comparisons to R-AM

Parameter	COMP I	COMP II	COMP III	COMP IV	COMP V	COMP VI
Acute Toxicity	---(a)	---	---	---	Rhe(b)	Nep(c)
Wet Weight *M. nasuta*						
PAHs	---	---	HPAH	HPAH	HPAH	LPAH,HPAH
Pesticides/PCBs	---	---	---	---	PCB	Pest,PCB
Butyltins	---	TBT	TBT,MBT	TBT,DBT	TBT,DBT	---
Dry Weight *M. nasuta*						
PAHs	---	---	HPAH	HPAH	HPAH	LPAH,HPAH
Pesticides/PCBs	---	Pest	---	---	PCB	Pest,PCB
Metals	Cr,Cu,Ni	Cd,Cr,Ni	Cr,Ni,Pb	Cr,Pb	Cr,Ni,Pb	Cr,Ni,Pb
Butyltins	---	TBT	TBT,MBT	TBT,DBT	TBT,DBT	---
Wet Weight *N. caecoides*						
PAHs	LPAH	LPAH,HPAH	HPAH	HPAH	HPAH	LPAH,HPAH
Pesticides/PCBs	---	---	PCB	---	---	---
Butyltins	---	---	---	---	---	---
Dry Weight *N. caecoides*						
PAHs	LPAH	HPAH	HPAH	HPAH	HPAH	LPAH,HPAH
Pesticides/PCBs	---	---	PCB	---	---	---
Metals	As	As,Zn	As,Pb	As,Cr,Pb	As,Cd,Cr,Pb,Zn	As,Cr,Se
Butyltins	---	---	---	---	---	---

(a) No significant difference from R-AM.
(b) Rhe is 10-day static test with *R. abronius*.
(c) Nep is 10-day flow-through test with *N. caecoides*.

4.4 CONCLUSIONS

The tiered approach to evaluating the potential impacts from ocean disposal of dredged material consists of a series of activities (tests) and decision modules (determination of compliance) to guide the evaluation of potential dredged sediment. The work presented in this report falls under the Tier III guidelines of the 1991 Implementation Manual, consisting of water column toxicity, deposited sediment (solid phase) toxicity, and deposited sediment bioaccumulation. Physical and chemical analyses of proposed dredged material are only used in this study to verify sediment grain size and to help explain toxicological and bioaccumulation results. The following discussion summarizes the tests conducted by MSL under Tier III, using the determination of compliance definitions provided by the 1991 Implementation Manual.

4.4.1 Water Column

Estimates of toxicity in the water column were evaluated by exposing three sensitive marine species (*H. sculpta*, *C. stigmaeus*, and *C. gigas*) to the SPP of the six sediment composites and R-AM. Four concentrations of SPP were tested: 0% (seawater), 10%, 50%, and 100%. Determination of compliance for this test involves deciding whether the concentration of dissolved plus suspended contaminants, after allowance for initial mixing, is greater than 0.01 of the acutely toxic concentration beyond the boundaries of the disposal site within the first 4 h after disposal. The SPP tests involving the six COMPs showed no acute toxicity that produced a 50% decrease in test organism survival relative to the control (0% SPP); thus, LC50s could not be calculated.

4.4.2 Deposited Sediment Toxicity

Deposited sediment toxicity was determined by exposing four species of marine organisms (*M. nasuta*, *N. caecoides*, *C. stigmaeus* and *R. abronius*) to test sediment treatments using solid-phase tests. Tier III guidelines in the 1991 Implementation Manual concerning determination of compliance for deposited sediment provide the criteria necessary to evaluate whether the mortality of organisms exposed to the composite samples representing potential dredged material is significantly different than mortality of organisms exposed to the reference R-AM, and whether test organism mortality in test treatments exceeds the reference treatment by 20% (*R. abronius*) or 10% (other species). If the mortality of test organisms in test treatments is significantly different than the reference mortality and

exceeds the reference by the above percentages, then the test material does not comply with the benthic bioassay criteria of Section 227.13(c) in Appendix A of the 1991 Implementation Manual. Acute toxicity relative to the reference R-AM was observed in COMP V and COMP VI. These COMPs do not comply with the above benthic bioassay criteria.

4.4.3 Bioaccumulation

The potential for bioaccumulation of contaminants was evaluated through 28-day solid-phase flow-through tests of *M. nasuta* and *N. caecoides*. The concentrations of contaminants were compared to existing Food and Drug Administration (FDA) limits, and also compared through ANOVA and Dunnett's Test to determine whether statistically significant ($\alpha = 0.05$) levels of contaminants existed relative to the reference R-AM. The bioaccumulation results in this project showed that contaminants in tissues exposed to the six COMPs did not exceed the FDA action limits (where available) summarized in the 1991 Implementation Manual, but statistically significant levels of contaminants existed in the tissues of *M. nasuta* and *N. caecoides* when compared to tissues exposed to R-AM. Compared to R-AM, COMPs I and II produced the fewest occurrences of significant bioaccumulation; COMPs V and VI produced the most occurrences of significant bioaccumulation.

According to the 1991 Implementation Manual, further evaluation of the test sediments and the potential dredged material they represent may be necessary to determine whether these materials can be disposed of in the open water. The summary results presented in this report are intended to aid in this determination. Further evaluations in the form of numerical modeling, case-specific testing, or other management action as defined by the 1991 Implementation Manual and developed by the District Engineer and Regional Administrator may be necessary.

5.0 REFERENCES

American Society for Testing and Materials (ASTM). 1972. Standard Method for Particle-Size Analysis of Soils. D422. American Society for Testing and Materials. Philadelphia, Pennsylvania.

American Society for Testing and Materials (ASTM). 1978. Standard Method for Dry Preparation of Soil Samples for Particle-size Analysis and Determination of Soil Constants. D421. American Society for Testing and Materials. Philadelphia, Pennsylvania.

American Society for Testing and Materials (ASTM). 1984. Standard Practice for Description and Identification of Soils. D2488-84, American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 293-302.

Bloom, N. S., and E. A. Crecelius. 1983. "Determination of Mercury in Seawater at Nub-Nanogram per Liter Levels." Mar. Chem. 14:49-59.

Bloom, N. S., and E. A. Crecelius. 1984. "Distribution of Silver, Mercury, Lead, Copper and Cadmium in Central Puget Sound Sediments." Marine Chemistry 21:377-390.

Finney, D. J. 1971. Probit Analysis. Third ed., Cambridge University Press. Cambridge.

Krauskopf, K. 1967. Introduction to Geochemistry. McGraw-Hill International Series in the Earth and Planetary Sciences, McGraw-Hill, New York.

Puget Sound Estuary Program (PSEP). 1986. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Prepared by Tetra Tech, Inc. for the Puget Sound Estuary Program. Volumes 1 and 2, Bellevue, Washington.

Sanders, R. W. 1987. Energy Dispersive X-Ray Fluorescence Spectroscopy. PNL-SOP: PNL-SP-19, Pacific Northwest Laboratory, Richland, Washington.

Unger, M. A., W. G. MacIntyre, J. Greaves, and R. J. Huggett. 1986. "GC Determination of Butyltins in Natural Waters by Flame Photometric Detection of Hexyl Derivatives with Mass Spectrometric Confirmation." Chemosphere 15(4):461-470.

U.S. Army Corps of Engineers (USACE). 1975. Maintenance Dredging: Existing Navigation Projects. San Francisco Bay Region, California: U.S. Army Corps of Engineers, San Francisco District. Final Composite Environment Statement, San Francisco, California.

U.S. Environmental Protection Agency (EPA). 1979. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA-600 4-79-020 Methods 413.2, 418.1, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

U.S. Environmental Protection Agency (EPA). 1985. Ambient Water Quality Criteria for Copper-1984. EPA 440/5-84-031. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1986. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA-955-001-00000. U.S. Environmental Protection Agency, Government Printing Office, Washington, DC.

U.S. Environmental Protection Agency/U.S. Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material (EPA/USACE). 1977. Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters: Implementation Manual for Section 103 of Public Law 92-532 (Marine Protection, Research, and Sanctuaries Act of 1972). Environmental Effects Laboratory, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Environmental Protection Agency/U.S. Army Corps of Engineers (EPA/USACE). 1990. Draft Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters. EPA-503-8-90/002. U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC.

U.S. Environmental Protection Agency/U.S. Army Corps of Engineers (EPA/USACE). 1991. Evaluation of Dredged Material Proposed for Ocean Disposal (Testing Manual). EPA-68-C8-0105. U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC.

Ward, J. A., J. Q. Word, M. R. Pinza, H. L. Mayhew, M. S. Barrows, N. P. Kohn, L. K. Lefkovitz. 1991. Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor Into Ocean Waters (Phase III, -38-Foot Project). PNL 7890, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX A

STATISTICAL ANALYSIS OF BIOACCUMULATION IN *MACOMA nasuta* (WET WEIGHT CONCENTRATIONS)

TABLE A.1. Mean Tissue Concentration (wet weight) and Statistical Grouping for Naphthalene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	6.2 U[a]	NS[b]
COMP II	6.6 UB[c]	NS
COMP III	6.2 U	NS
COMP IV	6.4 UB	NS
COMP V	7.3 UB	NS
COMP VI	6.2 U	NS
R-AM	6.4 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(d) NA Not applicable.

TABLE A.2. ANOVA Results for Naphthalene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.071	6	0.012	0.781	0.5914[a]
Residual	0.452	30	0.015		

(a) Significance Level: $p \leq 0.05$.

TABLE A.3. Mean Tissue Concentration (wet weight) and Statistical Grouping for 2-Methylnaphthalene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I		
COMP II		
COMP III	Compound not analyzed in *M. nasuta*	
COMP IV		
COMP V		
COMP VI		
R-AM		

TABLE A.4. ANOVA Results for 2-Methylnaphthalene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment					
Residual	Compound not analyzed in *M. nasuta*				

TABLE A.5. Mean Tissue Concentration (wet weight) and Statistical Grouping for Acenaphthylene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	0.95 U[a]	NS[b]
COMP ii	1.58 UB[c]	NS
COMP III	0.94	NS
COMP IV	0.98	NS
COMP V	1.14 U	NS
COMP VI	0.94	NS
R-AM	0.97 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(c) NA Not applicable.

TABLE A.6. ANOVA Results for Acenaphthylene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.347	6	0.058	0.758	0.6085[a]
Residual	2.289	30	0.076		

(a) Significance Level: $p \leq 0.05$.

TABLE A.7. Mean Tissue Concentration (wet weight) and Statistical Grouping for Acenaphthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.37 U[a]	NS[b]
COMP II	3.26	NS
COMP III	2.36 U	NS
COMP IV	2.36 U	NS
COMP V	2.78 U	NS
COMP VI	2.40 U	NS
R-AM	2.42 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.8. ANOVA Results for Acenaphthene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.207	6	0.035	0.791	0.5844[a]
Residual	1.311	30	0.044		

(a) Significance Level: $p \leq 0.05$.

TABLE A.9. Mean Tissue Concentration (wet weight) and Statistical Grouping for Fluorene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.88 U[a]	NS[b]
COMP II	10.32	NS
COMP III	4.48	NS
COMP IV	1.86 U	NS
COMP V	2.22 U	NS
COMP VI	2.80	NS
R-AM	1.93 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.10. ANOVA Results for Fluorene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.753	6	0.292	0.671	0.6736[a]
Residual	13.059	30	0.435		

(a) Significance Level: $p \leq 0.05$.

TABLE A.11. Mean Tissue Concentration (wet weight) and Statistical Grouping for Phenanthrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	3.40 UB[a]	NS[b]
COMP II	3.38 UB	NS
COMP III	4.44 B[c]	NS
COMP IV	4.45 B	NS
COMP V	4.10	NS
COMP VI	10.10 B	S[d]
R-AM	4.68 UB	NA[e]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) B Analyte detected in blanks at less than twice the detection limit for all replicates; sample concentrations were not blank-corrected.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE A.12. ANOVA Results for Phenanthrene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	3.986	6	0.664	5.399	0.0007[a]
Residual	3.691	30	0.123		

(a) Significance Level: $p \leq 0.05$.

TABLE A.13. Mean Tissue Concentration (wet weight) and Statistical Grouping for Anthracene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.18	NS[a]
COMP II	1.26	NS
COMP III	1.26	NS
COMP IV	1.22	NS
COMP V	1.58	NS
COMP VI	1.72	NS
R-AM	1.23	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE A.14. ANOVA Results for Anthracene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.516	6	0.860	1.481	0.2183[a]
Residual	1.743	30	0.058		

(a) Significance Level: $p \leq 0.05$.

TABLE A.15. Mean Tissue Concentration (wet weight) and Statistical Grouping for Fluoranthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.92	NS[a]
COMP II	7.74	NS
COMP III	8.48 UB[b]	NS
COMP IV	12.36 B[c]	NS
COMP V	6.38	NS
COMP VI	31.30 B	S[d]
R-AM	7.77 B	NA[e]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(c) B Analyte detected in blanks at less than twice the detection limit for all replicates; sample concentrations were not blank-corrected.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE A.16. ANOVA Results for Fluoranthene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	19.254	6	3.209	8.220	0.0001[a]
Residual	11.322	29	0.390		

(a) Significance Level: $p \leq 0.05$.

TABLE A.17. Mean Tissue Concentration (wet weight) and Statistical Grouping for Pyrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	12.42	NS[a]
COMP II	14.34 B[b]	NS
COMP III	73.08	S[c]
COMP IV	108.12	S
COMP V	60.58	NS
COMP VI	208.96	S
R-AM	36.43 B	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) B Analyte detected in associated blank at less than twice the method detection limit in all replicates; sample concentrations were not blank-corrected.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.18. ANOVA Results for Pyrene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	35.232	6	5.827	7.677	0.0001[a]
Residual	22.181	29	0.765		

(a) Significance Level: $p \leq 0.05$.

TABLE A.19. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(a)anthracene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.50	NS[a]
COMP II	2.96	NS
COMP III	6.96	NS
COMP IV	5.96	S[b]
COMP V	4.50	NS
COMP VI	9.58	S
R-AM	1.70	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.20. ANOVA Results for Benzo(a)anthracene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	10.969	6	1.828	3.392	0.0117[a]
Residual	15.630	29	0.539		

(a) Significance Level: $p \leq 0.05$.

TABLE A.21. Mean Tissue Concentration (wet weight) and Statistical Grouping for Chrysene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.30	NS[a]
COMP II	2.12	NS
COMP III	5.98	NS
COMP IV	2.72	NS
COMP V	3.80	NS
COMP VI	11.12	S[b]
R-AM	3.15	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.22. ANOVA Results for Chrysene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	15.395	6	2.566	8.992	0.0001[a]
Residual	8.274	29	0.285		

(a) Significance Level: $p \leq 0.05$.

TABLE A.23. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(b,k)fluoranthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	3.70	NS[a]
COMP II	7.18	NS
COMP III	34.64	S[b]
COMP IV	25.68	NS
COMP V	40.88	S
COMP VI	53.20	S
R-AM	13.48	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.24. ANOVA Results for Benzo(b,k)fluoranthene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	36.977	6	6.163	7.977	0.0001[a]
Residual	22.405	29	0.773		

(a) Significance Level: $p \leq 0.05$.

TABLE A.25. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(k)fluoranthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I		
COMP II		
COMP III	Reported as Benzo(b,k)fluoranthene (Table A.23)	
COMP IV		
COMP V		
COMP VI		
FI-AC		

TABLE A.26. ANOVA Results for Benzo(k)fluoranthene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment					
Residual	Reported as Benzo(b,k)fluoranthene (Table A.24)				

TABLE A.27. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(a)pyrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.84	NS[a]
COMP II	2.00	NS
COMP III	22.64	S[b]
COMP IV	12.32	S
COMP V	23.24	S
COMP VI	31.26	S
R-AM	3.45	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.28. ANOVA Results for Benzo(a)pyrene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	58.135	6	9.689	17.375	0.0001[a]
Residual	16.172	29	0.558		

(a) Significance Level: $p \leq 0.05$.

TABLE A.29. Mean Tissue Concentration (wet weight) and Statistical Grouping for Dibenzo(a,h)anthracene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	0.88 U[a]	NS[b]
COMP II	0.84 U	NS
COMP III	3.14	NS
COMP IV	5.24	S[c]
COMP V	6.66	S
COMP VI	3.00	NS
R-AM	0.88 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.30. ANOVA Results for Dibenzo(a,h)anthracene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	16.124	6	2.687	4.489	0.0025[a]
Residual	17.360	29	0.599		

(a) Significance Level: $p \leq 0.05$.

TABLE A.31. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(g,h,i)perylene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.38	NS[a]
COMP II	1.16	NS
COMP III	8.88	S[b]
COMP IV	5.06	NS
COMP V	9.44	S
COMP VI	10.54	S
R-AM	2.98	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.32. ANOVA Results for Benzo(g,h,i)perylene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	27.268	6	4.545	6.188	0.0003[a]
Residual	21.297	29	0.734		

(a) Significance Level: $p \leq 0.05$.

TABLE A.33. Mean Tissue Concentration (wet weight) and Statistical Grouping for Indeno(1,2,3-c,d)pyrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.50 U[a]	NS[b]
COMP II	1.44 U	NS
COMP III	6.22	NS
COMP IV	5.08	NS
COMP V	8.24	S[c]
COMP VI	7.56	S
R-AM	2.25	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.34. ANOVA Results for Indeno(1,2,3-c,d)pyrene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	14.964	6	2.494	6.973	0.0001[a]
Residual	10.373	29	0.358		

(a) Significance Level: $p \leq 0.05$.

TABLE A.35. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1016 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	20.0 U[a]	NS[b]
COMP II	20.0 U	NS
COMP III	20.0 U	NS
COMP IV	20.0 U	NS
COMP V	20.0 U	NS
COMP VI	20.0 U	NS
R-AM	20.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.36. ANOVA Results for Aroclor-1016 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	9.312×10^{-35}	6	1.552×10^{-35}	NA[a]	NA
Residual	-2.220×10^{-16}	32	-6.939×10^{-18}		

(a) Not applicable, no variance

TABLE A.37. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1221 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	20.0 U[a]	NS[b]
COMP II	20.0 U	NS
COMP III	20.0 U	NS
COMP IV	20.0 U	NS
COMP V	20.0 U	NS
COMP VI	20.0 U	NS
R-AM	20.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.38. ANOVA Results for Aroclor-1221 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	9.312×10^{-35}	6	1.552×10^{-35}	NA[a]	NA
Residual	-2.220×10^{-16}	32	-6.939×10^{-18}		

(a) Not applicable, no variance

TABLE A.39. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1232 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (ug/kg wet weight)	Statistical Significance
COMP I	20.0 U[a]	NS[b]
COMP II	20.0 U	NS
COMP III	20.0 U	NS
COMP IV	20.0 U	NS
COMP V	20.0 U	NS
COMP VI	20.0 U	NS
R-AM	20.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.40. ANOVA Results for Aroclor-1232 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	9.312×10^{-35}	6	1.552×10^{-35}	NA[a]	NA
Residual	-2.220×10^{-16}	32	-6.939×10^{-18}		

(a) Not applicable, no variance

TABLE A.41. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1242 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	30.0	NS[a]
COMP II	20.0 U[b]	NS
COMP III	60.0 U	NS
COMP IV	20.0 U	NS
COMP V	33.3 U	NS
COMP VI	156.0	S[c]
R-AM	20.0 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.42. ANOVA Results for Aroclor-1242 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	8.645	6	1.441	2.910	0.0222[a]
Residual	15.844	32	0.495		

(a) Significance Level: $p \leq 0.05$.

TABLE A.43. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1248 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	20.0 U[a]	NS[b]
COMP II	20.0 U	NS
COMP III	20.0 U	NS
COMP IV	20.0 U	NS
COMP V	20.0 U	NS
COMP VI	20.0 U	NS
R-AM	20.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.44. ANOVA Results for Aroclor-1248 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	9.312×10^{-35}	6	1.552×10^{-35}	NA[a]	NA
Residual	-2.220×10^{-16}	32	-6.939×10^{-18}		

(a) Not applicable, no variance

TABLE A.45. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1254 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	76.2	NS[a]
COMP II	20.0 U[b]	NS
COMP III	101.8	NS
COMP IV	56.4	NS
COMP V	73.9	NS
COMP VI	186.0	S[c]
R-AM	33.0	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.46. ANOVA Results for Aroclor-1254 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	10.648	6	1.775	2.640	0.0341[a]
Residual	21.514	32	0.672		

(a) Significance Level: $p \leq 0.05$.

TABLE A.47. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1260 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	24.8	NS[a]
COMP II	20.0 U[b]	NS
COMP III	20.0 U	NS
COMP IV	36.0	NS
COMP V	52.3	S[c]
COMP VI	27.6 U	NS
R-AM	20.0 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.48. ANOVA Results for Aroclor-1260 (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.343	6	0.390	1.876	0.1157[a]
Residual	6.661	32	0.208		

(a) Significance Level: $p \leq 0.05$.

TABLE A.49. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aldrin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.3 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.8	NS
COMP IV	2.0 U	NS
COMP V	2.0	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.50. ANOVA Results for Aldrin (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.240	6	0.040	0.911	0.4998[a]
Residual	1.405	32	0.044		

(a) Significance Level: $p \leq 0.05$.

TABLE A.51. Mean Tissue Concentration (wet weight) and Statistical Grouping for Alpha-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.4 U	NS
COMP IV	2.4	NS
COMP V	2.0 U	NS
COMP VI	2.9	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.52. ANOVA Results for Alpha-BHC (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.319	6	0.053	0.915	0.4971[a]
Residual	1.861	32	0.058		

(a) Significance Level: $p \leq 0.05$.

TABLE A.53. Mean Tissue Concentration (wet weight) and Statistical Grouping for Beta-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.2	NS[a]
COMP II	7.0 U[b]	NS
COMP III	2.1	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	2.1 U	NS
R-AM	2.0 U	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NA Not applicable.

TABLE A.54. ANOVA Results for Beta-BHC (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.104	6	0.184	1.045	0.4155[a]
Residual	5.636	32	0.176		

(a) Significance Level: $p \leq 0.05$.

TABLE A.55. Mean Tissue Concentration (wet weight) and Statistical Grouping for Delta-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.4	NS
COMP IV	2.0 U	NS
COMP V	2.7	NS
COMP VI	4.9	S[c]
R-AM	2.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.56. ANOVA Results for Delta-BHC (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.090	6	0.348	3.235	0.0134[a]
Residual	3.446	32	0.108		

(a) Significance Level: $p \leq 0.05$.

TABLE A.57. Mean Tissue Concentration (wet weight) and Statistical Grouping for Gamma-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.5	NS
COMP IV	2.0 U	NS
COMP V	2.2	NS
COMP VI	5.0	S[c]
R-AM	2.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.58. ANOVA Results for Gamma-BHC (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.941	6	0.324	3.529	0.0086[a]
Residual	2.934	32	0.092		

(a) Significance Level: $p \leq 0.05$.

TABLE A.59. Mean Tissue Concentration (wet weight) and Statistical Grouping for Alpha-Chlordane in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.1	NS
COMP IV	2.0 U	NS
COMP V	2.3	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.60. ANOVA Results for Alpha-Chlordane (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.053	6	0.009	0.674	0.6716[a]
Residual	0.422	32	0.013		

(a) Significance Level: $p \leq 0.05$.

TABLE A.61. Mean Tissue Concentration (wet weight) and Statistical Grouping for Gamma-Chlordane in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.5	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.0	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.62. ANOVA Results for Gamma-Chlordane (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.101	6	0.017	1.139	0.3629[a]
Residual	0.471	32	0.015		

(a) Significance Level: $p \leq 0.05$.

TABLE A.63. Mean Tissue Concentration (wet weight) and Statistical Grouping for 4,4'-DDD in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.64. ANOVA Results for 4,4'-DDD (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.367×10^{-36}	6	7.278×10^{-37}	3.36×10^{-18}	1.000[a]
Residual	6.939×10^{-18}	32	2.168×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE A.65. Mean Tissue Concentration (wet weight) and Statistical Grouping for 4,4'-DDE in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.9 U	NS
COMP III	4.2	NS
COMP IV	2.3	NS
COMP V	2.0 U	NS
COMP VI	3.9 U	NS
R-AM	2.1	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.66. ANOVA Results for 4,4'-DDE (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.304	6	0.217	1.255	0.3053[a]
Residual	5.540	32	0.173		

(a) Significance Level: $p \leq 0.05$

TABLE A.67. Mean Tissue Concentration (wet weight) and Statistical Grouping for 4,4'-DDT in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.2 U	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	5.5 U	S[c]
R-AM	2.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.68. ANOVA Results for 4,4'-DDT (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.723	6	0.287	2.574	0.0378[a]
Residual	3.570	32	0.112		

(a) Significance Level: $p \leq 0.05$.

TABLE A.69. Mean Tissue Concentration (wet weight) and Statistical Grouping for Dieldrin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	3.7 UB[a]	NS[b]
COMP II	2.0 U[c]	NS
COMP III	2.8 U	NS
COMP IV	2.0 U	NS
COMP V	3.4 U	NS
COMP VI	7.2 UB	NS
R-AM	2.1 U	NA[d]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the assoicated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE A.70. ANOVA Results for Dieldrin (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.403	6	0.400	1.128	0.3686[a]
Residual	11.361	32	0.355		

(a) Significance Level: $p \leq 0.05$.

TABLE A.71. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endosulfan I in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.72. ANOVA Results for Endosulfan I (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.367×10^{-36}	6	7.278×10^{-37}	3.36×10^{-18}	1.0000[a]
Residual	6.939×10^{-18}	32	2.168×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE A.73. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endosulfan II in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	3.5 UB[a]	NS[b]
COMP II	2.0 U[c]	NS
COMP III	5.8 UB	NS
COMP IV	2.2 U	NS
COMP V	2.6 UB	NS
COMP VI	6.7 UB	S[d]
R-AM	2.0 U	NA[e]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the assoicated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE A.74. ANOVA Results for Endosulfan II (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	3.671	6	0.612	1.897	0.1119[a]
Residual	10.323	32	0.323		

(a) Significance Level: $p \leq 0.05$.

TABLE A.75. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endosulfan Sulfate in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	3.2	S[c]
R-AM	2.1	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.76. ANOVA Results for Endosulfan Sulfate (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.534	6	0.089	2.528	0.0407[a]
Residual	1.128	32	0.035		

(a) Significance Level: $p \leq 0.05$.

TABLE A.77. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endrin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 UB[a]	NS[b]
COMP II	2.4 U[c]	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.5	NS
COMP VI	4.0 U	S[d]
R-AM	2.0 U	NA[e]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the assoicated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE A.78. ANOVA Results for Endrin (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.445	6	0.241	3.559	0.0082[a]
Residual	2.165	32	0.068		

(a) Significance Level: $p \leq 0.05$.

TABLE A.79. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endrin Ketone in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.80. ANOVA Results for Endrin Ketone (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.367×10^{-36}	6	7.278×10^{-37}	3.36×10^{-18}	1.0000[a]
Residual	6.939×10^{-18}	32	2.168×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE A.81. Mean Tissue Concentration (wet weight) and Statistical Grouping for Heptachlor in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.0 U	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	2.0 U	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.82. ANOVA Results for Heptachlor (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.367×10^{-36}	6	7.278×10^{-37}	3.36×10^{-18}	1.0000[a]
Residual	6.939×10^{-18}	32	2.168×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE A.83. Mean Tissue Concentration (wet weight) and Statistical Grouping for Heptachlor Epoxide in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.0 U[a]	NS[b]
COMP II	2.0 U	NS
COMP III	2.4	NS
COMP IV	2.0 U	NS
COMP V	2.0 U	NS
COMP VI	2.2	NS
R-AM	2.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.84. ANOVA Results for Heptachlor Epoxide (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.117	6	0.019	1.008	0.4375[a]
Residual	0.617	32	0.019		

(a) Significance Level: $p \leq 0.05$.

TABLE A.85. Mean Tissue Concentration (wet weight) and Statistical Grouping for Methoxychlor in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.86. ANOVA Results for Methoxychlor (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.115×10^{-34}	6	3.525×10^{-35}	8.13×10^{-18}	1.0000[a]
Residual	1.388×10^{-16}	32	4.337×10^{-18}		

(a) Significance Level: $p \leq 0.05$.

TABLE A.87. Mean Tissue Concentration (wet weight) and Statistical Grouping for Toxaphene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	20.0 U[a]	NS[b]
COMP II	20.0 U	NS
COMP III	20.0 U	NS
COMP IV	20.0 U	NS
COMP V	20.0 U	NS
COMP VI	20.0 U	NS
R-AM	20.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.88. ANOVA Results for Toxaphene (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.153×10^{-34}	6	6.992×10^{-35}	NA[a]	NA
Residual	-4.718×10^{-16}	32	-1.475×10^{-17}		

(a) Significance Level: $p \leq 0.05$.

TABLE A.89. Mean Tissue Concentration (wet weight) and Statistical Grouping for Tributyltin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	2.7	NS[a]
COMP II	3.1	S[b]
COMP III	3.7	S
COMP IV	4.1	S
COMP V	4.0	S
COMP VI	2.8	NS
R-AM	2.2	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.90. ANOVA Results for Tributyltin (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.048	6	0.341	6.463	0.0001[a]
Residual	1.743	33	0.053		

(a) Significance Level: $p \leq 0.05$.

TABLE A.91. Mean Tissue Concentration (wet weight) and Statistical Grouping for Dibutyltin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.5	NS[a]
COMP II	1.3	NS
COMP III	1.6	NS
COMP IV	4.2	S[b]
COMP V	4.4	S
COMP VI	1.9	NS
R-AM	1.2	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE A.92. ANOVA Results for Dibutyltin (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.348	6	1.225	7.272	0.0001[a]
Residual	5.557	33	0.168		

(a) Significance Level: $p \leq 0.05$.

TABLE A.93. Mean Tissue Concentration (wet weight) and Statistical Grouping for Monobutyltin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	1.2 U[a]	NS[b]
COMP II	0.9	NS
COMP III	1.5 U	S[c]
COMP IV	0.7	NS
COMP V	1.0 U	NS
COMP VI	1.0 U	NS
R-AM	0.9 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE A.94. ANOVA Results for Monobutyltin (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.796	6	0.299	3.096	0.0162[a]
Residual	3.191	33	0.097		

(a) Significance Level: $p \leq 0.05$.

TABLE A.95. Mean Tissue Concentration (wet weight) and Statistical Grouping for Metals in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg wet weight)	Statistical Significance

Statistical comparison of metals was conducted on a dry weight basis only

TABLE A.96. ANOVA Results for Metals (wet weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level

Statistical comparison of metals was conducted on a dry weight basis only

APPENDIX B

STATISTICAL ANALYSIS OF BIOACCUMULATION IN *MACOMA nasuta* (DRY WEIGHT CONCENTRATIONS)

TABLE B.1. Mean Tissue Concentration (dry weight) and Statistical Grouping for Naphthalene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	47.2 U[a]	NS[b]
COMP II	56.7 UB[c]	NS
COMP III	50.1 U	NS
COMP IV	47.8 UB	NS
COMP V	61.8 UB	NS
COMP VI	39.7 U	NS
R-AM	47.8 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(d) NA Not applicable.

TABLE B.2. ANOVA Results for Naphthalene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.630	6	0.105	2.077	0.0838[a]
Residual	1.617	32	0.051		

(a) Significance Level: $p \leq 0.05$.

TABLE B.3. Mean Tissue Concentration (dry weight) and Statistical Grouping for 2-Methylnaphthalene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I		
COMP II		
COMP III	Compound not analyzed in *M. nasuta*	
COMP IV		
COMP V		
COMP VI		
R-AM		

TABLE B.4. ANOVA Results for 2-Methylnaphthalene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment					
Residual	Compound not analyzed in *M. nasuta*				

TABLE B.5. Mean Tissue Concentration (dry weight) and Statistical Grouping for Acenaphthylene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	7.2 U[a]	NS[b]
COMP II	14.1 UB[c]	NS
COMP III	7.7	NS
COMP IV	7.4	NS
COMP V	9.6	NS
COMP VI	6.1	NS
R-AM	7.1 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(d) NA Not applicable.

TABLE B.6. ANOVA Results for Acenaphthylene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.216	6	0.203	1.828	0.1250[a]
Residual	3.550	32	0.111		

(a) Significance Level: $p \leq 0.05$.

TABLE B.7. Mean Tissue Concentration (dry weight) and Statistical Grouping for Acenaphthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	17.9 U[a]	NS[b]
COMP II	28.2	NS
COMP III	19.0 U	NS
COMP IV	17.5 U	NS
COMP V	23.2 U	NS
COMP VI	15.1 U	NS
R-AM	17.9 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.8. ANOVA Results for Acenaphthene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.921	6	0.153	1.910	0.1095[a]
Residual	2.570	32	0.080		

(a) Significance Level: $p \leq 0.05$.

TABLE B.9. Mean Tissue Concentration (dry weight) and Statistical Grouping for Fluorene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	14.4 U[a]	NS[b]
COMP II	92.8	NS
COMP III	33.9	NS
COMP IV	14.0 U	NS
COMP V	18.7 U	NS
COMP VI	17.4	NS
R-AM	14.3 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.10. ANOVA Results for Fluorene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.658	6	0.443	1.015	0.4332[a]
Residual	13.968	32	0.436		

(a) Significance Level: $p \leq 0.05$.

TABLE B.11. Mean Tissue Concentration (dry weight) and Statistical Grouping for Phenanthrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	25.1 UB[a]	NS[b]
COMP II	29.0 UB	NS
COMP III	35.4 B[c]	NS
COMP IV	33.9 B	NS
COMP V	42.7	NS
COMP VI	66.2 B	S[d]
R-AM	34.1 B	NA[e]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) B Analyte detected in associated blank at less than twice the method detection limit in all replicates; sample concentrations were not blank-corrected.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE B.12. ANOVA Results for Phenanthrene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.269	6	0.378	2.567	0.383[a]
Residual	4.715	32	0.147		

(a) Significance Level: $p \leq 0.05$.

TABLE B.13. Mean Tissue Concentration (dry weight) and Statistical Grouping for Anthracene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	8.9	NS[a]
COMP II	10.6	NS
COMP III	10.2	NS
COMP IV	9.0	NS
COMP V	13.5	NS
COMP VI	11.2	NS
R-AM	9.1	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.14. ANOVA Results for Anthracene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.650	6	0.108	1.236	0.3144[a]
Residual	2.807	32	0.088		

(a) Significance Level: $p \leq 0.05$.

TABLE B.15. Mean Tissue Concentration (dry weight) and Statistical Grouping for Fluoranthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	28.0	NS[a]
COMP II	65.3	NS
COMP III	67.4 UB[b]	NS
COMP IV	90.8 B[c]	NS
COMP V	53.2	NS
COMP VI	196.8 B	S[d]
R-AM	57.2 B	NA[e]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(c) B Analyte detected in associated blank at less than twice the method detection limit in all replicates; sample concentrations were not blank-corrected.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE B.16. ANOVA Results for Fluoranthene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	15.133	6	2.522	6.540	0.0001[a]
Residual	12.342	32	0.386		

(a) Significance Level: $p \leq 0.05$.

TABLE B.17. Mean Tissue Concentration (dry weight) and Statistical Grouping for Pyrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	86.6	NS[a]
COMP II	121.1 B[b]	NS
COMP III	592.9	S[c]
COMP IV	786.2	S
COMP V	494.1	S
COMP VI	1300.3	S
R-AM	278.1 B	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) B Analyte detected in associated blank at less than twice the method detection limit in all replicates; sample concentrations were not blank-corrected.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.18. ANOVA Results for Pyrene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	34.496	6	5.749	8.640	0.0001[a]
Residual	21.295	32	0.665		

(a) Significance Level: $p \leq 0.05$.

TABLE B.19. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(a)anthracene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	10.6	NS[a]
COMP II	24.6	NS
COMP III	57.0	S[b]
COMP IV	43.5	S
COMP V	43.8	S
COMP VI	53.1	S
R-AM	12.4	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.20. ANOVA Results for Benzo(a)anthracene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	12.443	6	2.074	4.752	0.0014[a]
Residual	13.965	32	0.436		

(a) Significance Level: $p \leq 0.05$.

TABLE B.21. Mean Tissue Concentration (dry weight) and Statistical Grouping for Chrysene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	9.2	NS[a]
COMP II	18.0	NS
COMP III	46.9	S[b]
COMP IV	20.1	NS
COMP V	30.3	NS
COMP VI	72.5	S
R-AM	23.3	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.22. ANOVA Results for Chrysene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	14.004	6	2.334	9.021	0.0001[a]
Residual	8.280	32	0.259		

(a) Significance Level: $p \leq 0.05$.

TABLE B.23. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(b,k)fluoranthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	67.1	NS[a]
COMP II	59.9	NS
COMP III	278.9	S[b]
COMP IV	186.5	NS
COMP V	351.8	S
COMP VI	340.4	S
R-AM	102.9	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.24. ANOVA Results for Benzo(b,k)fluoranthene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	34.714	6	5.786	6.783	0.0001[a]
Residual	27.296	32	0.853		

(a) Significance Level: $p \leq 0.05$.

TABLE B.25. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(k)fluoranthene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I		
COMP II		
COMP III	Not analyzed separately in *M. nasuta*; reported as benzo(b,k)fluoranthene (Table B.23)	
COMP IV		
COMP V		
COMP VI		
R-AM		

TABLE B.26. ANOVA Results for Benzo(k)fluoranthene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	Not analyzed separately in *M. nasuta*; reported as benzo(b,k)fluoranthene (Table B.24)				
Residual					

TABLE B.27. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(a)pyrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	18.6	NS[a]
COMP II	16.8	NS
COMP III	182.9	S[b]
COMP IV	89.8	S
COMP V	209.8	S
COMP VI	202.0	S
R-AM	26.3	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.28. ANOVA Results for Benzo(a)pyrene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	60.100	6	10.017	18.063	0.0001[a]
Residual	17.746	32	0.555		

(a) Significance Level: $p \leq 0.05$.

TABLE B.29. Mean Tissue Concentration (dry weight) and Statistical Grouping for Dibenzo(a,h)anthracene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	6.6 U[a]	NS[b]
COMP II	7.1 U	NS
COMP III	25.2	NS
COMP IV	39.6	S[c]
COMP V	70.2	S
COMP VI	17.2	NS
R-AM	6.6 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.30. ANOVA Results for Dibenzo(a,h)anthracene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	23.674	6	3.946	6.770	0.0001[a]
Residual	18.649	32	0.583		

(a) Significance Level: $p \leq 0.05$.

TABLE B.31. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(g,h,i)perylene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	29.6	NS[a]
COMP II	9.8	NS
COMP III	68.9	S[b]
COMP IV	37.2	NS
COMP V	83.9	S
COMP VI	65.4	S
R-AM	22.7	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.32. ANOVA Results for Benzo(g,h,i)perylene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	25.595	6	4.266	4.988	0.0010[a]
Residual	27.369	32	0.855		

(a) Significance Level: $p \leq 0.05$.

TABLE B.33. Mean Tissue Concentration (dry weight) and Statistical Grouping for Indeno(1,2,3-c,d)pyrene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	20.8	NS[a]
COMP II	12.3 U[b]	NS
COMP III	48.9	NS
COMP IV	37.5	NS
COMP V	87.5	S[c]
COMP VI	46.0	S
R-AM	16.9	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.34. ANOVA Results for Indeno(1,2,3-c,d)pyrene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	16.169	6	2.695	6.061	0.0003[a]
Residual	14.227	32	0.445		

(a) Significance Level: $p \leq 0.05$.

TABLE B.35. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1016 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	152.2 U[a]	NS[b]
COMP II	171.4 U	NS
COMP III	162.2 U	NS
COMP IV	150.2 U	NS
COMP V	178.0 U	NS
COMP VI	128.0 U	NS
R-AM	149.2 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.36. ANOVA Results for Aroclor-1016 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.37. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1221 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	152.2 U[a]	NS[b]
COMP II	171.4 U	NS
COMP III	162.2 U	NS
COMP IV	150.2 U	NS
COMP V	178.0 U	NS
COMP VI	128.0 U	NS
R-AM	149.2 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.38. ANOVA Results for Aroclor-1221 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.39. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1232 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	152.2 U[a]	NS[b]
COMP II	171.4 U	NS
COMP III	162.2 U	NS
COMP IV	150.2 U	NS
COMP V	178.0 U	NS
COMP VI	128.0 U	NS
R-AM	149.2 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.40. ANOVA Results for Aroclor-1232 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.41. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1242 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	229.0	NS[a]
COMP II	171.4 U[b]	NS
COMP III	495.4 U	NS
COMP IV	150.2 U	NS
COMP V	289.6 U	NS
COMP VI	870.0 U	S[c]
R-AM	149.2 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.42. ANOVA Results for Aroclor-1242 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	6.428	6	1.071	2.298	0.0588[a]
Residual	14.916	32	0.466		

(a) Significance Level: $p \leq 0.05$.

TABLE B.43. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1248 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	152.2 U[a]	NS[b]
COMP II	171.4 U	NS
COMP III	162.2 U	NS
COMP IV	150.2 U	NS
COMP V	178.0 U	NS
COMP VI	128.0 U	NS
R-AM	149.2 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.44. ANOVA Results for Aroclor-1248 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.45. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1254 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	567.5	NS[a]
COMP II	171.4 U[b]	NS
COMP III	833.6	NS
COMP IV	418.4	NS
COMP V	617.0	NS
COMP VI	1015.8	S[c]
R-AM	249.2	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.46. ANOVA Results for Aroclor-1254 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	8.476	6	1.413	2.193	0.0696[a]
Residual	20.611	32	0.644		

(a) Significance Level: $p \leq 0.05$.

TABLE B.47. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1260 in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	184.5	NS[a]
COMP II	171.4 U[b]	NS
COMP III	162.2 U	NS
COMP IV	267.6	NS
COMP V	434.7	S[c]
COMP VI	172.6 U	NS
R-AM	149.2 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.48. ANOVA Results for Aroclor-1260 (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	3.208	6	0.535	2.494	0.0429[a]
Residual	6.859	32	0.214		

(a) Significance Level: $p \leq 0.05$.

TABLE B.49. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aldrin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	17.5 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	23.4	NS
COMP IV	14.8 U	NS
COMP V	18.0	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.50. ANOVA Results for Aldrin (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.781	6	0.130	1.786	0.1335[a]
Residual	2.332	32	0.073		

(a) Significance Level: $p \leq 0.05$.

TABLE B.51. Mean Tissue Concentration (dry weight) and Statistical Grouping for Alpha-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	16.8 U	NS
COMP IV	18.2	NS
COMP V	17.7 U	NS
COMP VI	18.2	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.52. ANOVA Results for Alpha-BHC (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.148	6	0.025	0.307	0.9289[a]
Residual	2.577	32	0.081		

(a) Significance Level: $p \leq 0.05$.

TABLE B.53. Mean Tissue Concentration (dry weight) and Statistical Grouping for Beta-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	16.8	NS[a]
COMP II	55.6 U[b]	S[c]
COMP III	18.4	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	13.4 U	NS
R-AM	14.7 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.54. ANOVA Results for Beta-BHC (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.978	6	0.330	1.660	0.1631[a]
Residual	6.354	32	0.199		

(a) Significance Level: $p \leq 0.05$.

TABLE B.55. Mean Tissue Concentration (dry weight) and Statistical Grouping for Delta-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	19.4	NS
COMP IV	14.8 U	NS
COMP V	23.7	NS
COMP VI	28.4	S[c]
R-AM	14.7 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.56. ANOVA Results for Delta-BHC (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.240	6	0.207	1.875	0.1159[a]
Residual	3.527	32	0.110		

(a) Significance Level: $p \leq 0.05$.

TABLE B.57. Mean Tissue Concentration (dry weight) and Statistical Grouping for Gamma-BHC in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	20.4	NS
COMP IV	14.8 U	NS
COMP V	19.7	NS
COMP VI	27.2	S[c]
R-AM	14.7 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.58. ANOVA Results for Gamma-BHC (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.051	6	0.175	2.462	0.0452[a]
Residual	2.278	32	0.071		

(a) Significance Level: $p \leq 0.05$.

TABLE B.59. Mean Tissue Concentration (dry weight) and Statistical Grouping for Alpha-Chlordane in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	17.6	NS
COMP IV	14.8 U	NS
COMP V	20.1	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.60. ANOVA Results for Alpha-Chlordane (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.680	6	0.113	2.386	0.511[a]
Residual	1.519	32	0.047		

(a) Significance Level: $p \leq 0.05$.

TABLE B.61. Mean Tissue Concentration (dry weight) and Statistical Grouping for Gamma-Chlordane in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	20.6	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.9	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.62. ANOVA Results for Gamma-Chlordane (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.699	6	0.117	2.700	0.310[a]
Residual	1.381	32	0.043		

(a) Significance Level: $p \leq 0.05$.

TABLE B.63. Mean Tissue Concentration (dry weight) and Statistical Grouping for 4,4'-DDD in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.64. ANOVA Results for 4,4'-DDD (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.061	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.65. Mean Tissue Concentration (dry weight) and Statistical Grouping for 4,4'-DDE in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	23.8 U	NS
COMP III	34.6	NS
COMP IV	16.8	NS
COMP V	17.7 U	NS
COMP VI	26.6 U	NS
R-AM	15.5	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.66. ANOVA Results for 4,4'-DDE (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.087	6	0.181	0.896	0.5100[a]
Residual	6.474	32	0.202		

(a) Significance Level: $p \leq 0.05$

TABLE B.67. Mean Tissue Concentration (dry weight) and Statistical Grouping for 4,4'-DDT in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	18.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	29.0 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.68. ANOVA Results for 4,4'-DDT (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.758	6	0.126	1.320	0.2771[a]
Residual	3.062	32	0.096		

(a) Significance Level: $p \leq 0.05$.

TABLE B.69. Mean Tissue Concentration (dry weight) and Statistical Grouping for Dieldrin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	28.2 UB[a]	NS[b]
COMP II	17.0 U[c]	NS
COMP III	23.4 U	NS
COMP IV	14.8 U	NS
COMP V	28.0 U	NS
COMP VI	42.4 UB	NS
R-AM	15.7 U	NA[d]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE B.70. ANOVA Results for Dieldrin (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.449	6	0.241	0.722	0.6350[a]
Residual	10.704	32	0.334		

(a) Significance Level: $p \leq 0.05$.

TABLE B.71. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endosulfan I in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.72. ANOVA Results for Endosulfan I (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.73. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endosulfan II in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	27.0 UB[a]	NS[b]
COMP II	17.0 U[c]	NS
COMP III	47.6 UB	NS
COMP IV	16.2 U	NS
COMP V	23.0 UB	NS
COMP VI	37.8 UB	NS
R-AM	14.7 U	NA[d]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE B.74. ANOVA Results for Endosulfan II (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.403	6	0.401	1.223	0.3204[a]
Residual	10.477	32	0.327		

(a) Significance Level: $p \leq 0.05$.

TABLE B.75. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endosulfan Sulfate in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	18.4	NS
R-AM	15.2	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.76. ANOVA Results for Endosulfan Sulfate (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.153	6	0.025	0.675	0.6703[a]
Residual	1.206	32	0.038		

(a) Significance Level: $p \leq 0.05$.

TABLE B.77. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endrin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3UB[a]	NS[b]
COMP II	20.6 U[c]	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	21.1	NS
COMP VI	24.6 U	S[d]
R-AM	14.7 U	NA[e]

(a) UB Analyte was undetected in one or more replicates. Analyte was found in the associated blank (at less than twice the method detection limit) for the remaining replicates, but the sample concentrations were not corrected.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) S Significant difference from R-AM ($\alpha = 0.05$).
(e) NA Not applicable.

TABLE B.78. ANOVA Results for Endrin (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.944	6	0.157	2.235	0.0650[a]
Residual	2.252	32	0.070		

(a) Significance Level: $p \leq 0.05$.

TABLE B.79. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endrin Ketone in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (ug/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.80. ANOVA Results for Endrin Ketone (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.81. Mean Tissue Concentration (dry weight) and Statistical Grouping for Heptachlor in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	16.4 U	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	12.8 U	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.82. ANOVA Results for Heptachlor (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.83. Mean Tissue Concentration (dry weight) and Statistical Grouping for Heptachlor Epoxide in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	15.3 U[a]	NS[b]
COMP II	17.0 U	NS
COMP III	20.0	NS
COMP IV	14.8 U	NS
COMP V	17.7 U	NS
COMP VI	13.6	NS
R-AM	14.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.84. ANOVA Results for Heptachlor Epoxide (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.407	6	0.068	1.834	0.1236[a]
Residual	1.184	32	0.037		

(a) Significance Level: $p \leq 0.05$.

TABLE B.85. Mean Tissue Concentration (dry weight) and Statistical Grouping for Methoxychlor in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	76.0 U[a]	NS[b]
COMP II	85.6 U	NS
COMP III	80.6 U	NS
COMP IV	75.0 U	NS
COMP V	88.7 U	NS
COMP VI	63.6 U	NS
R-AM	74.7 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.86. ANOVA Results for Methoxychlor (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.87. Mean Tissue Concentration (dry weight) and Statistical Grouping for Toxaphene in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	152.2 U[a]	NS[b]
COMP II	171.4 U	NS
COMP III	162.2 U	NS
COMP IV	150.2 U	NS
COMP V	178.0 U	NS
COMP VI	128.0 U	NS
R-AM	149.2 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.88. ANOVA Results for Toxaphene (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.430	6	0.072	2.161	0.0732[a]
Residual	1.062	32	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE B.89. Mean Tissue Concentration (dry weight) and Statistical Grouping for Tributyltin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	18.5	NS[a]
COMP II	24.2	S[b]
COMP III	26.4	S
COMP IV	27.3	S
COMP V	27.2	S
COMP VI	20.8	NS
R-AM	15.3	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.90. ANOVA Results for Tributyltin (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.085	6	0.347	5.724	0.0003[a]
Residual	2.064	34	0.061		

(a) Significance Level: $p \leq 0.05$.

TABLE B.91. Mean Tissue Concentration (dry weight) and Statistical Grouping for Dibutyltin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	10.4	NS[a]
COMP II	10.4	NS
COMP III	11.4	NS
COMP IV	27.6	S[b]
COMP V	29.3	S
COMP VI	14.3	NS
R-AM	8.5	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.92. ANOVA Results for Dibutyltin (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	6.706	6	1.118	6.876	0.0001[a]
Residual	5.526	34	0.163		

(a) Significance Level: $p \leq 0.05$.

TABLE B.93. Mean Tissue Concentration (dry weight) and Statistical Grouping for Monobutyltin in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	7.9 U[a]	NS[b]
COMP II	7.2	NS
COMP III	10.4 U	S[c]
COMP IV	4.8	NS
COMP V	6.4 U	NS
COMP VI	7.2 U	NS
R-AM	6.4 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.94. ANOVA Results for Monobutyltin (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.877	6	0.313	3.248	0.0124[a]
Residual	3.275	34	0.096		

(a) Significance Level: $p \leq 0.05$.

TABLE B.95. Mean Tissue Concentration (dry weight) and Statistical Grouping for Silver in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.31	NS[a]
COMP II	0.38	NS
COMP III	0.27	NS
COMP IV	0.22	NS
COMP V	0.37	NS
COMP VI	0.26	NS
R-AM	0.42	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.96. ANOVA Results for Silver (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	2.706	6	0.451	4.375	0.0022[a]
Residual	3.504	34	0.103		

(a) Significance Level: $p \leq 0.05$.

TABLE B.97. Mean Tissue Concentration (dry weight) and Statistical Grouping for Arsenic in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	25.5	NS[a]
COMP II	28.3	NS
COMP III	24.8	NS
COMP IV	23.6	NS
COMP V	24.6	NS
COMP VI	26.4	NS
R-AM	25.7	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.98. ANOVA Results for Arsenic (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.114	6	0.019	1.288	0.2883[a]
Residual	0.518	35	0.015		

(a) Significance Level: $p \leq 0.05$.

TABLE B.99. Mean Tissue Concentration (dry weight) and Statistical Grouping for Cadmium in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.33	NS[a]
COMP II	0.45	S[b]
COMP III	0.43	NS
COMP IV	0.32	NS
COMP V	0.38	NS
COMP VI	0.39	NS
R-AM	0.32	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.100. ANOVA Results for Cadmium (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.566	6	0.094	1.941	0.1023[a]
Residual	1.653	34	0.049		

(a) Significance Level: $p \leq 0.05$.

TABLE B.101. Mean Tissue Concentration (dry weight) and Statistical Grouping for Chromium in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	2.32	S[a]
COMP II	2.10	S
COMP III	2.55	S
COMP IV	2.35	S
COMP V	3.06	S
COMP VI	2.73	S
R-AM	0.89	NA[b]

(a) S Significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.102. ANOVA Results for Chromium (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	8.374	6	1.396	12.700	0.0001[a]
Residual	3.736	34	0.110		

(a) Significance Level: $p \leq 0.05$.

TABLE B.103. Mean Tissue Concentration (dry weight) and Statistical Grouping for Copper in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	40.3	S[a]
COMP II	19.8	NS[b]
COMP III	18.1	NS
COMP IV	14.9	NS
COMP V	16.3	NS
COMP VI	19.0	NS
R-AM	17.8	NA[c]

(a) S Significant difference from R-AM ($\alpha = 0.05$).
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE B.104. ANOVA Results for Copper (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.989	6	0.332	2.970	0.0189[a]
Residual	3.907	35	0.112		

(a) Significance Level: $p \leq 0.05$.

TABLE B.105. Mean Tissue Concentration (dry weight) and Statistical Grouping for Mercury in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.094	NS[a]
COMP II	0.090	NS
COMP III	0.117	NS
COMP IV	0.108	NS
COMP V	0.083	NS
COMP VI	0.070	NS
R-AM	0.147	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.106. ANOVA Results for Mercury (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.473	6	0.245	1.497	0.2088[a]
Residual	5.574	34	0.164		

(a) Significance Level: $p \leq 0.05$.

TABLE B.107. Mean Tissue Concentration (dry weight) and Statistical Grouping for Nickel in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	4.59	S[a]
COMP II	5.16	S
COMP III	4.93	S
COMP IV	4.06	NS[b]
COMP V	4.64	S
COMP VI	5.00	S
R-AM	3.22	NA[c]

(a) S Significant difference from R-AM ($\alpha = 0.05$).
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.108. ANOVA Results for Nickel (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.168	6	0.195	5.089	0.0008[a]
Residual	1.338	35	0.038		

(a) Significance Level: $p \leq 0.05$.

TABLE B.109. Mean Tissue Concentration (dry weight) and Statistical Grouping for Lead in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	2.2 U[a]	NS[b]
COMP II	2.4	NS
COMP III	3.3	S[c]
COMP IV	3.0	S
COMP V	3.3	S
COMP VI	3.3	S
R-AM	2.0	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE B.110. ANOVA Results for Lead (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.769	6	0.295	5.395	0.0005[a]
Residual	1.913	35	0.055		

(a) Significance Level: $p \leq 0.05$.

TABLE B.111. Mean Tissue Concentration (dry weight) and Statistical Grouping for Selenium in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	1.70	NS[a]
COMP II	1.72	NS
COMP III	1.80	NS
COMP IV	1.54	NS
COMP V	1.67	NS
COMP VI	1.49	NS
R-AM	1.59	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.112. ANOVA Results for Selenium (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.150	6	0.025	0.424	0.8577[a]
Residual	2.067	35	0.059		

(a) Significance Level: $p \leq 0.05$.

TABLE B.113. Mean Tissue Concentration (dry weight) and Statistical Grouping for Zinc in *M. nasuta* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	121.0	NS[a]
COMP II	109.5	NS
COMP III	106.7	NS
COMP IV	106.7	NS
COMP V	109.9	NS
COMP VI	98.5	NS
R-AM	115.4	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE B.114. ANOVA Results for Zinc (dry weight) in *M. nasuta* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.157	6	0.026	1.272	0.2951[a]
Residual	0.721	35	0.021		

(a) Significance Level: $p \leq 0.05$.

APPENDIX C

STATISTICAL ANALYSIS OF BIOACCUMULATION IN *NEPHTYS caecoides* (WET WEIGHT CONCENTRATIONS)

TABLE C.1. Mean Tissue Concentration (wet weight) and Statistical Grouping for Naphthalene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	54.0	NS[a]
COMP II	57.8	S[b]
COMP III	50.0 U[c]	NS
COMP IV	40.0 U	NS
COMP V	40.0 U	NS
COMP VI	51.8	NS
R-AM	44.6	NA[d]

(a) NS No Significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$)
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE C.2. ANOVA Results for Naphthalene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.787	6	0.131	2.671	0.338[a]
Residual	1.473	30	0.049		

(a) Significance Level: $p \leq 0.05$.

TABLE C.3. Mean Tissue Concentration (wet weight) and Statistical Grouping for 2-Methylnaphthalene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	20.0 U[a]	NS[b]
COMP II	20.0 U	NS
COMP III	20.0 U	NS
COMP IV	20.0 U	NS
COMP V	20.0 U	NS
COMP VI	20.0 U	NS
R-AM	23.8	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.4. ANOVA Results for 2-Methylnaphthalene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.103	6	0.017	2.667	0.0341[a]
Residual	0.192	30	0.006		

(a) Significance Level: $p \leq 0.05$.

TABLE C.5. Mean Tissue Concentration (wet weight) and Statistical Grouping for Acenaphthylene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.6. ANOVA Results for Acenaphthylene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.674×10^{-36}	6	1.279×10^{-36}	2.76×10^{-18}	1.0000[a]
Residual	1.388×10^{-17}	30	4.626×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE C.7. Mean Tissue Concentration (wet weight) and Statistical Grouping for Acenaphthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	11.6	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.8. ANOVA Results for Acenaphthene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.060	6	0.010	1.081	0.3959[a]
Residual	0.276	30	0.009		

(a) Significance Level: $p \leq 0.05$.

TABLE C.9. Mean Tissue Concentration (wet weight) and Statistical Grouping for Fluorene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	17.2	NS[a]
COMP II	10.0 U[b]	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	14.8	NS
R-AM	10.0 U	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NA Not applicable.

TABLE C.10. ANOVA Results for Fluorene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.655	6	0.109	1.201	0.3329[a]
Residual	2.729	30	0.091		

(a) Significance Level: $p \leq 0.05$.

TABLE C.11. Mean Tissue Concentration (wet weight) and Statistical Grouping for Phenanthrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	39.0	S[a]
COMP II	30.3	S
COMP III	30.0 U[b]	NS[c]
COMP IV	15.6	NS
COMP V	17.3	NS
COMP VI	44.8	S
R-AM	19.0	NA[d]

(a) S Significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NS No significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE C.12. ANOVA Results for Phenanthrene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	5.890	6	0.982	6.754	0.0001[a]
Residual	4.361	30	0.145		

(a) Significance Level: $p \leq 0.05$.

TABLE C.13. Mean Tissue Concentration (wet weight) and Statistical Grouping for Anthracene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.6	NS[a]
COMP II	10.0 U[b]	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	14.4	S[c]
R-AM	10.0 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE C.14. ANOVA Results for Anthracene (wetweight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.538	6	0.090	21.167	0.0001[a]
Residual	0.127	30	0.004		

(a) Significance Level: $p \leq 0.05$.

TABLE C.15. Mean Tissue Concentration (wet weight) and Statistical Grouping for Fluoranthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	17.6	NS[a]
COMP II	26.7	NS
COMP III	42.2	NS
COMP IV	25.8	NS
COMP V	21.7	NS
COMP VI	82.4	S[b]
R-AM	22.2	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.16. ANOVA Results for Fluoranthene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	10.110	6	1.685	6.240	0.0002[a]
Residual	8.101	30	0.270		

(a) Significance Level: $p \leq 0.05$.

TABLE C.17. Mean Tissue Concentration (wet weight) and Statistical Grouping for Pyrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	26.8	NS[a]
COMP II	39.3	S[b]
COMP III	202.0	S
COMP IV	188.0	S
COMP V	86.0	S
COMP VI	566.0	S
R-AM	19.8	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.18. ANOVA Results for Pyrene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	48.223	6	8.037	97.388	0.0001[a]
Residual	2.476	30	0.083		

(a) Significance Level: $p \leq 0.05$.

TABLE C.19. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(a)anthracene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	14.2	S[c]
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE C.20. ANOVA Results for Benzo(a)anthracene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.332	6	0.055	2.458	0.0471[a]
Residual	0.676	30	0.023		

(a) Significance Level: $p \leq 0.05$.

TABLE C.21. Mean Tissue Concentration (wet weight) and Statistical Grouping for Chrysene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	11.0	NS[a]
COMP II	16.8	NS
COMP III	27.6	S[b]
COMP IV	13.2	NS
COMP V	11.8	NS
COMP VI	41.0	S
R-AM	10.0 U[c]	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE C.22. ANOVA Results for Chrysene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	8.505	6	1.418	16.518	0.0001[a]
Residual	2.575	30	0.086		

(a) Significance Level: $p \leq 0.05$.

TABLE C.23. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(b)fluoranthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.5	NS
COMP VI	19.4	S[c]
R-AM	10.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE C.24. ANOVA Results for Benzo(b)fluoranthene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.479	6	0.247	9.566	0.0001[a]
Residual	0.773	30	0.026		

(a) Significance Level: $p \leq 0.05$.

TABLE C.25. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(k)fluoranthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (ug/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.27. ANOVA Results for Benzo(k)fluoranthene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.674×10^{-36}	6	1.279×10^{-36}	2.76×10^{-18}	1.0000[a]
Residual	1.388×10^{-17}	30	4.626×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE C.27. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(a)pyrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.28. ANOVA Results for Benzo(a)pyrene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.674×10^{-36}	6	1.279×10^{-36}	2.76×10^{-18}	1.0000[a]
Residual	1.388×10^{-17}	30	4.626×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE C.29. Mean Tissue Concentration (wet weight) and Statistical Grouping for Dibenzo(a,h)anthracene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.30. ANOVA Results for Benzo(a,h)anthracene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.674×10^{-36}	6	1.279×10^{-36}	2.76×10^{-18}	1.0000[a]
Residual	1.388×10^{-17}	30	4.626×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE C.31. Mean Tissue Concentration (wet weight) and Statistical Grouping for Benzo(g,h,i)perylene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.32. ANOVA Results for Benzo(g,h,i)perylene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.674×10^{-36}	6	1.279×10^{-36}	2.76×10^{-18}	1.0000[a]
Residual	1.388×10^{-17}	30	4.626×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE C.33. Mean Tissue Concentration (wet weight) and Statistical Grouping for Indeno(1,2,3-c,d)pyrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	10.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.34. ANOVA Results for Indeno(1,2,3-c,d)pyrene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	7.674×10^{-36}	6	1.279×10^{-36}	2.76×10^{-18}	1.0000[a]
Residual	1.388×10^{-17}	30	4.626×10^{-19}		

(a) Significance Level: $p \leq 0.05$.

TABLE C.35. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1016 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	100.0 U	NS
COMP III	100.0 U	NS
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.36. ANOVA Results for Aroclor-1016 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.536	6	0.089	2.655	0.0347[a]
Residual	1.009	30	0.034		

(a) Significance Level: $p \leq 0.05$.

TABLE C.37. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1221 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	100.0 U	NS
COMP III	100.0 U	NS
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.38. ANOVA Results for Aroclor-1221 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.536	6	0.089	2.655	0.0347[a]
Residual	1.009	30	0.034		

(a) Significance Level: $p \leq 0.05$.

TABLE C.39. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1232 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	100.0 U	NS
COMP III	100.0 U	NS
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.40. ANOVA Results for Aroclor-1232 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.536	6	0.089	2.655	0.0347[a]
Residual	1.009	30	0.034		

(a) Significance Level: $p \leq 0.05$.

TABLE C.41. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1242 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	100.0 U	NS
COMP III	100.0 U	NS
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.42. ANOVA Results for Aroclor-1242 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.536	6	0.089	2.655	0.0347[a]
Residual	1.009	30	0.034		

(a) Significance Level: $p \leq 0.05$.

TABLE C.43. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1248 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	100.0 U	NS
COMP III	100.0 U	NS
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.44. ANOVA Results for Aroclor-1248 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.536	6	0.089	2.655	0.0347[a]
Residual	1.009	30	0.034		

(a) Significance Level: $p \leq 0.05$.

TABLE C.45. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1254 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	103.3	NS
COMP III	166.0	S[c]
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE C.46. ANOVA Results for Aroclor-1254 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.069	6	0.178	3.714	0.0070[a]
Residual	1.440	30	0.048		

(a) Significance Level: $p \leq 0.05$.

TABLE C.47. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aroclor-1260 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	100.0 U[a]	NS[b]
COMP II	100.0 U	NS
COMP III	100.0 U	NS
COMP IV	140.0 U	NS
COMP V	133.3 U	NS
COMP VI	100.0 U	NS
R-AM	100.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.48. ANOVA Results for Aroclor-1260 (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.536	6	0.089	2.655	0.0347[a]
Residual	1.009	30	0.034		

(a) Significance Level: $p \leq 0.05$.

TABLE C.49. Mean Tissue Concentration (wet weight) and Statistical Grouping for Aldrin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	15.0	NS[a]
COMP II	10.0	NS
COMP III	15.6	NS
COMP IV	10.0 U[b]	NS
COMP V	12.0 U	NS
COMP VI	10.4	NS
R-AM	10.0 U	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NA Not applicable.

TABLE C.50. ANOVA Results for Aldrin (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.475	6	0.079	0.765	0.6035[a]
Residual	2.896	28	0.103		

(a) Significance Level: $p \leq 0.05$.

TABLE C.51. Mean Tissue Concentration (wet weight) and Statistical Grouping for Alpha-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.52. ANOVA Results for Alpha-BHC (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.53. Mean Tissue Concentration (wet weight) and Statistical Grouping for Beta-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.54. ANOVA Results for Beta-BHC (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.55. Mean Tissue Concentration (wet weight) and Statistical Grouping for Delta-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.56. ANOVA Results for Delta-BHC (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.57. Mean Tissue Concentration (wet weight) and Statistical Grouping for Gamma-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.58. ANOVA Results for Gamma-BHC (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.59. Mean Tissue Concentration (wet weight) and Statistical Grouping for Chlordane in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.60. ANOVA Results for Chlordane (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.61. Mean Tissue Concentration (wet weight) and Statistical Grouping for Gamma-Chlordane in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I		
COMP II		
COMP III	Not analyzed separately in *N. caecoides*; reported as total Chlordane (Table C.59)	
COMP IV		
COMP V		
COMP VI		
R-AM		

TABLE C.62. ANOVA Results for Gamma-Chlordane (wet weight) in *N. caecoides* Tissue

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	Not analyzed separately in *N. caecoides*; reported as total Chlordane (Table C.60)				
Residual					

TABLE C.63. Mean Tissue Concentration (wet weight) and Statistical Grouping for 4,4'-DDD in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.64. ANOVA Results for 4,4'-DDD (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.65. Mean Tissue Concentration (wet weight) and Statistical Grouping for 4,4'-DDE in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	11.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.66. ANOVA Results for 4,4'-DDE (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.094	6	0.016	0.855	0.5395[a]
Residual	0.516	28	0.018		

(a) Significance Level: $p \leq 0.05$

TABLE C.67. Mean Tissue Concentration (wet weight) and Statistical Grouping for 4,4'-DDT in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.68. ANOVA Results for 4,4'-DDT (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.69. Mean Tissue Concentration (wet weight) and Statistical Grouping for Dieldrin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	11.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.70. ANOVA Results for Dieldrin (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.094	6	0.016	0.855	0.5395[a]
Residual	0.516	28	0.018		

(a) Significance Level: $p \leq 0.05$.

TABLE C.71. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endosulfan I in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.2	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.72. ANOVA Results for Endosulfan I (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.080	6	0.013	0.955	0.4729[a]
Residual	0.392	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.73. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endosulfan II in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.74. ANOVA Results for Endosulfan II (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.75. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endosulfan Sulfate in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.76. ANOVA Results for Endosulfan Sulfate (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.77. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endrin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.2	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.78. ANOVA Results for Endrin (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.080	6	0.013	0.955	0.4729[a]
Residual	0.392	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.79. Mean Tissue Concentration (wet weight) and Statistical Grouping for Endrin Aldehyde in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.80. ANOVA Results for Endrin Aldehyde (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.81. Mean Tissue Concentration (wet weight) and Statistical Grouping for Heptachlor in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.82. ANOVA Results for Heptachlor (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.83. Mean Tissue Concentration (wet weight) and Statistical Grouping for Heptachlor Epoxide in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	12.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	10.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.84. ANOVA Results for Heptachlor Epoxide (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.137	6	0.023	0.833	0.5545[a]
Residual	0.769	28	0.027		

(a) Significance Level: $p \leq 0.05$.

TABLE C.85. Mean Tissue Concentration (wet weight) and Statistical Grouping for Methoxychlor in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	10.0 U[a]	NS[b]
COMP II	10.0 U	NS
COMP III	10.0 U	NS
COMP IV	10.0 U	NS
COMP V	12.0 U	NS
COMP VI	10.0 U	NS
R-AM	11.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.86. ANOVA Results for Methoxychlor (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.094	6	0.016	0.855	0.5395[a]
Residual	0.516	28	0.018		

(a) Significance Level: $p \leq 0.05$.

TABLE C.87. Mean Tissue Concentration (wet weight) and Statistical Grouping for Toxaphene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	500.0 U[a]	NS[b]
COMP II	500.0 U	NS
COMP III	500.0 U	NS
COMP IV	500.0 U	NS
COMP V	600.0 U	NS
COMP VI	500.0 U	NS
R-AM	500.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.88. ANOVA Results for Toxaphene (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.082	6	0.014	1.000	0.4448[a]
Residual	0.384	28	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE C.89. Mean Tissue Concentration (wet weight) and Statistical Grouping for Tributyltin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	14.7 UJ[a]	NS[b]
COMP II	15.2	NS
COMP III	12.7 UJ	NS
COMP IV	23.7	NS
COMP V	9.8 UJ	NS
COMP VI	19.8 UJ	NS
R-AM	6.3 J[c]	NA[d]

(a) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) J Detected below method detection limit in all replicates; value is mean of detected values.
(d) NA Not applicable.

TABLE C.90. ANOVA Results for Tributyltin (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	6.371	6	1.062	1.097	0.3887[a]
Residual	27.106	28	0.968		

(a) Significance Level: $p \leq 0.05$.

TABLE C.91. Mean Tissue Concentration (wet weight) and Statistical Grouping for Dibutyltin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	6.6 UJ[a]	NS[b]
COMP II	5.9	NS
COMP III	8.6 UJ	NS
COMP IV	14.0	NS
COMP V	11.4	NS
COMP VI	11.9	NS
R-AM	8.3 UJ	NA[c]

(a) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE C.92. ANOVA Results for Dibutyltin (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	6.494	6	1.082	2.343	0.0585[a]
Residual	12.934	28	0.462		

(a) Significance Level: $p \leq 0.05$.

TABLE C.93. Mean Tissue Concentration (wet weight) and Statistical Grouping for Monobutyltin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg wet weight)	Statistical Significance
COMP I	8.7	NS[a]
COMP II	5.8	NS
COMP III	9.7	NS
COMP IV	15.5	NS
COMP V	12.2	NS
COMP VI	13.0	NS
R-AM	9.1 UJ[b]	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.
(c) NA Not applicable.

TABLE C.94. ANOVA Results for Monobutyltin (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.3017	6	0.718	3.468	0.0109[a]
Residual	5.796	28	0.207		

(a) Significance Level: $p \leq 0.05$.

TABLE C.95. Mean Tissue Concentration (wet weight) and Statistical Grouping for Metals in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg wet weight)	Statistical Significance

Statistical comparison of metals was conducted on a dry weight basis only

TABLE C.96. ANOVA Results for Metals (wet weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level

Statistical comparison of metals was conducted on a dry weight basis only

APPENDIX D

STATISTICAL ANALYSIS OF BIOACCUMULATION IN *NEPHTYS caecoides* (DRY WEIGHT CONCENTRATIONS)

TABLE D.1. Mean Tissue Concentration (dry weight) and Statistical Grouping for Naphthalene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	346.0	NS[a]
COMP II	347.1	NS
COMP III	288.4 U[b]	NS
COMP IV	240.5 U	NS
COMP V	258.3 U	NS
COMP VI	326.8	NS
R-AM	288.0	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NA Not applicable.

TABLE D.2. ANOVA Results for Naphthalene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.703	6	0.117	1.991	0.0983[a]
Residual	1.765	30	0.059		

(a) Significance Level: $p \leq 0.05$.

TABLE D.3. Mean Tissue Concentration (dry weight) and Statistical Grouping for 2-Methylnaphthalene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	127.5 U[a]	NS[b]
COMP II	120.8 U	NS
COMP III	115.4 U	NS
COMP IV	120.3 U	NS
COMP V	129.1 U	NS
COMP VI	126.2 U	NS
R-AM	152.9	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.4. ANOVA Results for 2-Methylnaphthalene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.208	6	0.035	2.201	0.0707[a]
Residual	0.474	30	0.016		

(a) Significance Level: $p \leq 0.05$.

TABLE D.5. Mean Tissue Concentration (dry weight) and Statistical Grouping for Acenaphthylene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	60.4 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	64.6 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.6. ANOVA Results for Acenaphthylene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.057	6	0.009	1.339	0.2710[a]
Residual	0.213	30	0.007		

(a) Significance Level: $p \leq 0.05$.

TABLE D.7. Mean Tissue Concentration (dry weight) and Statistical Grouping for Acenaphthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	60.4 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	64.6 U	NS
COMP VI	73.1	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.8. ANOVA Results for Acenaphthene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.140	6	0.023	1.449	0.2291[a]
Residual	0.482	30	0.016		

(a) Significance Level: $p \leq 0.05$.

TABLE D.9. Mean Tissue Concentration (dry weight) and Statistical Grouping for Fluorene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	112.6	NS[a]
COMP II	60.4 U[b]	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	64.6 U	NS
COMP VI	92.9	NS
R-AM	63.8 U	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NA Not applicable.

TABLE D.10. ANOVA Results for Fluorene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.866	6	0.144	1.403	0.2459[a]
Residual	3.084	30	0.103		

(a) Significance Level: $p \leq 0.05$.

TABLE D.11. Mean Tissue Concentration (dry weight) and Statistical Grouping for Phenanthrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	252.3	S[a]
COMP II	183.0	NS[b]
COMP III	173.0 U[c]	NS
COMP IV	94.4	NS
COMP V	113.1	NS
COMP VI	282.6	S
R-AM	122.1	NA[d]

(a) S Significant difference from R-AM ($\alpha = 0.05$).
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE D.12. ANOVA Results for Phenanthrene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	5.759	6	0.960	5.748	0.0004[a]
Residual	5.010	30	0.167		

(a) Significance Level: $p \leq 0.05$.

TABLE D.13. Mean Tissue Concentration (dry weight) and Statistical Grouping for Anthracene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	67.3	NS[a]
COMP II	60.4 U[b]	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	64.6 U	NS
COMP VI	90.9	S[c]
R-AM	63.8 U	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.14. ANOVA Results for Anthracene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.681	6	0.114	8.920	0.0001[a]
Residual	0.382	30	0.013		

(a) Significance Level: $p \leq 0.05$.

TABLE D.15. Mean Tissue Concentration (dry weight) and Statistical Grouping for Fluoranthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	113.4	NS[a]
COMP II	143.2	NS
COMP III	243.5	NS
COMP IV	157.9	NS
COMP V	135.0	NS
COMP VI	521.4	S[b]
R-AM	142.9	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.16. ANOVA Results for Fluoranthene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	10.020	6	1.670	5.504	0.0007[a]
Residual	8.495	28	0.303		

(a) Significance Level: $p \leq 0.05$.

TABLE D.17. Mean Tissue Concentration (dry weight) and Statistical Grouping for Pyrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	173.1	NS[a]
COMP II	233.3	S[b]
COMP III	1162.8	S
COMP IV	1134.3	S
COMP V	563.6	S
COMP VI	3572.4	S
R-AM	127.4	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.18. ANOVA Results for Pyrene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	46.693	6	7.782	75.604	0.0001[a]
Residual	2.882	28	0.103		

(a) Significance Level: $p \leq 0.05$.

TABLE D.19. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(a)anthracene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	81.8	NS
COMP IV	60.1 U	NS
COMP V	63.7 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.20. ANOVA Results for Benzo(a)anthracene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.190	6	0.032	1.001	0.4445[a]
Residual	0.885	28	0.032		

(a) Significance Level: $p \leq 0.05$.

TABLE D.21. Mean Tissue Concentration (dry weight) and Statistical Grouping for Chrysene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	70.4	NS[a]
COMP II	71.2	NS
COMP III	160.1	S[b]
COMP IV	79.4	NS
COMP V	77.4	NS
COMP VI	258.0	S
R-AM	63.8 U[c]	NA[d]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) U Undetected in all replicates; value is mean of detection limits.
(d) NA Not applicable.

TABLE D.22. ANOVA Results for Chrysene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	8.349	6	1.392	29.228	0.0001[a]
Residual	1.333	28	0.048		

(a) Significance Level: $p \leq 0.05$.

TABLE D.23. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(b)fluoranthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	67.4	NS
COMP VI	120.6	S[c]
R-AM	63.8 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.24. ANOVA Results for Benzo(b)fluoranthene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.652	6	0.275	9.327	0.0001[a]
Residual	0.826	28	0.030		

(a) Significance Level: $p \leq 0.05$.

TABLE D.25. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(k)fluoranthene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	63.7 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.26. ANOVA Results for Benzo(k)fluoranthene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.047	6	0.008	1.070	0.4038[a]
Residual	0.206	28	0.007		

(a) Significance Level: $p \leq 0.05$.

TABLE D.27. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(a)pyrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	63.7 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.28. ANOVA Results for Benzo(a)pyrene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.047	6	0.008	1.070	0.4038[a]
Residual	0.206	28	0.007		

(a) Significance Level: $p \leq 0.05$.

TABLE D.29. Mean Tissue Concentration (dry weight) and Statistical Grouping for Dibenzo(a,h)anthracene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	63.7 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.30. ANOVA Results for Dibenzo(a,h)anthracene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.047	6	0.008	1.070	0.4038[a]
Residual	0.206	28	0.007		

(a) Significance Level: $p \leq 0.05$.

TABLE D.31. Mean Tissue Concentration (dry weight) and Statistical Grouping for Benzo(g,h,i)perylene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	63.7 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.32. ANOVA Results for Benzo(g,h,i)perylene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.047	6	0.008	1.070	0.4038[a]
Residual	0.206	28	0.007		

(a) Significance Level: $p \leq 0.05$.

TABLE D.33. Mean Tissue Concentration (dry weight) and Statistical Grouping for Indeno(1,2,3-c,d)pyrene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	63.7 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.34. ANOVA Results for Indeno(1,2,3-c,d)pyrene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.047	6	0.008	1.070	0.4038[a]
Residual	0.206	28	0.007		

(a) Significance Level $\alpha \leq 0.05$.

TABLE D.35. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1016 *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	609.6 U	NS
COMP III	576.8 U	NS
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.36. ANOVA Results for Aroclor-1016 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.660	6	0.110	2.689	0.0345[a]
Residual	1.146	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.37. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1221 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	609.6 U	NS
COMP III	576.8 U	NS
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.38. ANOVA Results for Aroclor-1221 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.660	6	0.110	2.689	0.0345[a]
Residual	1.146	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.39. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1232 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	609.6 U	NS
COMP III	576.8 U	NS
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.40. ANOVA Results for Aroclor-1232 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.660	6	0.110	2.689	0.0345[a]
Residual	1.146	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.41. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1242 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	609.6 U	NS
COMP III	576.8 U	NS
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.42. ANOVA Results for Aroclor-1242 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.660	6	0.110	2.689	0.0345[a]
Residual	1.146	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.43. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1248 *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	609.6 U	NS
COMP III	576.8 U	NS
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.43. ANOVA Results for Aroclor-1248 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.660	6	0.110	2.689	0.0345[a]
Residual	1.146	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.45. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1254 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	631.2	NS
COMP III	950.4	S[c]
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.45. ANOVA Results for Aroclor-1254 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.840	6	0.140	2.699	0.0340[a]
Residual	1.452	28	0.052		

(a) Significance Level: $p \leq 0.05$.

TABLE D.47. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aroclor-1260 in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	637.8 U[a]	NS[b]
COMP II	609.6 U	NS
COMP III	576.8 U	NS
COMP IV	834.0 U	NS
COMP V	900.6 U	NS
COMP VI	631.2 U	NS
R-AM	638.0 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.48. ANOVA Results for Aroclor-1260 (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.660	6	0.110	2.689	0.0345[a]
Residual	1.146	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.49. Mean Tissue Concentration (dry weight) and Statistical Grouping for Aldrin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	97.2	NS[a]
COMP II	61.0	NS
COMP III	89.1	NS
COMP IV	60.1 U[b]	NS
COMP V	77.5 U	NS
COMP VI	66.0	NS
R-AM	63.8 U	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) U Undetected in all replicates; value is mean of detection limits.
(c) NA Not applicable.

TABLE D.50. ANOVA Results for Aldrin (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.470	6	0.078	0.665	0.6785[a]
Residual	3.302	28	0.118		

(a) Significance Level: $p \leq 0.05$.

TABLE D.51. Mean Tissue Concentration (dry weight) and Statistical Grouping for Alpha-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.52. ANOVA Results for Alpha-BHC (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.53. Mean Tissue Concentration (dry weight) and Statistical Grouping for Beta-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.54. ANOVA Results for Beta-BHC (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.55. Mean Tissue Concentration (dry weight) and Statistical Grouping for Delta-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.56. ANOVA Results for Delta-BHC (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.57. Mean Tissue Concentration (dry weight) and Statistical Grouping for Gamma-BHC in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.58. ANOVA Results for Gamma-BHC (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.59. Mean Tissue Concentration (dry weight) and Statistical Grouping for Chlordane in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.60. ANOVA Results for Chlordane (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.61. Mean Tissue Concentration (dry weight) and Statistical Grouping for Gamma-Chlordane in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I		
COMP II		
COMP III	Reported as total chlordane (Table D.59)	
COMP IV		
COMP V		
COMP VI		
R-AM		

TABLE D.62. ANOVA Results for Gamma-Chlordane (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment					
Residual	Reported as total chlordane (Table D.60)				

TABLE D.63. Mean Tissue Concentration (dry weight) and Statistical Grouping for 4,4'-DDD in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.64. ANOVA Results for 4,4'-DDD (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.65. Mean Tissue Concentration (dry weight) and Statistical Grouping for 4,4'-DDE in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	63.4 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.66. ANOVA Results for 4,4'-DDE (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.132	6	0.022	0.745	0.6182[a]
Residual	0.824	28	0.029		

(a) Significance Level: $p \leq 0.05$.

TABLE D.67. Mean Tissue Concentration (dry weight) and Statistical Grouping for 4,4'-DDT in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.68. ANOVA Results for 4,4'-DDT (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.69. Mean Tissue Concentration (dry weight) and Statistical Grouping for Dieldrin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	69.4 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.70. ANOVA Results for Dieldrin (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.203	6	0.034	1.151	0.3598[a]
Residual	0.823	28	0.029		

(a) Significance Level: $p \leq 0.05$.

TABLE D.71. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endosulfan I in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	58.8 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.72. ANOVA Results for Endosulfan I (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.159	6	0.027	1.056	0.4115[a]
Residual	0.702	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.73. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endosulfan II in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.74. ANOVA Results for Endosulfan II (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.75. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endosulfan Sulfate in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.76. ANOVA Results for Endosulfan Sulfate (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.77. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endrin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	64.4	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.78. ANOVA Results for Endrin (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.176	6	0.029	1.168	0.3510[a]
Residual	0.702	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.79. Mean Tissue Concentration (dry weight) and Statistical Grouping for Endrin Aldehyde in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.80. ANOVA Results for Endrin Aldehyde (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.81. Mean Tissue Concentration (dry weight) and Statistical Grouping for Heptachlor in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.82. ANOVA Results for Heptachlor (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3516[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.83. Mean Tissue Concentration (dry weight) and Statistical Grouping for Heptachlor Epoxide in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	77.2 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	63.8 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.84. ANOVA Results for Heptachlor Epoxide (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.274	6	0.046	1.111	0.3808[a]
Residual	1.150	28	0.041		

(a) Significance Level: $p \leq 0.05$.

TABLE D.85. Mean Tissue Concentration (dry weight) and Statistical Grouping for Methoxychlor in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (ug/kg dry weight)	Statistical Significance
COMP I	63.8 U[a]	NS[b]
COMP II	61.0 U	NS
COMP III	57.7 U	NS
COMP IV	60.1 U	NS
COMP V	77.5 U	NS
COMP VI	63.1 U	NS
R-AM	69.6 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.86. ANOVA Results for Methoxychlor (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.213	6	0.035	1.320	0.2810[a]
Residual	0.752	28	0.027		

(a) Significance Level: $p \leq 0.05$.

TABLE D.87. Mean Tissue Concentration (dry weight) and Statistical Grouping for Toxaphene in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (ug/kg dry weight)	Statistical Significance
COMP I	3188 U[a]	NS[b]
COMP II	3049 U	NS
COMP III	2884 U	NS
COMP IV	3007 U	NS
COMP V	3874 U	NS
COMP VI	3156 U	NS
R-AM	3190 U	NA[c]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.88. ANOVA Results for Toxaphene (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.174	6	0.029	1.167	0.3519[a]
Residual	0.696	28	0.025		

(a) Significance Level: $p \leq 0.05$.

TABLE D.89. Mean Tissue Concentration (dry weight) and Statistical Grouping for Tributyltin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	92.6 UJ[a]	NS[b]
COMP II	89.0	NS
COMP III	71.8 UJ	NS
COMP IV	146.0	NS
COMP V	62.8 UJ	NS
COMP VI	125.0 UJ	NS
R-AM	41.4 J[c]	NA[d]

(a) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) J Detected below method detection limit in all replicates; value is mean of detected values.
(d) NA Not applicable.

TABLE D.90. ANOVA Results for Tributyltin (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	6.071	6	1.012	1.023	0.4311[a]
Residual	27.697	28	0.989		

(a) Significance Level: $p \leq 0.05$.

TABLE D.91. Mean Tissue Concentration (dry weight) and Statistical Grouping for Dibutyltin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	42.2 UJ[a]	NS[b]
COMP II	36.0	NS
COMP III	50.0 UJ	NS
COMP IV	84.6	NS
COMP V	73.2	NS
COMP VI	73.8	NS
R-AM	53.4 UJ	NA[c]

(a) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.92. ANOVA Results for Dibutyltin (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	6.622	6	1.104	2.264	0.0660[a]
Residual	13.647	28	0.487		

(a) Significance Level: $p \leq 0.05$.

TABLE D.93. Mean Tissue Concentration (dry weight) and Statistical Grouping for Monobutyltin in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (µg/kg dry weight)	Statistical Significance
COMP I	57.0	NS[a]
COMP II	35.0	NS
COMP III	56.0	NS
COMP IV	92.2	NS
COMP V	77.4	NS
COMP VI	83.6	NS
R-AM	58.0 UJ[b]	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) UJ Undetected or detected below method detection limit in all replicates; value is mean of detected values and detection limits.
(c) NA Not applicable.

TABLE D.94. ANOVA Results for Monobutyltin (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	4.355	6	0.726	3.217	0.0157[a]
Residual	6.317	28	0.226		

(a) Significance Level: $p \leq 0.05$.

TABLE D.95. Mean Tissue Concentration (dry weight) and Statistical Grouping for Silver in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.05	NS[a]
COMP II	0.04	NS
COMP III	0.05	NS
COMP IV	0.05	NS
COMP V	0.07	NS
COMP VI	0.06	NS
R-AM	0.06	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.96. ANOVA Results for Silver (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.712	6	0.119	8.435	0.0007[a]
Residual	0.183	13	0.014		

(a) Significance Level: $p \leq 0.05$.

TABLE D.97. Mean Tissue Concentration (dry weight) and Statistical Grouping for Arsenic in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	27.9	S[a]
COMP II	28.3	S
COMP III	28.2	S
COMP IV	27.5	S
COMP V	27.7	S
COMP VI	26.2	S
R-AM	19.7	NA[b]

(a) S Significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.98. ANOVA Results for Arsenic (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.303	6	0.050	73.015	0.0001[a]
Residual	0.010	14	0.001		

(a) Significance Level: $p \leq 0.05$.

TABLE D.99. Mean Tissue Concentration (dry weight) and Statistical Grouping for Cadmium in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	1.18	NS[a]
COMP II	1.18	NS
COMP III	1.13	NS
COMP IV	1.05	NS
COMP V	1.45	S[b]
COMP VI	1.21	NS
R-AM	1.13	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.100. ANOVA Results for Cadmium (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.177	6	0.030	3.600	0.0251[a]
Residual	0.107	13	0.008		

(a) Significance Level: $p \leq 0.05$.

TABLE D.101. Mean Tissue Concentration (dry weight) and Statistical Grouping for Chromium in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.29	NS[a]
COMP II	0.28	NS
COMP III	0.34	NS
COMP IV	0.47	S[b]
COMP V	0.44	S
COMP VI	0.43	S
R-AM	0.30	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Significant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.102. ANOVA Results for Chromium (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.810	6	0.135.	14.189	0.0001[a]
Residual	0.124	13	0.010		

(a) Significance Level: $p \leq 0.05$.

TABLE D.103. Mean Tissue Concentration (dry weight) and Statistical Grouping for Copper in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	12.0	NS[a]
COMP II	11.3	NS
COMP III	11.6	NS
COMP IV	11.9	NS
COMP V	13.6	NS
COMP VI	11.3	NS
R-AM	25.7	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.104. ANOVA Results for Copper (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.580	6	0.263	97.583	0.0001[a]
Residual	0.003	14	0.003		

(a) Significance Level: $p \leq 0.05$.

TABLE D.105. Mean Tissue Concentration (dry weight) and Statistical Grouping for Mercury in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.073	NS[a]
COMP II	0.104	NS
COMP III	0.078	NS
COMP IV	0.088	NS
COMP V	0.072	NS
COMP VI	0.079	NS
R-AM	0.660	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.106. ANOVA Results for Mercury (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	11.535	6	1.922	6086.464	0.0001[a]
Residual	0.004	14	3.159×10^{-4}		

(a) Significance Level: $p \leq 0.05$.

TABLE D.107. Mean Tissue Concentration (dry weight) and Statistical Grouping for Nickel in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	3.30	NS[a]
COMP II	2.43	NS
COMP III	1.78	NS
COMP IV	2.85	NS
COMP V	2.07	NS
COMP VI	1.77	NS
R-AM	3.10	NA[b]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.108. ANOVA Results for Nickel (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	1.207	6	0.201	6.018	0.0027[a]
Residual	0.468	14	0.033		

(a) Significance Level: $p \leq 0.05$.

TABLE D.109. Mean Tissue Concentration (dry weight) and Statistical Grouping for Lead in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.90	NS[a]
COMP II	0.83	NS
COMP III	1.02	S[b]
COMP IV	1.03	S
COMP V	0.96	S
COMP VI	0.95	NS
R-AM	0.78	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Siginficant difference from R-AM ($\alpha = 0.05$).
(c) NA Not applicable.

TABLE D.110. ANOVA Results for Lead (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.200	6	0.033	2.976	0.0469[a]
Residual	0.146	13	0.011		

(a) Significance Level: $p \leq 0.05$.

TABLE D.111. Mean Tissue Concentration (dry weight) and Statistical Grouping for Selenium in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	0.98 U[a]	NS[b]
COMP II	1.54	NS
COMP III	1.13	NS
COMP IV	1.11	NS
COMP V	1.16	NS
COMP VI	1.79	S[c]
R-AM	1.17	NA[d]

(a) U Undetected in all replicates; value is mean of detection limits.
(b) NS No significant difference from R-AM ($\alpha = 0.05$).
(c) S Significant difference from R-AM ($\alpha = 0.05$).
(d) NA Not applicable.

TABLE D.112. ANOVA Results for Selenium (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.813	6	0.136	3.367	0.0287[a]
Residual	0.564	14	0.040		

(a) Significance Level: $p \leq 0.05$.

TABLE D.113. Mean Tissue Concentration (dry weight) and Statistical Grouping for Zinc in *N. caecoides* Tissues

Sediment Treatment	Mean Tissue Concentration (mg/kg dry weight)	Statistical Significance
COMP I	187	NS[a]
COMP II	203	S[b]
COMP III	196	NS
COMP IV	192	NS
COMP V	211	S
COMP VI	198	NS
R-AM	189	NA[c]

(a) NS No significant difference from R-AM ($\alpha = 0.05$).
(b) S Siginficant difference from R-AM ($\alpha = 0.05$).
(b) NA Not applicable.

TABLE D.114. ANOVA Results for Zinc (dry weight) in *N. caecoides* Tissues

Source of Variation	Sum of Squares	d.f.	Mean Square	F-Ratio	Significance Level
Treatment	0.031	6	0.005	4.959	0.0064[a]
Residual	0.015	14	0.001		

(a) Significance Level: $p \leq 0.05$.

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