REPORT OF TESTING OF SEDIMENTS COLLECTED FROM MARINA DEL REY HARBOR, CALIFORNIA

Submitted to:

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1.0 INTRODUCTION

1.1 Overview

The U.S. Army Corps of Engineers, Los Angeles District (Corps) plans to dredge the entrance of Marina del Rey Harbor in southern California. Existing depths range from –5 feet MLLW near the southern breakwater to –18 feet MLLW between the southern breakwater and the western breakwater. MEC Analytical Systems, Inc. (MEC) was contracted to conduct sampling in December 1997 and to perform selected analyses of sediments in accordance with the "Sampling and Analysis Plan for Testing of Sediments Collected From Marina del Rey Harbor", hereafter referred to as the Sampling and Analysis Plan (SAP). The purpose of the testing was to provide additional information to be used to determine the suitability of potential dredge material for ocean disposal at the EPA designated LA-2 Ocean Dredged Material Site (ODMDS). The recent information was to augment the bulk sediment chemistry testing that was conducted in October 1997 (Toxscan1997).

This report presents the results of the sample collection and laboratory analyses. Testing included selected sediment chemical analysis, suspended-particulate phase (SPP) bioassays, solid phase (SP) bioassays, and tissue chemistry bioaccumulation. Testing requirements are based on Section 102 of the Marine Protection, Research & Sanctuaries Act. Testing was performed in accordance with the Green Book (USEPA/USCOE 1991) and the draft RIA (Regional Implementation Agreement) for the evaluation of dredged material for ocean disposal (USCOE/USEPA 1993).

Volume 1 of this report provides summaries of the sediment chemistry, bioassay tests, and tissue chemistry results. All supporting documentation, including a copy of the SAP, sample core locations, and laboratory raw data are provided in appendices in Volume 2.

1.2 Site History

Adjacent land uses include a small boat harbor and urban watershed drainage. Recent data indicated the presence of elevated concentrations of lead, total hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). In October 1997 the Corps conducted bulk sediment chemistry analysis of the proposed dredged materials at the entrance of Marina del Rey (Toxscan 1997). That analysis followed the Green Book testing guidelines and analyzed the sediments for routine chemical analytes (See Section 2.3; Table 3). The Corps, in coordination with U.S. Environmental Protection Agency (EPA), reviewed the results of that evaluation and identified specific contaminants of concern. The sediment chemistry testing for the present study focuses on those specific contaminants. The present study also investigates the potential impact of disposal on organisms and the potential for bioaccumulation of chemical contaminants.

2.0 SAMPLE COLLECTION AND HANDLING

Location maps of the Marina del Rey proposed dredge area are presented in Figures 1 and 2. The target sample positions presented in Figure 2 were supplied by the Corps to correspond with the previous October 1997 sampling. The project site was divided into four spatial areas (Area 3, Area 4, Area 5/6, and Area 9), with several sampling stations per area. Dredge depths are -15 feet MLLW at Areas 3 and 4, and –20 feet MLLW at Areas 5/6 and 9. Samples were taken to a -2 feet overdredge (i.e., -17 feet MLLW at Areas 3 and 4, and -22 feet MLLW at Areas 5/6 and 9). The sediment from Area 5/6 was split vertically into bottom (Area 5) and top samples (Area 6). This resulted in five composite samples from Marina del Rey for Tier III ocean disposal suitability testing (Table 1). Sediments from the LA-2 ODMDS (Figure 3) were collected to serve as reference sediments for the Tier III testing. Control sediments were collected with test organisms for the solid phase and bioaccumulation tests. A copy of the SAP is presented in Appendix A.

Selected chemical analysis of sediments was done on the composite samples from Areas 3 and 4 (Table 2). Each station from Areas 5/6 and 9 was subdivided into top and bottom

Figure 1. Location map showing entrance to Marina del Rey.

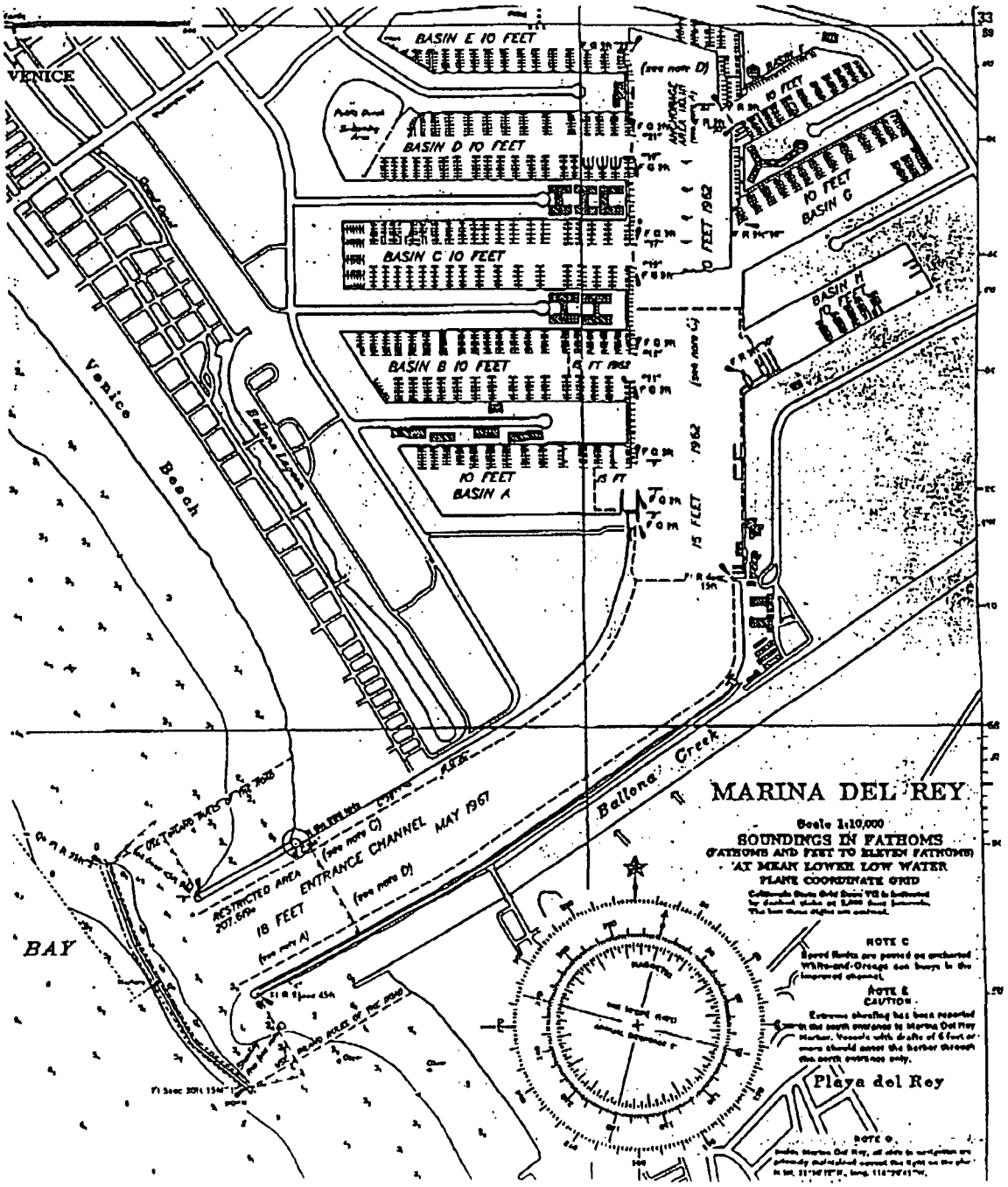


Figure 2. **Site map showing target core locations in the Marina del Rey proposed dredge areas.**

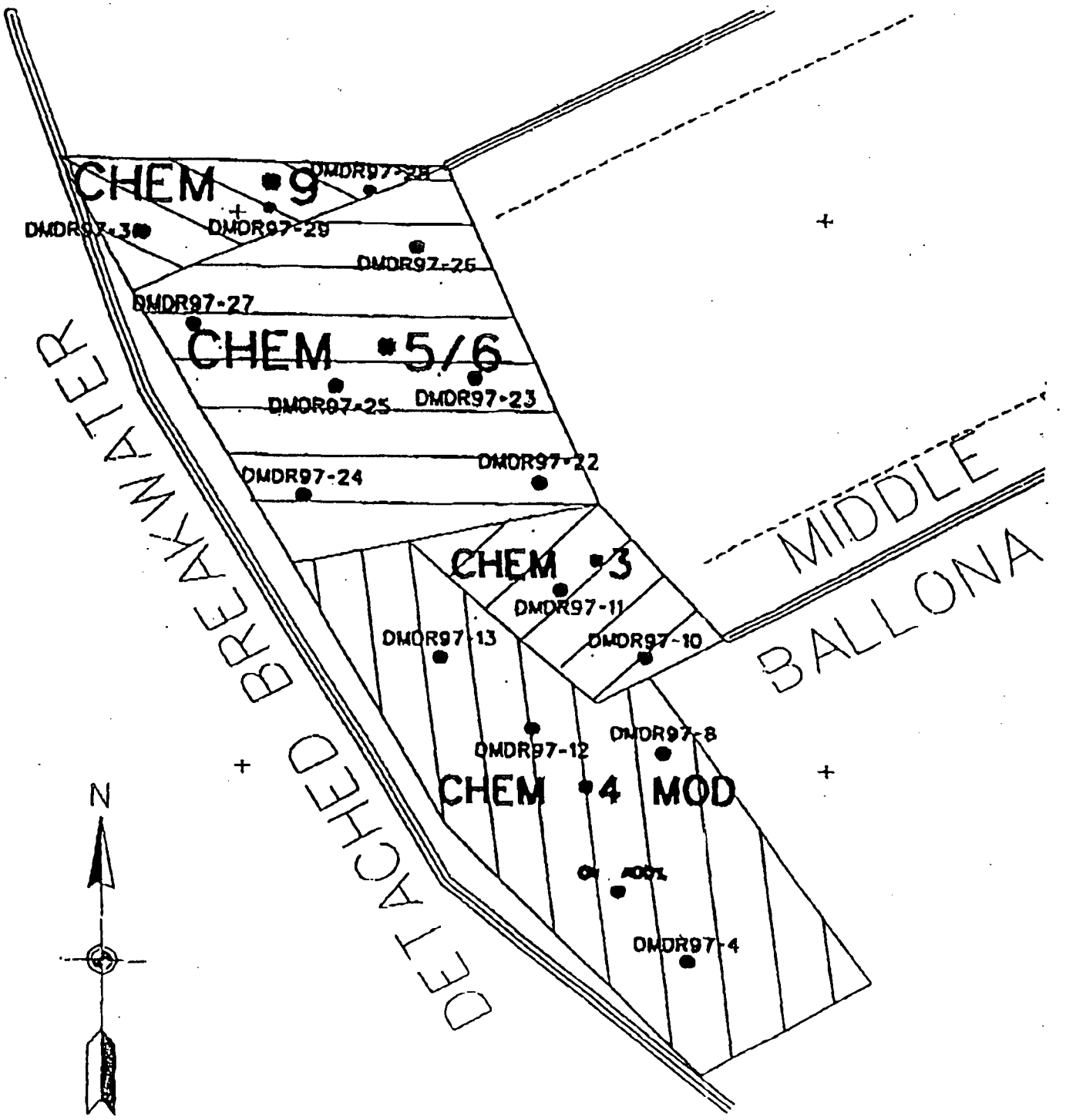


Figure 3. LA-2 Ocean Dredged Material Disposal Site vicinity map.

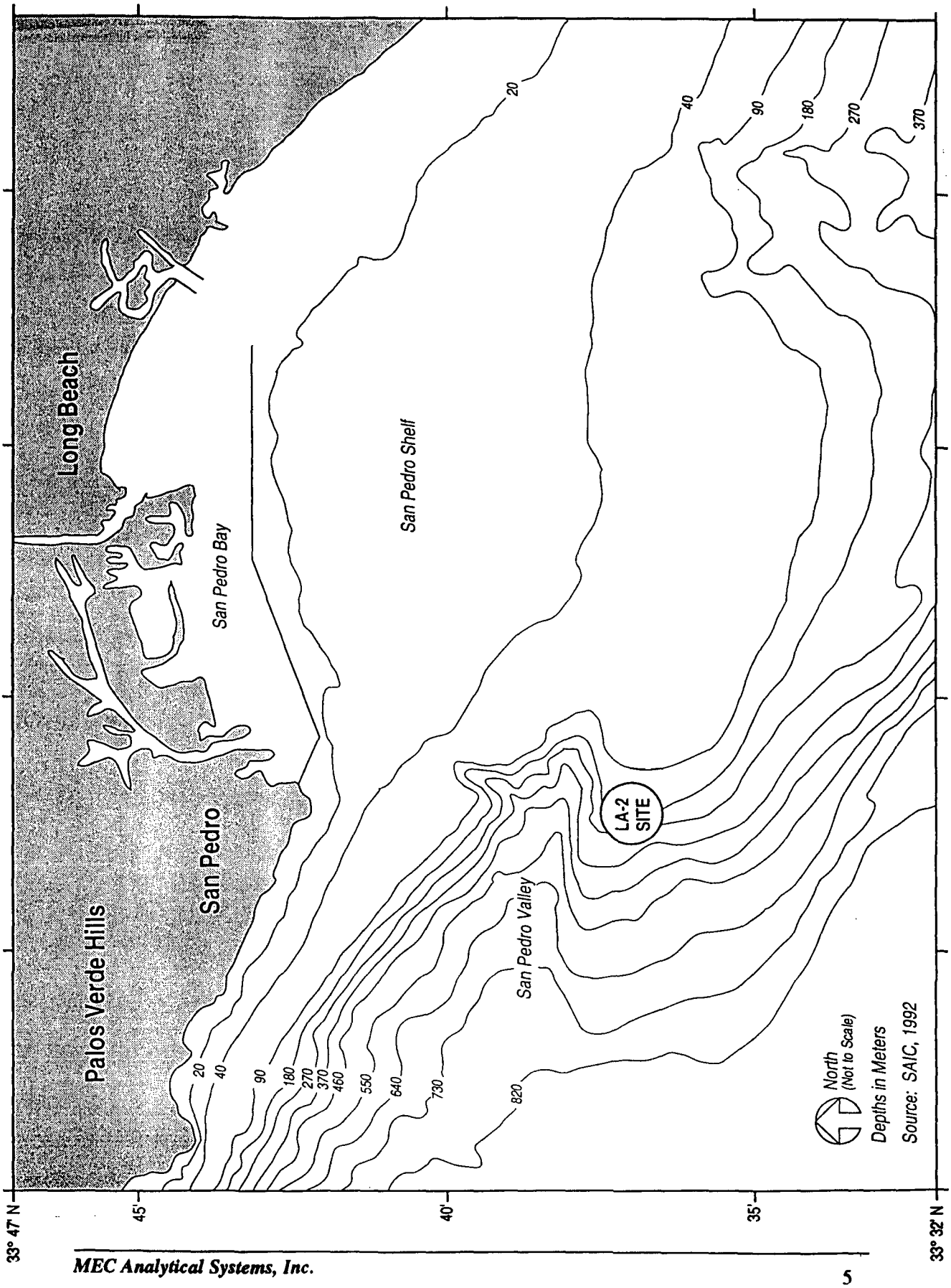


Figure 3. LA-2 Ocean Dredged Material Disposal Site vicinity map.

Table 1. Number of toxicity samples by area.

AREA	DEPTH (ft.MLLW)	NUMBER OF CORES	SAMPLE COMPOSITING	TOXICITY TESTS
3	Mudline to -17	2	1 Composite	SPP,SP,Bioaccumulation
4	Mudline to -17	5	1 Composite	SPP,SP,Bioaccumulation
5	-17 to -22	6 bottoms	1 Composite	SPP,SP,Bioaccumulation
6	Mudline to -17	6 tops	1 Composite	SPP,SP,Bioaccumulation
9	Mudline to -17	3 tops	1 Composite	SPP,SP,Bioaccumulation
Reference	NA	NA	1 grab	SP, Bioaccumulation
Control	NA	NA	1	SP, Bioaccumulation

Total number of Tier III toxicity samples = 7

SPP = supended-particulate phase bioassay

NA = not applicable

SP = solid phase bioassay

Table 2. Number of sediment chemistry samples by area.

AREA	DEPTH (ft. MLLW)	NUMBER OF CORES	SAMPLE COMPOSITING	CHEMICAL ANALYSIS
3	Mudline to –17	2	1 Composite	Lead, pesticides, PCBs, PAHs
4	Mudline to –17	5	1 Composite	Lead, PCBs, PAHs
5	-17 to –22	6 bottoms	6 discreet bottom samples	Lead, pesticides, PCBs, PAHs
6	Mudline to -17	6 tops	6 discreet top samples	Lead, PAHs
9	-17 to -22	3 bottoms	3 discreet bottom samples	PAHs
9	Mudline to -17	3 tops	3 discreet top samples	PAHs
Reference	NA	NA	1 grab	Full suite

Total number of chemistry samples = 21

PAHs = polynuclear aromatic hydrocarbons

NA = not applicable

PCBs = polychorinated biphenyls

core layers and analyzed for selected pollutants. This was done to allow more accurate identification of sites of potential contamination in those areas. Sediment from the surface to -17 feet MLLW was considered the "top" sample from each core. Sediment from below -17feet MLLW to –22 feet MLLW was considered the "bottom" sample from each

core. Sediments from the LA-2 ODMDS were used as reference sediments and were analyzed for the full suite of pollutants (Table 3, see Section 2.3).

Biological testing was performed by MEC Analytical Systems, Inc (MEC), Toxicity and Chemistry Division with laboratories in Tiburon, Carlsbad, and San Diego, California. Sediment chemistry analysis was carried out by West Coast Analytical Services, Inc. (WCAS) in Santa Fe Springs, California. Tissue chemistry analysis was performed by Pacific Treatment Analytical Services, Inc. (PTAS).

Seawater used in this study program came from the Scripps Institution of Oceanography at La Jolla, San Diego Bay, and from the Bodega Bay Marine Laboratory in Bodega Bay, California. Extensive reference toxicity testing on a wide variety of test species has shown that there is no significant potential for toxicity or bioaccumulation from these water supplies.

2.1 Sediment Collection

Marina del Rey sediments were collected using an electric vibracorer or Van Veen grab, operated from the 36 foot vessel *Early Bird* operated by Sea Ventures. Differential Global Positioning System (DGPS), with an accuracy of +/- 0.5 to 2 meters, was used to locate stations. An inflatable boat was used to assist multiple anchoring and station positioning.

Reference sediments were collected from the LA-2 ODMDS, which is located approximately seven miles west of Queen's Gate in Long Beach Harbor. Coordinates for the site, provided by EPA, are 33°33.20' North and 118°10.80' West at the 600-foot depth contour. The coordinates were verified using DGPS. Approximately 25 gallons of sediment was collected using a stainless steel pipe dredge to conduct the sediment chemistry, solid phase bioassay, and bioaccumulation testing.

Control sediments were collected at the time of the collection of amphipod test organisms for the solid phase tests. The amphipods were collected from San Pablo Bay, California.

Control sediments for the polychaete worm bioaccumulation tests were collected from Tomales Bay, California at the time of collection of the test organisms; sufficient control sediment was collected to also be used for the mysid and polychaete worm solid phase tests. Control sediments for the bivalve bioaccumulation tests were collected at the time of collection of the test organisms from Elkhorn Slough, California.

During the field sampling activities, field personnel characterized each core profile by length, color, odor, sediment type, and any evident stratification. Core logs are provided in Appendix B. One or more cores per station were collected in order to yield sufficient sample volume for all tests. In the case where multiple cores were collected at a station, each core was designated by letter (i.e., A, B, C, etc.). Each collected core section (top, bottom, or entire core) was emptied into individual plastic bags labeled with unique sample identifications, date and time of collection, and initialed. Samples were stored on ice in ice chests in the field and returned to the laboratory for processing and testing.

2.2 Sample Processing

Composite samples were prepared for each proposed dredge area for Tier III testing. Station cores (by sediment layer, if appropriate) from each proposed dredge area were thoroughly homogenized to a uniform color and consistency using a stainless steel mixing apparatus. The composite samples were stored in the dark at 4°C at MEC's Carlsbad laboratory until used. Samples tested at the Tiburon and San Diego laboratories were transported same day or overnight in ice chests with ice .

Sub-samples of the Area 3 and Area 4 composite samples were taken and placed into clean glass jars with Teflon lined lids for subsequent sediment chemical analysis. Samples for chemical analysis of sediments from each station (and layer) at Areas 5/6 and 9 were prepared by taking a sub-sample across the entire length of each core layer prior to making the composite sample for the Tier III testing. In the case of multiple cores per station, composite sub-samples for the top and the bottom layers for each station were prepared. The samples designated for sediment chemical analyses were placed into labeled, clean glass jars with teflon lined lids. Sediment chemistry samples were shipped

overnight with ice in ice chests to West Coast Analytical Services, Inc.

All remaining sediments from each sample (both top and bottom sections, as appropriate), as well as each composite used in testing, were archived in the dark at 4°C at MEC's Carlsbad laboratory to be used if further definition of chemical contamination is required.

All samples and sub-samples were fully tracked using chain-of-custody forms.

2.3 Chemical Analyses of Sediments and Tissues

The objectives of the sediment chemistry analysis were to characterize the site and to provide a selection of analytical targets for the tissue bioaccumulation tests. Tissue analysis was performed to determine the availability of sediment contaminants to be taken up into the organisms. Tissue composites from each replicate were analyzed individually. The test, reference, and control sediments were tested analytically for the list of chemicals shown in Table 1. Tissues were analyzed for the full suite of chemical constituents. The methods and target detection limits of chemical constituents for sediments (based on dry weight) and tissues (based on wet weight) are presented in Table 3.

All chemical analyses were performed as recommended in the Green Book (USEPA/USCOE 1991) using EPA (SW-846), National Oceanic and Atmospheric Administration (NOAA), or American Society for Testing and Materials (ASTM) methods, with approved modifications.

The analysis for priority pollutant metals involved a nitric acid digestion of the sample and subsequent analysis of the acid extract using Inductively Coupled Plasma (ICP) with mass detector (EPA Method 200.8). For mercury, the analysis was performed using Atomic Absorption with graphite furnace (EPA 7000 series).

Table 3. Target detection limits.

Constituent	Method (EPA)	[1]Sediment	[2]Tissue
Metals (mg/kg)	6010/200.8		
Arsenic (As)		0.1	0.1
Cadmium (Cd)		0.1	0.1
Chromium (Cr)		0.1	0.1
Copper (Cu)		0.1	0.1
Lead (Pb)		0.1	0.1
Mercury (Hg)	7471	0.02	0.02
Nickel (Ni)		0.1	0.1
Selenium (Se)		0.1	0.1
Silver (Ag)		0.1	0.1
Zinc (Zn)		0.1	0.1
TRPH (mg/kg)	418.1	5	------
PCBs (µg/kg)	8080M		
Aroclor1016		10	10
Aroclor1221		10	10
Aroclor1232		10	10
Aroclor1242		10	10
Aroclor1248		10	10
Aroclor1254		10	10
Aroclor1260		10	10
Pesticides (µg/kg)	8080M		
DDT and Derivatives		20	20
4,4'- DDE		20	20
Aldrin		20	20
Chlordane and Derivatives		20	20
delta BHC		20	20
Dieldrin		20	20
Endosulfan I		20	20
Endosulfan II		20	20
Endosulfan Sulfate		20	20
Endrin		20	20
Endrin Aldehyde		20	20
Hexachlorocyclohexane Isomers		30	30
Toxaphene			
Phenols (µg/kg)	8270M		
2,4-Dimethylphenol		20-100	20-100
2,4-Dichlorophenol		20-100	20-100
Pentachlorophenol		20-100	20-100
Total phenols		20-100	20-100

Constituent	Method (EPA)	[1]Sediment	[2]Tissue
Phthalates (µg/kg)	8270M		
Total	(GC/MS SIM)	10	10
PAHs (µg/kg)	8270M		
Naphthalene	(GC/MS SIM)	20	20
Acenaphthylene		20	20
Acenaphthene		20	20
Fluorene		20	20
Phenanthrene		20	20
Anthracene		20	20
Fluoranthene		20	20
Pyrene		20	20
Chrysene		20	20
Benzo (A) Anthracene		20	20
Benzo (K) Fluoranthene		20	20
Benzo (B) Fluoranthene		20	20
Benzo (A) Pyrene		20	20
Ideno (1,2,3-CD) Pyrene		20	20
Dibenzo (A,H) Anthracene		20	20
Benzo (G,H,I) Perylen		20	20
Total PAHs		20	20
	Unger (1986)		
Organotin (µg/kg)		1	1
Monobutyltin		1	1
Dibutyltin		1	1
Tributyltin			

[1]Concentrations based on dry weight
[2]Concentrations based on wet weight

The analysis for semi-volatile pollutants such as polynuclear aromatic hydrocarbons (PAHs), phthalates, and phenols were performed using EPA Method 8270M. The method includes gas chromatography/mass spectrometry with selective monitoring (GC/MS SIM) following serial extraction with methylene chloride and alumina and gel permeation column cleanup procedures.

Polychlorinated biphenyls (PCBs) and chlorinated pesticides were run using the EPA Method 8080M. The PCBs were identified to the Aroclor level.

The analysis of organotin was carried out using methods described in Unger (1986). Total recoverable petroleum hydrocarbons (TRPH) was measured using EPA Method 418.1.

Sediment porewater obtained by centrifugation was analyzed for ammonia, pH, and salinity using standard laboratory water quality meters (Orion SA-720, Beckman ∅10 and Orion 140, respectively).

2.4 Suspended-Particulate Phase Bioassays

Suspended-particulate phase (SPP) bioassay tests were performed to estimate the potential impact of ocean disposal on organisms that live in the water column. The SPP test was performed according to the Green Book (USEPA/USCOE 1991). Three species were tested, *Mytilus edulis* (bivalve mollusc larvae), *Atherinops affinis* (topsmelt), and *Mysidopsis bahia* (mysid shrimp). *Mytilus edulis* larvae were spawned from stock provided by Carlsbad Aquafarms, Carlsbad, California. *Atherinops affinis* was provided by Aquatic BioSystems, Fort Collins, Colorado. They were transported and held in seawater. *Mysidopsis bahia* was supplied by Aquatox in Hot Springs, Arizona. They were transported and held in seawater.

The test solution was prepared using seawater and dredge site sediments. Sediment and seawater were mixed to obtain a volumetric sediment-to-water ratio of 1:4. The mixture was agitated vigorously for 30 minutes, then allowed to settle for at least one hour. Following settling, the supernatant was used to create the test concentrations for the bioassays. Seawater was used as a test control.

The bivalve larvae test was run on the test sediment elutriates at 1, 10, 50 and 100 percent (%) dilutions. The test (ASTM 1992a) was run for 48 hours, or longer if necessary, for the development of the bivalve larvae to the "D-hinge" stage. The ASTM method uses the test criterion of 70% survival of normally developed D-hinge larvae in the control to determine test acceptability. Table 4 summarizes the test procedures for the bivalve larvae.

For the fish and the mysid, the SPP was tested at 10, 50 and 100% concentrations against a seawater control under static conditions. Ten animals were used per replicate with five replicates being tested. The test was run for 96 hours. In the event of mortality in the control exceeding 10%, the test was rerun. Mysids were fed two drops of concentrated brine shrimp (*Artemia*) nauplii twice daily. Tables 5 and 6 summarize the test procedures for fish and mysids, respectively.

Daily water quality monitoring of test chambers was carried out for pH, dissolved oxygen, salinity, and temperature. Ammonia was analyzed at the start and end of the test for the 100% concentration. Measurements in other concentrations were performed if the readings in the 100% concentration exceeded 4 parts per million (ppm) NH_3.

Dissolved oxygen was measured using a YSI Model 57 oxygen meter and probe or Orion-Model 840 oxygen meter; pH was measured using a Beckman ∅10 digital pH meter and probe or Orion Model 230A pH meter. Salinity and temperature were measured with an Orion Model 140 conductivity/salinity meter. Ammonia was analyzed by Orion 95-12 electrode using the Orion 720 digital ion analyzer and a two point calibration curve (1 and 10 milligrams per liter (mg/L). All instruments were calibrated daily and the calibration results were recorded in the Calibration Log as described in internal Laboratory Standard Operating Procedures (SOPs).

To evaluate the relative sensitivity of the organisms, toxicity tests were performed using copper sulfate, which is a standard reference toxicant (Lee, 1980).

At the termination of the study, survival was determined for each replicate test chamber and an average survivorship computed for each tested concentration.

Table 4. Bioassay procedure and organism data for the 48-hour suspended-particulate phase bioassay using larvae of *Mytilus edulis*. (ASTM E724-89).

Sample Identification	
Date Received at MEC	December 15, 1997
Volume Received	~1 gallon
Sample Storage Conditions	4° C in the dark
Test Species	Mussel, *Mytilus edulis*
Supplier	Carlsbad Aquafarms, Carlsbad, CA
Acclimation Time	Used Immediately
Age Group	Embryos, 3 hours old
Test Procedures	
Type: Duration	Critical Life-Stage; 48 hours
Test Dates	12/18-12/20/97
Control Water	Bodega Bay seawater, 0.5 µm filtered
Test Temperature	Recommended/(Actual) 16±2° C/(15.1 - 16.5° C)
Test Photoperiod	16 hour light: 8 hour dark
Salinity	Recommended/(Actual) 30±2 ppt / (30-32 ppt)
Test Chamber	20 mL glass scintillation vials
Organisms/Replicate	15-30 embryos/mL
Exposure Volume	10 mL
Replicates/Treatment	5
Feeding	None
Deviations from procedures	None

Table 5. Bioassay procedure and organism data for the 96-hour suspended-particulate phase bioassay using *Atherinops affinis* (USEPA/USCOE 1991).

Sample Identification	
Date Received at MEC	December 27, 1997
Volume Received	1 gallon
Sample Storage Conditions	4° C in the dark
Test Species	Topsmelt, *Atherinops affinis*
Supplier	Aquatic Biosystems, Ft. Collins, CO
Acclimation Time	Two Days
Age Group	Juveniles, 10 days old
Test Procedures	
Type: Duration	Acute/Static; 96 hours
Test Dates	12/29/97-1/2/98
Control Water	Bodega Bay seawater, 0.5 µm filtered uv-sterilized
Test Temperature	Recommended/(Actual) 20±2° C/(19.5 – 20.4° C)
Test Photoperiod	16 hour light: 8 hour dark
Salinity	Recommended/(Actual) 30±2 ppt / (31-34 ppt)
Test Chamber	600 mL glass beaker
Organisms/Replicate	10
Exposure Volume	500 mL
Replicates/Treatment	5
Feeding	0.2 mL concentrated *Artemia* nauplii twice daily
Deviations from procedures	Salinity ranged from 31 to 34 ppt

Table 6. Bioassay procedure and organism data for the 96-hour suspended-particulate phase bioassay using *Mysidopsis bahia* (USEPA/USCOE 1991).

Sample Identification	
Date Received at MEC	December 17, 1997
Volume Received	1 gallon
Sample Storage Conditions	4° C in the dark
Test Species	Mysid, *Mysidopsis bahia*
Supplier	Aquatox, Hot Springs, AR
Acclimation Time	Overnight
Age Group	Juveniles, 4 days old
Test Procedures	
Type: Duration	Acute/Static; 96 hours
Test Dates	12/18-12/22/97
Control Water	Bodega Bay seawater, 0.5 µm filtered uv-sterilized
Test Temperature	Recommended/(Actual) 19±1° C/(18.8 – 20.5° C)
Test Photoperiod	16 hour light: 8 hour dark
Salinity	Recommended/(Actual) 30±2 ppt / (31-32 ppt)
Test Chamber	1000 mL glass beaker
Organisms/Replicate	10
Exposure Volume	1000 mL
Replicates/Treatment	5
Feeding	0.2 mL concentrated *Artemia* nauplii twice daily
Deviations from procedures	None

LC50 and/or IC50 values were estimated using the Probit or Linear Interpolation (Bootstrap) Method. These values estimate the concentration that causes either a lethal (LC) or sublethal (IC) effect on 50% of the test population. In the event of mortality in excess of 50% in the 100% concentration of any of the SPP tests, a calculation of the Limiting Permissible Concentration (LPC) was carried out. The LPC, when required, is compared to estimated exposure concentrations generated from the mixing zone models used in the Green Book (USEPA/USCOE 1991).

2.5 Solid Phase Bioassays

Solid phase bioassays were performed to estimate the potential impact of ocean disposal on benthic organisms that attempt to re-colonize the area. Proposed dredge material was tested in 10-day solid phase tests using three species, the amphipod crustacean *Ampelisca abdita*, the mysid shrimp *Mysidopsis bahia*, and the polychaete worm *Neanthes arenaceodentata*. The mysid and polychaete solid phase tests followed Green Book (USEPA/USCOE 1991) guidelines. The amphipod solid phase bioassay was performed using the ASTM (1992b) methods. The test procedures for each species are summarized in Tables 7 through 9.

Amphipods were collected by Brezina and Associates from San Pablo Bay, California. *Mysidopsis bahia* was supplied by Aquatic Biosystems and Aquatic Indicators. They were transported and held in seawater. *Neanthes arenaceodentata* was supplied by Dr. Donald Reish and were transported and held in seawater. Control sediments for the mysid and polychaete worm tests came from Tomales Bay, California.

Prior to testing, sediments were sieved through a 2.0 mm mesh screen using only the water available in the sediment sample in order to remove large materials and organisms.

Table 7. Bioassay procedure and organism data for the 10-day solid phase bioassay using *Amplisca abdita* (ASTM E1367-92).

Sample Identification	
Date Received at MEC	December 17, 1997
Volume Received	1 gallon
Sample Storage Conditions	4° C in the dark
Test Species	Amphipod, *Amplisca abdita*
Supplier	Brezina and Associates, Dillon Beach, CA
Acclimation Time	Three days in control sediment; aerated
Age Group	Juveniles
Test Procedures	
Type: Duration	Acute/Static; 10 days
Test Dates	12/20/97-12/30/97
Control Water	Bodega Bay seawater, 0.5 μm filtered uv-sterilized
Test Temperature	Recommended/(Actual) 19±2° C/(18.5 – 20.9° C)
Test Photoperiod	Continuos Light
Salinity	Recommended/(Actual) 30±2 ppt / (29-32 ppt)
Test Chamber	950 mL glass container
Organisms/Replicate	20
Exposure Volume	4.0 cm sediment/~800 mL seawater
Replicates/Treatment	5
Feeding	None
Deviations from procedures	None

Table 8. Bioassay procedure and organism data for the 10-day solid phase bioassay using *Mysidopsis bahia* (USEPA/USCOE 1991).

Sample Identification	Test I	Test II
Date Received at MEC	December 18, 1997	January 7, 1998
Volume Received	1 gallon	1 gallon
Sample Storage Conditions	4° C in the dark	4° C in the dark
Test Species	Mysid, *Mysidopsis bahia*	Mysid, *Mysidopsis bahia*
Supplier	Aquatic Indicators, Saint Augustine, FL	Aquatic Biosystems, Ft. Collins, CO
Acclimation Time	Two days	Two days
Age Group	Juveniles, 5 days old	Juveniles, 5 days old
Test Procedures		
Type: Duration	10 days	10 days
Test Dates	12/20 – 12/29/97	1/9 – 1/18/98
Control Water	Scripps Institute of Oceanography seawater, 0.5 µm filtered uv-sterilized	Scripps Institute of Oceanography seawater, 0.5 µm filtered uv-sterilized
Test Temperature	Recommended/(Actual) 20±2° C/ (19.3 – 20.8° C)	Recommended/(Actual) 20±2°C/ (32.6 – 33.0° C)
Test Photoperiod	16 hours light: 8 hours dark	16 hours light: 8 hours dark
Salinity	Recommended/(Actual) 30±2 ppt / (31 – 33 ppt)	Recommended/(Actual) 30±2 ppt (32 – 33 ppt)
Test Chamber	2 L polyethylene container	2 L polyethylene container
Organisms/Replicate	20	20
Exposure Volume	2 cm/~1600 mL seawater	2 cm/~1600 mL seawater
Replicates/Treatment	5	5
Feeding	1500 mL conc. *Artemia* nauplii twice daily	1500 mL conc. *Artemia* nauplii twice daily
Deviations from procedures	Salinity ranged from 31 to 33 ppt	Salinity ranged from 32 to 33 ppt

Table 9. Bioassay procedure and organism data for the 10-day solid phase bioassay using *Neanthes arenceodentata* (USEPA/USCOE 1991).

Sample Identification	
Date Received at MEC	December 18, 1997
Sample Storage Conditions	4° C in the dark
Test Species	Polychaete, *Neanthes*
Supplier	Dr. Donald Reish, Long Beach, CA
Acclimation Time	Two days
Age Group	Juveniles, 2 weeks old
Test Procedures	
Type: Duration	Acute/Static renewal
Test Dates	12/20/97-12/30/97
Control Water	Scripps Institute of Oceanography seawater, uv-sterilized
Renewal	75% Every other day (twice)
Test Temperature	Recommended/(Actual) 19±2° C/(19.3 – 21.2° C)
Test Photoperiod	16 hours light: 8 hours dark
Salinity	Recommended/(Actual) 34±2 ppt / (31-33 ppt)
Test Chamber	1 L jars
Organisms/Replicate	10
Exposure Volume	2 cm of sediment
Replicates/Treatment	5
Feeding	None
Deviations from procedures	Salinity ranged from 31 to 33 ppt

Each sediment type (test, reference, and control) was run with five replicates. Reference sediments were from the LA-2 ODMDS. Control sediments were those sediments in which the *Ampelisca* were collected, San Pablo Bay, or were from Tomales Bay for *Neanthes* and *Mysidopsis*.

For the mysid and worm solid phase tests, a single 2-cm layer of test, reference, or control sediment was placed into each test chamber and filtered seawater added. Static renewal of 75% of the overlying water was performed every other day. Initial stocking densities in each replicate were ten per test chamber for the polychaete worm, and twenty for the mysid and the amphipod. Aeration was provided through glass or plastic pipettes, with care taken to avoid disturbing the sediment. Mysids were fed two drops of concentrated brine shrimp (*Artemia*) nauplii twice daily.

Water quality measurements were taken in one chamber from each test treatment daily and included pH, salinity, temperature, and dissolved oxygen. Ammonia was measured at the start and finish of the test for each site. Porewater ammonia, pH, and salinity were tested at the beginning and end of the tests. Ammonia in the interstitial water was reduced to below 20 milligrams per liter (mg/L) before addition of test organisms. Measurements were taken with the same instruments described for the suspended-particulate phase bioassays (Section 2.4). All instruments were calibrated and logged according to the laboratory SOPs. After ten days, the animals were carefully sieved out to determine survival and mortality. If control survival was below 90% for any species, the test was repeated.

To evaluate the relative sensitivity of the organisms, toxicity tests were performed using cadmium chloride, copper chloride, or copper sulfate, which are standard reference toxicants (Lee, 1980).

The survival data were analyzed through a Student's *t*-test when variances were homogenous and a modified *t*-test when the variances were heterogeneous. Significant effects in solid phase bioassays were defined as differences that are both statistically significant ($p \leq 0.05$) and substantial; i.e., survival > 20% reduced in test sediment as

compared to survival in reference sediment.

2.6 Tissue Bioaccumulation Tests

Tissue analysis was performed to assess the potential availability of sediment contaminants to be taken up into the tested organisms. Assessment of bioaccumulation potential was carried out using the clam *Macoma nasuta* and the polychaete worm *Nephtys caecoides* over a 28-day test period. The tests were initiated using proposed dredge sediments, reference sediments, and control sediments in the same manner as the 10-day solid phase test. A minimum of twenty *Macoma* and ten *Nereis* were placed in each of five replicate test chambers for each sediment type. The test chambers were maintained under flow-through conditions, and daily water quality measurements were taken within the test chambers. Measurements were taken with the same instruments described for the suspended-particulate phase bioassays (Section 2.4). All instruments were calibrated and logged according to the laboratory SOPs. Test procedures for the bioaccumulation tests are summarized in Table 10.

On Day 28, the sediments were sieved to remove the clams and worms. The surviving animals were placed in clean flow-through aquaria to depurate for at least 24 hours. Organisms were frozen and sent to Pacific Treatment Analytical Services, Inc. for analysis. At the chemical laboratory, animal tissue was homogenized and assayed to determine levels of trace metals, PAHs, phthalates, pesticides, PCBs, phenols, and organotins according to the methods specified in Table 3.

The analysis of bioaccumulation was made by statistically comparing tissue levels from the reference group to those of the test group for each species. If the mean of the data from a test site was greater than the mean of the reference site, a paired, one-tailed *t*-test was performed to determine if the difference was statistically significant ($p \leq 0.05$). The *t*-test requires that the sample mean and variance are known and measurable. Statistical analysis of data sets containing non-detectable values is problematic; therefore, modified analysis of censored data sets has been advocated by several authors (Newman et al. 1989, Helsel 1990, Slymen and de Peyster 1994). Since some values in this data set were reported as

Table 10. Bioassay procedure and organism data for the 10-day solid phase bioassay using *Nephtys caecoides* and *Macoma nasuta* (USEPA/USCOE 1991).

Sample Identification	
Date Received at MEC	December 18, 1997
Volume Received	~25 gallons
Sample Storage Conditions	4° C in the dark
Test Species	Marine clam *Macoma nasuta* and Polychaete worm, *Nephtys caecoides*
Supplier	*Macoma*: Kim Siewers, Santa Cruz, CA *Nephtys*: Brezina and Associates, Dillon Beach, CA
Acclimation Time	One day with flow-through seawater
Age Group	Juveniles
Test Procedures	
Type: Duration	Bioacumulation/Flow-through; 28 days
Test Dates	12/18/97 – 1/15/98
Control Water	San Diego Bay seawater, uv-sterilized
Seawater flow-rate	50cc/8 sec.
Test Temperature	15±2° C
Test Photoperiod	16 hours light: 8 hours dark
Salinity	Ambient (32±2 ppt)
Test Chamber	28 x 8 x 7 inch fiberglass trays
Organisms/Replicate	30 clams/75 worms
Exposure Volume	4 L of sediment
Replicates/Treatment	5
Feeding	None
Deviations from procedures	None

non-detectable, or below the Reporting Limit (RL), it became necessary to estimate the mean and variance around a value so the statistical tests could be performed.

To better describe the variance around means when some, or all, of the individual replicate values were below the RL of the analytical methodology, an estimate of the non-detectable value was used for the statistical test. This estimate was based upon the recommended approach of using one-half of the measured detection limit as the estimated mean (Paasivirta 1991).

In situations in which more than one replicate was reported as below the RL, estimated data values were derived based on a symmetrical breakdown of the data range in such a way that the mean of the estimates was entered around a value of one-half of the RL. This is a statistical treatment of non-value data such that statistically valid means and variances are generated and statistical testing may continue. For example, if the five replicate values for a tissue residue are reported as all being below the RL of 20, the estimated data would be treated as: 5, 15, 10, 15, 5. This would produce a value with a mean of 10 (one-half the RL) and an associated variance. This method is superior to giving a blanket value of one-half the RL because it estimates both the mean and variance.

Analytes also were compared (when appropriate) with "Food and Drug Administration (FDA) Action Levels for Poisonous and Deleterious Substances in Fish and Shellfish for Human Food."

3.0 Quality Assurance/Quality Control Procedures

Quality assurance/quality control (QA/QC) methods used for sediment collection, sediment testing, and bioassays were consistent with procedures described in the Green Book (USEPA/USCOE 1991). Quality checks were made in the field to assure sample integrity and to avoid contamination. All samples were tracked with chain-of-custody documentation. Laboratory QA/QC protocols were followed that included analysis of reference, control, duplicate, and matrix spike samples.

3.1 Field Collection and Sample Handling

Differential Global Positioning System (DGPS) and multiple anchoring was used to locate and stay on sampling stations. Lexan liners were used in the vibracore to avoid sample contamination. Vibracore samples were placed into plastic bags and field personnel wore plastic gloves when handling samples. All sample containers (glass, plastic) and utensils (stainless steel, teflon) were pre-cleaned before use and cleaned between use, if appropriate, to avoid sample contamination.

Sediment samples were stored on ice in ice chests in the field and during shipment to analytical laboratories. Samples were stored in the dark at 4°C until used at the laboratories. Full chain-of-custody sample tracking was performed from the field through the laboratory for all samples.

3.2 Chemical Analyses of Sediments and Tissues

The quality assurance objectives for chemical analysis conducted by West Coast Analytical Services, Inc. and Pacific Treatment Analytical Services, Inc. are detailed in their Laboratory QA Manuals. These objectives for accuracy and precision involve all aspects of the testing process including:

- Methods and SOPs;
- Calibration Methods and Frequency;
- Data Analysis, Validation and Reporting;
- Internal Quality Control;
- Preventive Maintenance; and
- Procedures to Assure Data Accuracy and Completeness.

Environmental sample matrix spike and matrix spike duplicate analysis were performed at a rate of 5%. In the absence of adequate sample quantity to perform matrix spiking for all matrix types, either the imaginary matrix as described in SW-846 or a laboratory water sample was used for preparing matrix spikes. Matrix spikes are an environmental sample

which is split into three separate aliquots and one aliquot is analyzed free from matrix spike introduction. A known concentration of the analyte of interest is added to the other two aliquots prior to sample preparation and analysis. Both percent recovery and relative percent difference are reported for matrix spikes/matrix spike duplicates. Spike data can provide an indication of matrix bias or interference on analyte recovery. Duplicate data can provide an indication of laboratory precision.

Method or reagent blanks were analyzed at a frequency of 5% or for every analytical batch, whichever was greater.

Results of all laboratory QA/QC analyses were reported with the final data. Any QA/QC samples that fail to meet the QA/QC criteria specified in the methodology or in the SAP were identified and the corresponding data appropriately qualified in this report.

An audit or reference sample was included with the chemical analyses. This was an EPA, NABS, or other EPA-acceptable source material and was analyzed and reported in the quality control report. The source material was of a similar matrix as the test samples and included analyte concentrations in a similar range.

4.3 Bioassay Tests

The quality assurance objectives for toxicity testing conducted by MEC Analytical Systems Bioassay Division are as those detailed in U.S. EPA (1985a, 1985b) and the Green Book (USEPA/USCOE 1991). These objectives for accuracy and precision involve all aspects of the testing process, including: (1) water and sediment sampling and handling; (2) source and condition of test organisms; (3) condition of equipment; (4) test conditions; (5) instrument calibration; (6) use of reference toxicants; (7) record keeping; and (8) data evaluation.

A reference toxicant was tested on each test organism during the test period to establish the validity of the toxicity data. For those species with substantive reference toxicant data available, the LC50 and EC50 should fall within two standard deviations of the laboratory

mean.

Water quality measurements were monitored to ensure they fall within prescribed limits, and corrective actions (EPA recommended) were taken if necessary. All limits established for this program meet or exceed those recommended by EPA.

The methods employed in every phase of the toxicity testing program are detailed in MEC's Laboratory Standard Operating Procedures (SOPs). These SOPs have been audited and approved by an independent, EPA recommended laboratory and placed in the QA/QC files as well as laboratory files. All MEC laboratory staff receive regular documented training in all SOPs and test methods.

All data collected and produced as a result of the analysis was recorded on approved data sheets, which serve as the permanent data record for the program.

If any aspect of a test deviated from protocol, the test was evaluated to determine whether it was valid according to the regulatory agency to which it will be submitted.

Data Analysis, Validation and Reporting. All acute and chronic toxicity tests were performed according to protocols and conditions listed in MEC SOPs. Raw data and study records were checked to ensure that required test conditions were within specifications cited in the SOPs. Major deviations from protocol must be approved by both the client and the quality control manager. Unforeseen circumstances that may affect the integrity of the study would be reported with the test results. The data, analysis, and report were reviewed for accuracy by the Quality Control Manager.

Internal Quality Control. MEC's quality control staff performs periodic audits to ensure that test conditions, data collection, and test procedures are conducted according to Green Book protocol and MEC SOPs. Animal receipt and maintenance log books are used to record the source and health of organisms. Reference toxicant tests act as an internal check on organism health and performance.

Preventive Maintenance. Key analytical equipment are maintained routinely to ensure that equipment failure or changes in operational parameters can be prevented. Procedures used to maintain equipment are included in the Maintenance and Calibration Log.

Replacement parts are available for commonly expected repairs and replacement. Spare parts include pH electrodes, dissolved oxygen (DO) probe membrane replacement kits, calibrated thermometers, pipettes, graduated cylinders, etc.

Stock standard solutions are stored in at least two separate containers, so that a fresh standard solution is available in case the stock standard currently in use becomes contaminated. Working standards which are in frequent contact with electrodes, pipettes, etc., are kept in separate working bottles to reduce chances of contamination of stock standards.

Procedures Used to Assess Data Precision Accuracy and Completeness. The precision of the LC50 or IC50 determinations are shown by calculating the 95% confidence intervals. The computer program used to analyze the data is designed in such a way that regardless of the data characteristics, it will calculate an LC50 and corresponding confidence intervals as long as sufficient mortality is observed. Accuracy cannot be determined as a true value but rather must be determined relative to a reference value of the substance being measured.

The precision of all the analytical instruments (DO meter, pH meter, balances, etc.) is assumed to be that stipulated by the manufacturer. The accuracy of the measurements is assessed through calibration each time the instruments are used.

Sample Storage and Tracking. Sample chain-of-custody sheets, sample receipt logs, sample holding, and sample labeling procedures are audited periodically by MEC's quality control staff. Sample storage conditions and holding times are adhered to strictly. Samples are archived when necessary.

4.0 RESULTS

This section presents results from sample collection and testing of proposed dredge materials, the reference sample from the LA-2 ODMDS, and control sediments from organism collection sites.

4.1 Field Sampling

Sediments were collected at the LA-2 ODMDS on December 10, 1997. Proposed dredge sediments from Marina del Rey were collected on December 11 through 14, 1997. Strong winds (> 30 knots) interrupted sampling on December 11, 1997. Weather was mild with winds of 5 to 15 knots and clear to partly cloudy skies on December 12 through 14, 1997. The tides were ebbing in the morning and flooding in late afternoon. Currents posed no difficulty to sampling.

Table 11 summarizes locations, length of cores, and number of cores collected at each station within the proposed dredge areas in Marina del Rey. Latitude and longitude are reported in NAD 83 (North American Datum 1983) coordinates. One or more cores were collected at each station to collect sufficient volume for bioassay testing. Multiple cores are designated by letter (i.e., A, B, C, etc.). The post-plot locations of the core locations confirm that they were collected within the designated test areas (Figure 4).

The field characteristics of each core were noted at the time of collection. These included core length, color, odor, sediment type, and obvious sediment stratification. Copies of the core logs are presented in Appendix B.

Sediments from Stations 10 and 11 in Area 3 typically were black in color and smelled of hydrogen sulfide (H_2S). Cores at Station 10 generally consisted of organic debris overlying sand. Sediments at Station 11 were collected by a Van Veen grab sampler because the required penetration was less than 1.5 feet. Samples from Station 11 were silty sand. Urban trash (e.g., aluminum cans, plastic pieces, trash bags, etc.) was recovered in some grabs.

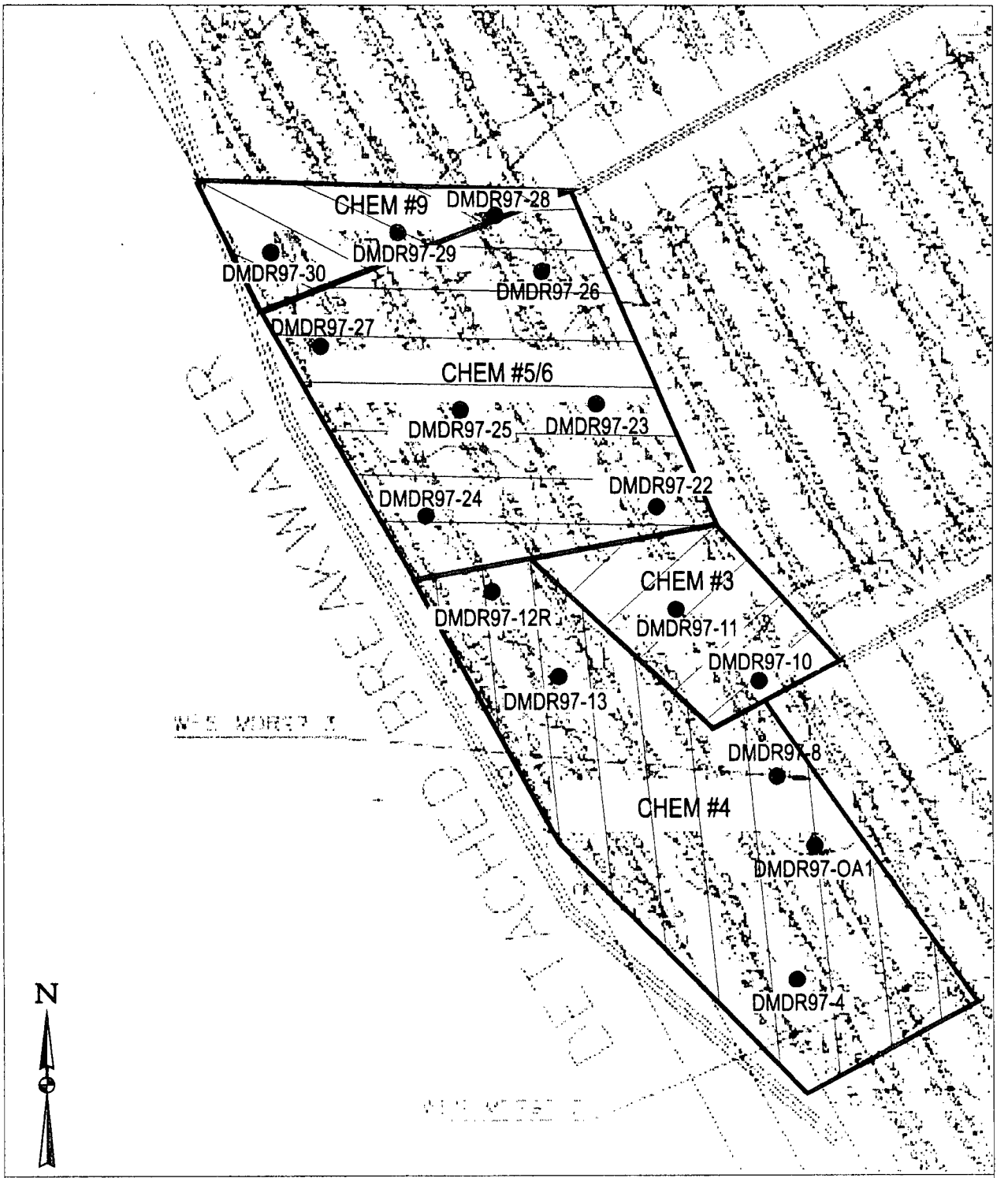
Table 11. Summary of station locations, water depths, core lengths, and number of cores collected at the Marina del Rey proposed dredge areas.

LOCATION	STATION ID	DATE SAMPLED	LATITUDE	LONGITUDE	WATER DEPTH (FT MLLW)	TARGET CORE LENGTH (FT)	FINAL CORE LENGTH (FT)	CORE NUMBEI
Area 3	DMDR-97-10	13 Dec 97	33° 57.621'	118° 27.649'	12.0	3.5	3.5	A
Area 3	DMDR-97-10	13 Dec 97	33° 57.621'	118° 27.649'	13.5	3.5	3.5	B
Area 3	DMDR-97-10	13 Dec 97	33° 57.621'	118° 27.649'	13.5	3.5	1.5+	C
Area 3	DMDR-97-10	13 Dec 97	33° 57.621'	118° 27.649'	13.5	3.5	2.0+	D
Area 3	DMDR-97-10	13 Dec 97	33° 57.621'	118° 27.649'	13.5	3.5	3.5	E
Area 3	DMDR-97-11	14 Dec 97	33° 57.642'	118° 27.678'	15.8	1.2	1.2	A-F*
Area 4	DMDR-97-0A-1	13 Dec 97	33° 57.575'	118° 27.629'	10.0	7.0	3.0+	A
Area 4	DMDR-97-0A-2	13 Dec 97	33° 57.575'	118° 27.629'	10.0	7.0	7.0	B
Area 4	DMDR-97-4	13 Dec 97	33° 57.531'	118° 27.634'	16.3	0.7	0.7	A-C*
Area 4	DMDR-97-8	13 Dec 97	33° 57.592'	118° 27.642'	6.7	10.3	7.0+	A
Area 4	DMDR-97-8	13 Dec 97	33° 57.594'	118° 27.643'	6.7	6.3	6.3	B
Area 4	DMDR-97-12R	13 Dec 97	33° 57.644'	118° 27.739'	11.5	5.5	5.5	1
Area 4	DMDR-97-13	12 Dec 97	33° 57.621'	118° 27.716'	11.5	5.0	5.0	1
Area 5/6	DMDR-97-22	11 Dec 97	33° 57.673'	118° 27.684'	15.5	6.5	6.5	1
Area 5/6	DMDR-97-23	11 Dec 97	33° 57.703'	118° 27.704'	14.4	7.6	10.0++	1
Area 5/6	DMDR-97-24	12 Dec 97	33° 57.667'	118° 27.761'	10.5	11.5	12.0	A
Area 5/6	DMDR-97-24	12 Dec 97	33° 57.667'	118° 27.761'	10.5	11.5	11.5	B
Area 5/6	DMDR-97-25	12 Dec 97	33° 57.699'	118° 27.752'	14.8	7.2	7.2	1
Area 5/6	DMDR-97-26	12 Dec 97	33° 57.739'	118° 27.726'	7.2	14.8	14.8	1
Area 5/6	DMDR-97-27	12 Dec 97	33° 57.715'	118° 27.798'	14.7	7.3	7.3	1
Area 9	DMDR-97-28	12 Dec 97	33° 57.757'	118° 27.742'	5.4	16.6	6.0+	A
Area 9	DMDR-97-28	12 Dec 97	33° 57.753'	118° 27.747'	4.5	17.5	18	B
Area 9	DMDR-97-29	11 Dec 97	33° 57.751'	118° 27.773'	15.4	6.6	6.5	1
Area 9	DMDR-97-30	11 Dec 97	33° 57.744'	118° 27.813'	12.8	9.2	5.5+	A
Area 9	DMDR-97-30	11 Dec 97	33° 57.744'	118° 27.813'	12.7	9.3	9.3	B

* Collected with Van Veen grab
\+ Core encountered refusal at the indicated depth
++ Core was deeper than required depth

Stations 4, 8, 12, 13, and a new station designated "OA" (not sampled in October 1997) comprised Area 4. Sediments at Station 4 were collected by a Van Veen grab sampler because the required penetration was less than 1.5 feet. Station 12 was relocated because the water depth was already at project depth (-17 feet MLLW). The relocated station (12R) was still within Area 4 and had sufficient depth to obtain a representative sediment sample. Sediments were black to gray/black with a H_2S odor at Stations 8, 12, 13, and OA. Sediments were black/gray at Station 4, but were without odor. Sediments were

Figure 4. Post-plot of core locations.



sandy silt at Stations OA and 4, silt and sand with shell hash at Station 8, silt to sand at Station 12, and silty sand to sand at Station 13. Urban trash was recovered in some of the cores from Area 4.

Sediments from Area 5/6 typically were black with a H_2S smell. Sediments were sandy silt to sand. Wood chips were encountered in cores from Stations 22 and 26. The bottom layer of Station 26 (Area 5) had substantial amounts of wood chips and leaves. Limited organic debris was seen in cores from Stations 22, 23, 24, 25, and 27. The core from Station 23 was 2.4 feet deeper than the target length. Review of the sediment chemistry data indicated that contaminant concentrations for that core were within the range of other cores for Area 5 (see Section 4.2).

Sediments from Station 28 and 29 of Area 9 generally were gray, predominantly sands, and without odor. Some wood debris was encountered. Sediments from Station 30 of Area 9 were black, had a sulfide odor, and were sandy silts over sand with some detritus.

4.2 Sediment Chemistry

Summaries of sediment chemistry results by area and by station (or area composite) are presented in Table 12. Concentrations are reported in dry weight. Complete analytical reports of data are presented in Appendix C.

LA-2 ODMDS reference sediments had relatively low levels of contamination. Metals were detected at concentrations ranging from 0.02 mg/kg (ppm) for mercury to 29.4 mg/kg for chromium. The concentrations of most of the organic contaminants were below detectable levels in the reference site sample. Pyrene was the only detected PAH compound and was measured at 0.6 µg/kg (ppb). The only detected phthalate was bis(2-ethylhexyl)phthalate (30 µg/kg), which is present in many plastic products such as laboratory gloves and is a common sample contaminant. The pesticides 4,4'-DDE was detected at 2 µg/kg, and delta-BHC was 0.7 µg/kg. No PCBs nor organotins were detected. TRPH was detected at 22 mg/kg.

Table 12. Summary of chemical concentrations in sediments by station and sampling location.

Table 12. Summary of chemical concentrations (dry weight) in sediments by station and sampling location. (page 1 of 4).

Analyte	Units	LA-2 OMDS Reference	Area 3	Area 4	Area 5/6							
			Composites		DMDR97-22		DMDR97-23		DMDR97-24		DMDR97-25	
					Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Metals												
Arsenic	mg/kg	2.68										
Cadmium	mg/kg	0.108										
Chromium (TOTAL)	mg/kg	29.4										
Copper	mg/kg	10.6										
Lead	mg/kg	6.5	154	111	129	143	52	95	144	470	115	287
Mercury	mg/kg	0.024										
Nickel	mg/kg	12.3										
Selenium	mg/kg	<0.5										
Silver	mg/kg	0.108										
Zinc	mg/kg	41										
PAHs												
Acenaphthene	ug/kg	<0.5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthylene	ug/kg	<0.5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	ug/kg	<0.3	<6	<5	<7	<7	<6	9	<5	10	<6	8
Benzo(a)anthracene	ug/kg	<0.8	<20	<20	<20	<20	<20	<20	<20	40	<20	<20
Benzo(b & k)fluoranthenes	ug/kg	<1	<30	<30	40	40	<30	40	<30	60	<30	50
Benzo(g,h,i)perylene	ug/kg	<1	<30	<20	<30	<30	<30	<30	<20	<30	<30	<30
Benzo(a)pyrene	ug/kg	<0.7	<20	<10	<20	<20	<10	20	<10	30	20	<20
Chrysene	ug/kg	<0.7	<20	<10	30	<20	20	30	20	40	20	30
Dibenzo(a,h)anthracene	ug/kg	<1	<30	<20	<30	<30	<30	<30	<20	<30	<30	<30
Fluoranthene	ug/kg	<0.7	30	20	60	50	30	50	30	70	30	50
Fluorene	ug/kg	<0.4	<9	<8	<10	<10	<9	10	<8	<9	<8	30
Indeno(1,2,3-cd)pyrene	ug/kg	<1	<30	<20	<30	<30	<30	<30	<20	<30	<30	<30
Naphthalene	ug/kg	<0.5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	ug/kg	<0.4	20	10	30	30	10	30	20	40	20	30
Pyrene	ug/kg	0.6	30	20	70	60	30	60	40	90	40	60
Total Detectable PAHs	ug/kg	0.6	80	50	230	180	90	249	110	380	130	258
Phthalates												
Bis(2-ethylhexyl)phthalate	ug/kg	30										
Butyl benzyl phthalate	ug/kg	<0.8										
Di-n-butyl phthalate	ug/kg	<5										
Diethyl phthalate	ug/kg	<8										
Dimethyl phthalate	ug/kg	<5										
Di-n-octyl phthalate	ug/kg	<4										

Table 12. Summary of chemical concentrations (dry weight) in sediments by station and sampling location. (page 2 of 4).

Analyte	Units	Area 5/6				Area 9						Area 5	Area 6	Area 9
		DMDR97-26		DMDR97-27		DMDR97-28		DMDR97-29		DMDR97-30				
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Composites		
Metals														
Arsenic	mg/kg													
Cadmium	mg/kg													
Chromium (TOTAL)	mg/kg													
Copper	mg/kg													
Lead	mg/kg	11.9	63	400	440									
Mercury	mg/kg													
Nickel	mg/kg													
Selenium	mg/kg													
Silver	mg/kg													
Zinc	mg/kg													
PAHs														
Acenaphthene	ug/kg	<5	<6	<10	<10	<0.5	0.7	<10	<10	<10	<10			
Acenaphthylene	ug/kg	<5	<6	<10	<10	<0.5	<0.5	<10	<10	<10	<10			
Anthracene	ug/kg	<3	9	9	9	<0.3	<0.3	<5	<5	7	<6			
Benzo(a)anthracene	ug/kg	<8	20	<20	<20	<0.8	2	<20	<20	<20	<20			
Benzo(b & k)fluoranthenes	ug/kg	<10	40	40	50	<1	4	<30	<30	40	<30			
Benzo(g,h,i)perylene	ug/kg	<10	<10	<30	<30	<1	<1	<20	<20	<20	<30			
Benzo(a)pyrene	ug/kg	<6	20	20	20	0.7	2	<10	<10	20	20			
Chrysene	ug/kg	<6	20	20	30	<0.6	2	<10	<10	20	20			
Dibenzo(a,h)anthracene	ug/kg	<10	<10	<30	<30	<1	<1	<20	<20	<20	<30			
Fluoranthene	ug/kg	<6	50	40	40	1	5	30	<10	30	30			
Fluorene	ug/kg	<4	5	<8	10	<0.4	0.6	<8	<8	<8	<9			
Indeno(1,2,3-cd)pyrene	ug/kg	<10	<10	<30	<30	<1	<1	<20	<20	<20	<30			
Naphthalene	ug/kg	<5	<6	<10	<10	<0.5	<0.5	<10	<10	<10	<10			
Phenanthrene	ug/kg	<4	30	20	30	0.8	4.1	10	<8	20	20			
Pyrene	ug/kg	<5	50	50	70	1	6	30	<10	60	50			
Total Detectable PAHs	ug/kg	0	244	199	259	3.5	26.4	70	0	197	140			
Phthalates														
Bis(2-ethylhexyl)phthalate	ug/kg													
Butyl benzyl phthalate	ug/kg													
Di-n-butyl phthalate	ug/kg													
Diethyl phthalate	ug/kg													
Dimethyl phthalate	ug/kg													
Di-n-octyl phthalate	ug/kg													

Table 12, continued.

Table 12. Summary of chemical concentrations (dry weight) in sediments by station and sampling location. (page 3 of 4).

Analyte	Units	LA-2 OMDS Reference	Area 3	Area 4	Area 5/6							
			Composites		DMDR97-22		DMDR97-23		DMDR97-24		DMDR97-25	
					Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Pesticides												
Aldrin	ug/kg	<0.3	<0.3			<0.3		<0.3		<0.3		<0.3
Alpha-BHC	ug/kg	<0.3	<0.3			<0.3		<0.3		<0.3		<0.3
beta-BHC	ug/kg	<0.5	<0.6			<0.7		<0.6		<0.6		<0.6
gamma-BHC (LINDANE)	ug/kg	<0.3	<0.3			<0.3		<0.3		<0.3		<0.3
delta-BHC	ug/kg	0.7	0.5			<0.3		<0.3		<0.3		<0.3
alpha-Chlordane	ug/kg	<0.3	<0.3			<0.3		<0.3		<0.3		<0.3
gamma-Chlordane	ug/kg	<0.3	9.9			<0.3		12		<0.3		28
4,4'-DDD	ug/kg	<0.5	5			<0.7		5		<0.6		<0.6
4,4'-DDE	ug/kg	2	13			<0.7		<0.6		<0.6		<0.6
4,4'-DDT	ug/kg	<0.5	<0.6			<0.7		<0.6		8.7		<0.6
Dieldrin	ug/kg	<0.5	<0.6			<0.7		<0.6		<0.6		<0.6
Endosulfan I	ug/kg	<0.3	<0.3			13		7.7		<0.3		23
Endosulfan II	ug/kg	<0.5	5			<0.7		5		<0.6		<0.6
Endosulfan sulfate	ug/kg	<0.5	1			<0.7		1		<0.6		<0.6
Endrin	ug/kg	<0.5	<0.6			1		<0.6		<0.6		5
Endrin aldehyde	ug/kg	<0.5	<0.6			<0.7		<0.6		<0.6		<0.6
Endrin ketone	ug/kg	<0.5	<0.6			<0.7		<0.6		<0.6		<0.6
Heptachlor	ug/kg	<0.3	<0.3			<0.3		<0.3		<0.3		<0.3
Heptachlor epoxide	ug/kg	<0.3	<0.3			<0.3		<0.3		<0.3		<0.3
Methoxychlor	ug/kg	<3	<3			<3		<3		7.1		<3
Toxaphene	ug/kg	<30	<30			<30		<30		<30		<30
PCBs												
PCB-1016	ug/kg	<10	<20	<10		<20		<10		<10		<20
PCB-1221	ug/kg	<10	<20	<10		<20		<10		<10		<20
PCB-1232	ug/kg	<10	<20	<10		<20		<10		<10		<20
PCB-1242	ug/kg	<10	<20	<10		<20		<10		<10		<20
PCB-1248	ug/kg	<10	<20	<10		<20		<10		<10		<20
PCB-1254	ug/kg	<10	<20	<10		<20		<10		<10		<20
PCB-1260	ug/kg	<10	<20	<10		<20		<10		<10		<20
Total Detectable PCBs	ug/kg	0	0	0		0		0		0		0
Organotins												
Monobutyltin	ug/kg	<1										
Dibutyltin	ug/kg	<1										
Tributyltin	ug/kg	<2										
TRPH	mg/Kg	22										
Percent Solids	percent	76.5	64.2	75.4	61.4	61.5	67.2	69.8	75.9	70.3	71.4	65.5

Table 12. Summary of chemical concentrations (dry weight) in sediments by station and sampling location. (page 4 of 4).

Analyte	Units	Area 5/6				Area 9						Area 5	Area 6	Area 9
		DMDR97-26		DMDR97-27		DMDR97-28		DMDR97-29		DMDR97-30		Composites		
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom			
Pesticides														
Aldrin	ug/kg		<0.3		<0.3									
Alpha-BHC	ug/kg		<0.3		<0.3									
beta-BHC	ug/kg		<0.6		<0.6									
gamma-BHC (LINDANE)	ug/kg		<0.3		<0.3									
delta-BHC	ug/kg		<0.3		<0.3									
alpha-Chlordane	ug/kg		<0.3		<0.3									
gamma-Chlordane	ug/kg		6.5		<0.3									
4,4'-DDD	ug/kg		<0.6		<0.6									
4,4'-DDE	ug/kg		<0.6		53									
4,4'-DDT	ug/kg		<0.6		<0.6									
Dieldrin	ug/kg		<0.6		<0.6									
Endosulfan I	ug/kg		<0.3		<0.3									
Endosulfan II	ug/kg		<0.6		26									
Endosulfan sulfate	ug/kg		2		2									
Endrin	ug/kg		0.9		2									
Endrin aldehyde	ug/kg		<0.6		<0.6									
Endrin ketone	ug/kg		<0.6		<0.6									
Heptachlor	ug/kg		<0.3		<0.3									
Heptachlor epoxide	ug/kg		2		<0.3									
Methoxychlor	ug/kg		<3		<3									
Toxaphene	ug/kg		<30		<30									
PCBs														
PCB-1016	ug/kg		<10		<10									
PCB-1221	ug/kg		<10		<10									
PCB-1232	ug/kg		<10		<10									
PCB-1242	ug/kg		<10		<10									
PCB-1248	ug/kg		<10		<10									
PCB-1254	ug/kg		<10		<10									
PCB-1260	ug/kg		<10		<10									
Total Detectable PCBs	ug/kg		0		0									
Organotins														
Monobutyltin	ug/kg													
Dibutyltin	ug/kg													
Tributyltin	ug/kg													
TRPH	mg/Kg													
Percent Solids	percent	77.9	70.0	72.0	71.3	79.5	74.7	74.0	74.8	74.1	70.2	74.8	75.2	78.4

Lead concentrations ranged from 11.9 to 470 mg/kg in Areas 3, 4, and 5/6, which were one to two orders of magnitude higher than that at the LA-2 ODMDS reference location (6.5 mg/kg). The highest amount of metals contamination was found in Area 5, which was the bottom layer (-17 to -22 feet MLLW) of Area 5/6. The EPA did not require testing of lead at Area 9 or other metals given the relatively low concentrations detected at the test areas in October 1997 (Toxscan 1997).

Total detectable polynuclear aromatic hydrocarbon (PAH) concentrations ranged from 50 to 262 µg/kg in the proposed dredge sediments, which were two to three orders of magnitude higher than at the LA-2 ODMDS reference site that (0.6 µg/kg). The highest concentrations of PAHs were found at Area 5/6 with the greatest concentrations in the bottom layer (-17 to -22 feet MLLW). PAH concentrations were variable among cores. Concentrations were fairly uniform throughout the core length (top and bottom layers) of Stations 22 and 27, whereas, concentrations were lower (0 to 130 µg/kg) in the top layers (mudline to -17 feet MLLW) and higher (244 to 380 µg/kg) in the bottom layers (-17 to – 22 feet MLLW) of Stations 23, 24, 25, and 27.

Pesticide concentrations were one to two orders of magnitude higher in sediments from Area 3 and Area 5 (bottom layer) than the LA-2 ODMDS reference site. The highest pesticide contaminations occurred at Area 5. Total DDTs (4,4'-DDD, -DDE, -DDT) were not detected at Stations 22, 25 and 26 in Area 5, but were 5, 9, and 53 µg/kg at Stations 23, 24, and 27, respectively. Gamma-Chlordane ranged from non-detected to 28 µg/kg at Station 25. Total Endosulfans (Endosulfan 1, II, and Endosulfan sulfate) ranged from non-detected to 23 and 28 µg/kg at Stations 25 and 27, respectively. Endrin ranged from non-detected to 5 µg/kg at Station 25. Heptachlor epoxide was detected at 2 µg/kg at Station 26 and methoxychlor was detected at 7 µg/kg at Station 24.

Area 3 sediments had a gamma-Chlordane concentration of 10 µg/kg, total DDTs of 18 µg/kg, total Endosulfans of 6 µg/kg, and 0.5 µg/kg of delta-BHC. The EPA did not require further testing of pesticides in Areas 4, 6, and 9 based on review of the October 1997 data (Toxscan 1997).

No PCBs were detected in the proposed dredge sediments.

4.3 Bioassays

4.3.1 Suspended-Particulate Phase Tests

Results of the suspended-particulate phase (SSP) bioassays are summarized in Table 13. Copies of the complete MEC laboratory reports are presented in Appendix D. Survival was generally high in all SSP tests. Mortality was insufficient for calculation of LC50 values. IC50 values were > 100% for survival of bivalve larvae, fish, and mysids for most tests.

IC50 values were lower for fish survival at Area 5, which represents the bottom layer (- 17 to -22 feet MLLW) of sediments from Area 5/6, and were lower for development of bivalve larvae at Areas 5 and 3.

Mytilus edulis Bivalve Larvae Bioassay Results

Bivalve tests were run in two randomized blocks of samples with each run with a control. One control was tested against Areas 3, 4, and 5; the other control was run against Areas 6, 9, and the reference toxicant. The laboratory controls met the passing criterion of 70% survival of normally developed D-hinge larvae. Water quality met protocol requirements. Dissolved oxygen ranged from 6.6 to 8.3 mg/L, pH ranged from 7.8 to 8.2, ammonia ranged from 2.7 to 9.1 mg/L, temperature ranged from 15.0 to 16.5°C, and salinity ranged from 30 to 32 parts per thousand (ppt).

Survival ranged from 81 to 99% for elutriate concentrations of 1 to 50%. Survival was somewhat lower (77 to 92%) for the 100% elutriate test. IC50 values for survival and development were > 100%. IC50 values for % normal development ranged from 29 to 75%, with the lowest values for sediments from Areas 3 and 5.

The copper sulfate reference toxicant IC50 was 41.8 µg/L for survival and development. The IC50 for % normal development was 20.6 µg/L. The IC50 values were within two

Table 13. Summary of suspended particulate phase bioassay test results.

Sample ID	Conc. %	Bivalve Larvae – *Mytilus edulis*				Fish – *Atherinops affinis*		Mysid – *Mysidopsis bahia*	
		Average %		IC50 Survival and Development	IC50% Normal	Average % Survival	IC50 Survival	Average % Survival	IC50 Survival
		Survival	Normal						
Control	0	99.1	97.7	NA	NA	96.0	NA	98.0	NA
Area 3	1	95.2	96.2	>100%	29.8%	NA	>100%	NA	>100%
	10	87.7	97.3			98.0		100.0	
	50	92.5	0.0			96.0		96.0	
	100	78.0	0.0			80.0		96.0	
Area 4	1	89.1	96.3	>100%	74.7%	NA	>100%	NA	>100%
	10	98.6	95.8			96.0		98.0	
	50	99.1	97.4			98.0		98.0	
	100	91.9	0.0			98.0		98.0	
Area 5	1	94.9	96.2	>100%	29.5%	NA	87.1%	NA	>100%
	10	97.6	95.5			98.0		100.0	
	50	81.1	0.0			96.0		96.0	
	100	76.6	0.0			32.0		92.0	
Area 6*	1	97.1	96.8	>100%	74.7%	NA	>100%	NA	>100%
	10	97.6	97.7			98.0		94.0	
	50	94.8	96.1			100.0		100.0	
	100	79.6	0.0			98.0		96.0	
Area 9*	1	96.5	98.2	>100%	75.0%	NA	>100%	NA	>100%
	10	99.7	97.6			98.0		98.0	
	50	96.7	97.8			98.0		98.0	
	100	83.8	0.1			98.0		98.0	

Copper Sulfate Reference Toxicant

Conc. µg/L	Bivalve Larvae – *Mytilus edulis*				Fish – *Atherinops affinis*			Mysid – *Mysidopsis bahia*		
	Average %		IC50 Survival and Development	IC50 % Normal	Conc. µg/L	Average % Survival	IC50 Survival	Conc. µg/L	Average % Survival	EC50 Survival
	Survival	Normal								
Control	97.4	97.3	41.8 µg/L	20.6 µg/L	Control	90.0	176.8 µg/L	Control	100.0	337.1 µg/L
0.56	90.4	97.6			12.8	100.0		63	100.0	
3.2	97.2	97.4			25.5	100.0		125	95.0	
10	95.8	94.4			51	95.0		250	55.0	
32	79.0	0.0			102	85.0		500	30.0	
56	4.6	0.0			204	35.0		1000	20.0	

NA = not applicable.

* = The bivalve control for Area 6 and 9 tests was the same as that used for the reference toxicant (i.e. 97.4% survival and 97.3% normal).

standard deviations of the laboratory mean. These results indicate that the test organisms were normally sensitive for the development endpoint.

Atherinops affinis Fish Bioassay Results

Control survival met the minimum requirement of 90%. Water quality was generally within Green Book guidelines (USEPA/USCOE 1991). Dissolved oxygen ranged from 6.7 to 8.0 mg/L, pH ranged from 7.6 to 8.4, ammonia ranged from < 0.1 to 12.1 mg/L, temperature ranged from 19.5 to 20.4°C, and salinity ranged from 31 to 34 ppt. The range in salinity concentrations was slightly higher (2 ppt) than recommended (30 ± 2).

Survival in test elutriates ranged from 80 to 100% for all areas with the exception of Area 5. Survival was greater than 90% in the 10 and 50% elutriate test concentrations for Area 5, but was 32% in the 100% elutriate test. IC50 survival values were > 100% for all areas except Area 5, which was 87%.

The IC50 value for the copper sulfate reference toxicant was 176.8 µg/L, which is within two standard deviations of the laboratory mean. The results indicate that the test organisms were normally sensitive for the bioassay tests.

Mysidopsis bahia Mysid Bioassay Results

Control survival met the minimum requirement of 90%. Water quality was within Green Book guidelines (USEPA/USCOE 1991). Dissolved oxygen ranged from 6.6 to 7.8 mg/L, pH ranged from 7.8 to 8.4, ammonia ranged from 0.1 to 16.2 mg/L, temperature ranged from 18.8 to 20.5°C, and salinity ranged from 31 to 32 ppt. Survival in test elutriates ranged from 92 to 98% for the 100% concentration, and was higher for the lower concentration elutriates. IC50 survival values were > 100%.

The IC50 value for the copper sulfate reference toxicant was 337.1 µg/L, which is within two standard deviations of the laboratory mean. The results indicate that the test organisms were normally sensitive for the bioassay tests.

4.3.2 Solid Phase Tests

Results of the solid phase (SP) bioassays are summarized in Table 14. Copies of the complete MEC laboratory reports are presented in Appendix E. Survival was generally high for the mysid and polychaete worm tests. Significant mortality occurred in the amphipod tests. Amphipod mortality was highest for Area 5, which represents the bottom layer sediments (- 17 to -22 feet MLLW) of Area 5/6.

Ampelisca abdita Amphipod Bioassay Results

Water quality met Green Book requirements (USEPA/USCOE 1991). Dissolved oxygen ranged from 6.5 to 7.8 mg/L, pH ranged from 7.6 to 8.6, ammonia ranged from < 0.1 to 2.5 mg/L, temperature ranged from 18.5 to 20.9°C, and salinity ranged from 29 to 32 ppt. Sediment interstitial porewater had dissolved oxygen concentrations of 2.5 to 5.4 mg/L, pH of 7.0 to 8.3, ammonia of 1.1 to 18.6 mg/L, and salinity of 29.1 to 32.0 ppt. Porewater ammonia concentrations were relatively high in Area 5 sediments, but were below 10 mg/L in sediments from all other areas. The porewater ammonia in Area 5 sediments was 13.9 mg/L at the end of the test; values during the test were below the 20 mg/L requirement, but were slightly higher than the EPA recommended concentration of 12 mg/L.

The control met the passing criterion of > 90% survival. Survival in the LA-2 ODMDS reference sediments was 73%. Survival in the proposed dredge sediments ranged from 0 (Area 5) to about 50% (Areas 6 and 9). Area 6 represents the top layer of sediments (mudline to -17 feet MLLW) from Area 5/6. The mortality of amphipods was significantly ($p \leq 0.05$) and substantially (> 20% reduced) different than the control and reference samples, respectively.

The EC50 value for the cadmium chloride reference toxicant was 3.0 mg/L, which is within two standard deviations of the laboratory mean. The results indicate that the test organisms were normally sensitive for the bioassay tests.

Table 14. Summary of solid phase bioassay test results.

Sample ID	Amphipod – *Ampelisca abdita*			Mysid – *Mysidopsis bahia* Test I			Mysid – *Mysidopsis bahia* Test II			Polychaete Worm – *Neanthes arenacaodentata*		
	% Survival			% Survival			% Survival			% Survival		
Control	94.0			92.0			100.0			96.0		
Reference	73.0			77.0						100.0		
Area 3	24.0* +						95			94.0		
Area 4	36.0* +			81.0						100.0		
Area 5	0.0* +			85.0						98.0		
Area 6	54.0*						96.0			98.0		
Area 9	50.0* +			82.0						100.0		
Reference Toxicant	Cadmium Conc. (mg/L)	% Survival	EC50	Copper Chloride Conc. (µg/L)	% Survival	EC50	Copper Sulfate Conc. (µg/L)	% Survival	EC50	Cadmium Conc. (mg/L)	% Survival	EC50
	Control	100.0	3.0 mg/L	Control	90.0	190.9 µg/L	Control	100	268.3 µg/L	Control	100.0	10.6 mg/L
	0.25	100.0		62.5	90.0		62.5	90		3.8	100.0	
	0.5	96.6		125	80.0		125	90		7.5	100.0	
	1.0	76.7		250	20.0		250	80		15.0	0.0*	
	2.0	60.0		500	0.0		500	25		30.0	0.0*	
	4.0	26.7		1000	0.0		1000	0		60.0	0.0*	

* = *t* – test significantly different relative to control ($p \leq 0.05$).
\+ = survival > 20% reduced relative to reference.

Mysidopsis bahia Mysid Bioassay Results

Mysid tests were run in two randomized blocks of samples with each run with a control. The control sample for one block of samples (including reference and Areas 4, 5, and 9) met the passing criterion of 90% survival. Water quality parameters were within acceptable limits throughout the testing period. Dissolved oxygen ranged from 5.1 to 7.7 mg/L (70 to 105% saturation), pH ranged from 7.9 to 8.3, ammonia ranged from < 0.1 to 2.4 mg/L, temperature ranged from 19.3 to 20.8°C, and salinity ranged from 31.4 to 33.2 ppt. The range in salinity concentrations was slightly greater (1 ppt) than recommended (30 ± 2).

The control for the other block of samples (including Areas 3 and 6) originally did not meet the passing survivorship criterion, therefore, the test was repeated. The repeated bioassay met the 90% survivorship criterion for the control. Water quality parameters were within acceptable limits throughout the test, although the range in salinity was slightly greater (1 ppt) than recommended (30 ± 2).

Survival in the LA-2 ODMDS reference sediments was 77%. Survival in the proposed

dredge sediments ranged from 81 to 96%, which was not significantly or substantially different from the control or reference sediments.

The EC50 value for the copper chloride reference toxicant was 190.9 µg/L for the first test. The EC50 value for the copper sulfate reference toxicant was 268.3 µg/L for the second test. The reference toxicant values were within two standard deviations of the laboratory mean. These results indicate that the test organisms were normally sensitive for the bioassay tests.

Neanthes arenaceodentata Polychaete Worm Bioassay Results

The control met the passing criterion of > 90% survival. Water quality parameters were generally within acceptable limits throughout the testing period. Dissolved oxygen ranged from 4.5 to 7.6 mg/L (60 to 103% saturation), pH was 7.7 to 8.5, ammonia ranged from < 0.1 to 2.4 mg/L, temperature ranged from 19.3 to 21.2 °C, and salinity ranged from 31.1 to 33.3 ppt. The range in salinity concentrations was slightly greater (1 ppt) than recommended (30 ± 2). Sediment interstitial porewater ammonia concentrations ranged from 5.2 to 52.4 mg/L at the start of the test and ranged from 0.9 to 13.0 mg/L at the end of the test. The highest porewater ammonia concentrations at the end of the test were in sediments from Areas 5 and 6. The high survivorship of *Neanthes* in all tests indicate that water quality did not adversely affect the bioassays. Survival in the LA-2 ODMDS reference sediments was 100%. Survival in the proposed dredge sediments ranged from 94 to 100%.

The EC50 value for the cadmium chloride reference toxicant was 10.6 mg/L, which was within two standard deviations of the laboratory mean. The results indicate that the test organisms were normally sensitive for the bioassay tests.

4.3.3 Tissue Bioaccumulation Tests

Complete analytical reports of the 28-day tests and tissue chemistry data are presented in Appendices F.

Water quality parameters in the flow-through bioaccumulation tests reflect those of San Diego Bay seawater. Temperatures ranged from 14.8 to 16.2 °C, salinity ranged from 32.1 to 33.0 ppt, and dissolved oxygen concentrations ranged from 7.0 to 9.0 mg/L (87 to 111% saturation).

Control survival of *Macoma nasuta* was 97.3% and reference site survival was 98.0%. Survival of clams in proposed dredged sediments ranged from 94.7% to 100%. Control survival for *Nephtys caecoides* was 93.3% and reference survival was 98.4%. Survival of worms in proposed dredged sediments ranged from 81.9% to 96.0%.

4.4 Tissue Chemistry

Complete analytical reports of tissue chemistry data (wet and dry weight) are provided in Appendix G.

Macoma nasuta Clam Tissue Bioaccumulation Results

Measurable concentrations of arsenic, chromium, copper, lead, nickel, and zinc were detected in clam tissues (Table 15, wet weight). Cadmium, mercury, selenium, and silver generally were not detected; however, silver was detected in one or more replicates from the LA-2 reference site and proposed dredge Areas 3 and 9.

Mean arsenic concentrations in clam tissues from the test areas were of the same order of magnitude as that of the reference site; however, the mean concentration for Area 4 (2.82 mg/kg) was significantly greater than at the reference site (2.24 mg/kg). Mean lead concentrations were significantly higher in tissues from all test areas (range 0.8 to 1.9 mg/kg) relative to the reference site (0.4 mg/kg). Mean zinc concentrations in tissues from the test areas (range 28.8 to 37.8 mg/kg) were of the same order of magnitude, but concentrations from Areas 3, 6, and 9 (34.2 to 37.8 mg/kg) were significantly higher than that of the reference site (22.4 mg/kg).

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 1 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Metals (mg/kg)							
Arsenic	1	1.6	2.5	3.3	2.9	1.6	2.1
	2	2.2	2.7	2.2	3.1	1.9	1.6
	3	2.3	2.1	3	2.8	2.4	1.4
	4	2.4	1.8	3.2	1.9	1.9	1.6
	5	2.7	2.4	2.4	4.2	2.4	1.3
Cadmium	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	1	0.6	0.3	0.4	0.3	0.4	0.4
	2	0.3	0.9	0.3	0.4	0.4	0.4
	3	0.4	0.3	0.4	0.2	0.4	0.6
	4	0.3	0.4	0.3	0.6	0.5	0.5
	5	1.1	0.8	0.3	0.6	0.3	0.5
Copper	1	11	16	28	23	26	39
	2	49	51	42	19	29	54
	3	17	33	10	13	31	32
	4	21	41	14	11	41	15
	5	22	34	16	52	29	34
Lead	1	0.3	0.9	1.1	1.6	0.9	1.5
	2	0.5	1.7	0.8	1.9	3.5	1.4
	3	0.3	1	0.7	1	1.7	1.6
	4	0.5	1.4	0.8	1.9	2	2.9
	5	0.4	1	0.7	2.1	1.2	1.7
Mercury	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	1	0.9	1.2	2	1.1	1.1	1.4
	2	1.5	1.9	1.6	1.5	2.1	1.2
	3	1.8	1.6	1.3	1.4	1.3	1.5
	4	1.3	2.2	1.7	1.9	2.1	1.8
	5	1.9	1.9	1.7	2.2	1.7	1.5
Selenium	1	0.1	<0.5	<0.5	<0.5	<0.5	<0.5
	2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
	2	0.1	0.1	<0.1	<0.1	<0.1	<0.1
	3	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
	4	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	1	14	27	29	30	23	41
	2	22	50	27	37	46	34
	3	23	34	32	23	38	31
	4	19	40	31	24	34	34
	5	34	38	25	40	30	28

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 2 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Polynuclear Aromatic Hydrocarbons (PAHs) (µg/kg)							
Acenaphthene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Acenaphthylene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Anthracene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo (b)Fluoranthene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo (k)Fluoranthene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo(a)Anthracene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo(a)pyrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo(ghi)Perylene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Chrysene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Dibenzo(a,h)Anthracene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 3 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Fluoranthrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	25	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Fluorene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Indeno(1,2,3-cd)Pyrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Naphthalene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Phenanthrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Pyrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Pesticides (µg/kg)							
4,4-DDD	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
4,4-DDE	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
4,4-DDT	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Aldrin	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 4 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Alpha-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Beta-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Chlordane	1	<20	<20	<20	20	<20	<20
	2	<20	<20	<20	44	<20	<20
	3	<20	<20	<20	24	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	23	<20	<20
Delta-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Dieldrin	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endosulfan I	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endosulfan II	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endosulfan Sulfate	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endrin	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endrin Aldehyde	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 5 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Gamma-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Heptachlor	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Heptachlor Epoxide	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Methoxychlor	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Toxaphene	1	<25	<25	<25	<25	<25	<25
	2	<25	<25	<25	<25	<25	<25
	3	<25	<25	<25	<25	<25	<25
	4	<25	<25	<25	<25	<25	<25
	5	<25	<25	<25	<25	<25	<25
Polychlorinated biphenyls (PCBs) (µg/kg)							
Arochlor-1016	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1221	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1232	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1242	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1248	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 6 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Arochlor-1254	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1260	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Phenols (µg/kg)							
2,4,6-trichloroPhenol	1	<30	<30	<30	<30	<30	<30
	2	<30	<30	<30	<30	<30	<30
	3	<30	<30	<30	<30	<30	<30
	4	<30	<30	<30	<30	<30	<30
	5	<30	<30	<30	<30	<30	<30
2,4-dichloroPhenol	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
2,4-dimethylPhenol	1	<80	<80	<80	<80	<80	<80
	2	<80	<80	<80	<80	<80	<80
	3	<80	<80	<80	<80	<80	<80
	4	<80	<80	<80	<80	<80	<80
	5	<80	<80	<80	<80	<80	<80
2,4-dinitroPhenol	1	<100	<100	<100	<100	<100	<100
	2	<100	<100	<100	<100	<100	<100
	3	<100	<100	<100	<100	<100	<100
	4	<100	<100	<100	<100	<100	<100
	5	<100	<100	<100	<100	<100	<100
2-chloroPhenol	1	<25	<25	<25	<25	<25	<25
	2	<25	<25	<25	<25	<25	<25
	3	<25	<25	<25	<25	<25	<25
	4	<25	<25	<25	<25	<25	<25
	5	<25	<25	<25	<25	<25	<25
2-nitroPhenol	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
4,6-dinitro-2-methylPhenol	1	<50	<50	<50	<50	<50	<50
	2	<50	<50	<50	<50	<50	<50
	3	<50	<50	<50	<50	<50	<50
	4	<50	<50	<50	<50	<50	<50
	5	<50	<50	<50	<50	<50	<50
4-chloro-3-methylPhenol	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 7 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
4-nitroPhenol	1	<40	<40	<40	<40	<40	<40
	2	<40	<40	<40	<40	<40	<40
	3	<40	<40	<40	<40	<40	<40
	4	<40	<40	<40	<40	<40	<40
	5	<40	<40	<40	<40	<40	<40
PentachloroPhenol	1	<40	<40	<40	<40	<40	<40
	2	<40	<40	<40	<40	<40	<40
	3	<40	<40	<40	<40	<40	<40
	4	<40	<40	<40	<40	<40	<40
	5	<40	<40	<40	<40	<40	<40
Phenol	1	<30	<30	<30	<30	<30	<30
	2	<30	<30	<30	<30	<30	<30
	3	<30	<30	<30	<30	<30	<30
	4	<30	<30	<30	<30	<30	<30
	5	<30	<30	<30	<30	<30	<30
Phthalates (µg/kg)							
Bis(2-ethylhexyl)phthalate	1	59	155	236	89	130	144
	2	82	91	114	143	131	260
	3	71	111	207	80	153	129
	4	60	235	131	58	163	231
	5	73	176	102	84	241	204
Butyl benzylphthalate	1	<10	<10	17	<10	<10	19
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	17	<10	<10
	5	<10	<10	<10	25	<10	<10
Di-n-butylphthalate	1	71	56	255	81	59	93
	2	81	55	125	99	66	217
	3	78	72	86	42	90	91
	4	69	169	120	73	114	220
	5	85	163	62	99	170	165
Di-n-octylphthalate	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Diethylphthalate	1	<10	11	14	12	<10	15
	2	<10	<10	15	13	13	15
	3	11	<10	13	<10	<10	14
	4	<10	13	16	<10	15	37
	5	<10	19	<10	13	15	16
Dimethylphthalate	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Organotins (µg/kg)							
Dibutyltin	1	<1	<1	<1	<1	<1	<1
	2	<1	<1	<1	<1	<1	<1
	3	<1	<1	<1	<1	<1	<1
	4	<1	<1	<1	<1	<1	<1
	5	<1	<1	<1	<1	<1	<1

Table 15. Summary of bioaccumulation results (wet weight) for *Macoma nasuta* Clam Tissue. (Page 8 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Monobutyltin	1	<1	<1	<1	<1	<1	<1
	2	<1	<1	<1	<1	<1	<1
	3	<1	<1	<1	<1	<1	<1
	4	<1	<1	<1	<1	<1	<1
	5	<1	<1	<1	<1	<1	<1
Tetrabutyltin	1	<1	<1	<1	<1	<1	<1
	2	<1	<1	<1	<1	<1	<1
	3	<1	<1	<1	<1	<1	<1
	4	<1	<1	<1	<1	<1	<1
	5	<1	<1	<1	<1	<1	<1
Tributyltin	1	8.4	1.4	<1	<1	<1	<1
	2	1.4	1.6	<1	<1	<1	<1
	3	2.1	2.5	<1	<1	<1	<1
	4	1	1.2	<1	<1	<1	<1
	5	1.6	8.1	<1	<1	<1	<1

Mean concentrations of chromium, copper, and nickel in tissues from the test areas were not significantly different from those of the reference site. Mean concentrations of these constituents in test area and reference site tissues were, as follows: chromium (range 0.3 to 0.5 mg/kg), copper (range 22.0 to 34.8 mg/kg), and nickel (range 1.48 to 1.76 mg/kg). There was no significant difference in the mean concentration of silver in tissues from the test areas, where it was detected (0.06 and 0.08 mg/kg), and that of the reference site (0.06 mg/kg). Cadmium, mercury, and selenium were not detected in clam tissues exposed to proposed dredge sediment.

The only PAHs measured in clam tissues above detection limits were fluoranthrene and pyrene from replicate 2 of Area 5. The mean fluoranthrene (13.0 µg/kg) and pyrene (12 µg/kg) concentrations were below the detection limit (20 µg/kg). The mean concentrations of fluoranthrene at Area 5 were not significantly different from that of one-half the detection limits for the reference site (10.0 µg/kg).

The only pesticide measured in clam tissues above detection limits was chlordane in Area 5. Chlordane concentrations at Area 5 ranged from non-detected to 44.0 µg/kg. The mean concentration (24.2 µg/kg) was significantly higher than the mean of one-half of the detection limits at the reference site (10.0 µg/kg).

Tributyltin was the only detectable organotin in clam tissue. It was detected in tissues from Area 3 and the reference site. There was no significant difference in the mean concentration of tributyltin from Area 3 (3.0 µg/kg) and the reference site (2.9 µg/kg).

Phthalates were detected in clam tissues from all test areas and the reference site. Bis (2-ethylhexyl)phthalate and di-n-butylphthalate were found in the method blanks and are suspected laboratory contaminants; they are present in many plastic products such as laboratory gloves. Mean tissue concentrations of bis(2-ethylhexyl)phthalate in tissues from most test areas (except Area 5) (range 153.6 to 193.6 µg/kg) were significantly greater than that in tissues from the reference site (69.0 µg/kg). Butyl benzylphthalate was measured above detection limits in tissues from Areas 4, 5, and 9; however, the mean concentrations (range 7.4 to 11.4 µg/kg) were not significantly higher than one-half the

detection limits of the reference site (5.0 μg/kg). Di-n-butylphthalate was measured above detection limits in all test areas and the reference site. The mean concentration of di-n-butylphthalate was only significantly higher in tissues from Area 9 (157.2 μg/kg) relative to that of the reference site (76.8 μg/kg). Diethylphthalate was measured above detection limits in tissues from all test areas, and in tissues from one replicate from the reference site. Mean concentrations of diethylphthalate were significantly higher in Areas 4 and 9 (range 12.6 and 19.4 μg/kg) than at the reference site (6.2 μg/kg).

No PCBs or phenols were detected in clam tissue.

Nephtys caecoides Polychaete Bioaccumulation Results

Measurable concentrations of arsenic, cadmium, chromium, copper, lead, nickel, and zinc were detected in worm tissues (Table 16, wet weight). Mercury, selenium, and silver generally were not detected; however, selenium was detected in one or more replicates from the LA-2 reference site and test Areas 4 and 5.

Mean concentrations of arsenic in tissues exposed to test sediments were of the same order of magnitude (range 1.6 to 2.3 mg/kg) as that of the LA-2 reference site (1.8 mg/kg); however, the mean concentration was significantly higher in tissues from Area 9 (2.3 mg/kg). Mean copper concentrations in tissues from the test areas were of the same order of magnitude as that of the reference site; however, concentrations were significantly higher at Areas 3, 4, 6, and 9 (range 2.6 to 4.9 mg/kg) than that of the reference site (1.9 mg/kg). Mean concentrations of zinc in tissues from the test areas (range 35.8 to 72.4 mg/kg) were of the same order of magnitude; however, all test areas except Area 5 had significantly higher concentrations than that of the reference site (28.4 mg/kg).

Mean concentrations of cadmium, chromium, lead, nickel, and selenium in tissues from the test areas were not significantly different from mean concentrations in tissues from the reference site. Mean concentrations in worm tissues from the test areas were, as follows: cadmium (0.16 to 0.26 mg/kg), chromium (0.22 to 0.54 mg/kg), lead (0.06 to 0.17 mg/kg), nickel (0.58 to 1.0 mg/kg), and selenium (0.2 to 0.3 mg/kg). Mercury and silver

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 1 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Metals (mg/kg)							
Arsenic	1	1.6	1.4	1.8	1.7	2.5	2.3
	2	1.9	1.8	1.8	1.5	3	1.9
	3	2	1.5	1.7	1.7	1.5	2.5
	4	1.6	1.5	1.8	1.4	1.6	2.5
	5	2	1.7	1.9	3.7	2.7	2.3
Cadmium	1	0.2	0.2	0.2	0.2	0.2	0.2
	2	0.2	0.2	0.2	0.3	0.2	0.1
	3	0.3	0.5	0.2	0.2	0.2	0.2
	4	0.2	0.2	0.2	0.2	0.2	0.1
	5	0.2	0.2	0.2	0.2	0.2	0.2
Chromium	1	0.2	0.2	0.2	0.5	0.9	0.2
	2	0.3	0.2	0.3	0.2	0.2	0.2
	3	0.3	0.3	0.2	0.2	0.2	0.1
	4	0.3	0.2	0.2	0.2	0.1	0.1
	5	0.2	0.2	0.2	1	1.3	0.2
Copper	1	1.5	3.4	2.9	2.2	5.5	4.4
	2	1.6	4	2.8	2.3	4.9	4.6
	3	2.3	3.8	2.1	2.9	3.7	5.4
	4	2.1	4.2	2.7	2.2	4.1	3.5
	5	2	3.5	2.7	4.8	6.1	4.2
Lead	1	0.2	0.2	<0.1	0.2	0.2	0.2
	2	0.2	0.1	0.1	0.1	0.2	<0.1
	3	<0.1	<0.1	<0.1	<0.1	0.2	0.2
	4	0.1	<0.1	<0.1	0.2	0.1	0.1
	5	<0.1	<0.1	<0.1	0.3	0.1	<0.1
Mercury	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	1	0.4	0.5	0.6	0.6	1.1	1
	2	0.7	0.6	0.5	0.9	1.4	1.1
	3	0.6	<0.1	0.6	0.8	0.5	0.6
	4	0.6	0.8	0.5	0.4	0.5	0.8
	5	0.8	1	0.7	1.3	1.5	0.8
Selenium	1	<0.1	<0.1	0.5	<0.1	<0.5	<0.5
	2	<0.1	0.3	0.3	<0.1	<0.5	<0.5
	3	<1	<0.1	0.2	0.2	<0.5	<0.5
	4	0.2	0.3	<0.1	0.3	<0.5	<0.5
	5	<0.1	0.6	0.4	<0.5	<0.5	<0.5
Silver	1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.5
	2	<0.1	<0.1	<0.1	<0.1	<0.5	<0.5
	3	<0.1	<0.1	<0.1	<0.1	<0.5	<0.5
	4	<0.1	<0.1	<0.1	<0.1	<0.5	<0.5
	5	<0.1	<0.1	<0.1	<0.5	<0.5	<0.5
Zinc	1	25	36	35	39	87	69
	2	20	36	34	39	78	70
	3	30	36	36	38	67	66
	4	35	38	39	37	65	65
	5	32	39	35	88	65	61

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 2 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Polynuclear Aromatic Hydrocarbons (PAHs) (µg/kg)							
Acenaphthene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Acenaphthylene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Anthracene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo (b)Fluoranthene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo (k)Fluoranthene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo(a)Anthracene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo(a)pyrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Benzo(ghi)Perylene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Chrysene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	35	<20	<20
	3	<20	<20	<20	36	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Dibenzo(a,h)Anthracene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 3 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Fluoranthrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	27	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	22	26	<20	<20
Fluorene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Indeno(1,2,3-cd)Pyrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Naphthalene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Phenanthrene	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Pyrene	1	<20	<20	<20	34	46	30
	2	<20	<20	24	37	43	29
	3	<20	<20	<20	43	29	31
	4	<20	<20	28	31	29	28
	5	<20	25	25	55	27	37
Pesticides (µg/kg)							
4,4-DDD	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
4,4-DDE	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
4,4-DDT	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Aldrin	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 4 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Alpha-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Beta-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Chlordane	1	<20	<20	<20	71	61	96
	2	<20	<20	<20	71	60	106
	3	<20	<20	<20	106	30	114
	4	<20	<20	<20	92	78	39
	5	<20	<20	<20	136	<20	118
Delta-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Dieldrin	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endosulfan I	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endosulfan II	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endosulfan Sulfate	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endrin	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Endrin Aldehyde	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 5 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Gamma-BHC	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Heptachlor	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Heptachlor Epoxide	1	<2	<2	<2	<2	<2	<2
	2	<2	<2	<2	<2	<2	<2
	3	<2	<2	<2	<2	<2	<2
	4	<2	<2	<2	<2	<2	<2
	5	<2	<2	<2	<2	<2	<2
Methoxychlor	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
Toxaphene	1	<25	<25	<25	<25	<25	<25
	2	<25	<25	<25	<25	<25	<25
	3	<25	<25	<25	<25	<25	<25
	4	<25	<25	<25	<25	<25	<25
	5	<25	<25	<25	<25	<25	<25
Polychlorinated biphenyls (PCBs) (µg/kg)							
Arochlor-1016	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1221	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1232	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1242	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1248	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 6 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Arochlor-1254	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Arochlor-1260	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Phenols (µg/kg)							
2,4,6-trichloroPhenol	1	<30	<30	<30	<30	<30	<30
	2	<30	<30	<30	<30	<30	<30
	3	<30	<30	<30	<30	<30	<30
	4	<30	<30	<30	<30	<30	<30
	5	<30	<30	<30	<30	<30	<30
2,4-dichloroPhenol	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
2,4-dimethylPhenol	1	<80	<80	<80	<80	<80	<80
	2	<80	<80	<80	<80	<80	<80
	3	<80	<80	<80	<80	<80	<80
	4	<80	<80	<80	<80	<80	<80
	5	<80	<80	<80	<80	<80	<80
2,4-dinitroPhenol	1	<100	<100	<100	<100	<100	<100
	2	<100	<100	<100	<100	<100	<100
	3	<100	<100	<100	<100	<100	<100
	4	<100	<100	<100	<100	<100	<100
	5	<100	<100	<100	<100	<100	<100
2-chloroPhenol	1	<25	<25	<25	<25	<25	<25
	2	<25	<25	<25	<25	<25	<25
	3	<25	<25	<25	<25	<25	<25
	4	<25	<25	<25	<25	<25	<25
	5	<25	<25	<25	<25	<25	<25
2-nitroPhenol	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20
4,6-dinitro-2-methylPhenol	1	<50	<50	<50	<50	<50	<50
	2	<50	<50	<50	<50	<50	<50
	3	<50	<50	<50	<50	<50	<50
	4	<50	<50	<50	<50	<50	<50
	5	<50	<50	<50	<50	<50	<50
4-chloro-3-methylPhenol	1	<20	<20	<20	<20	<20	<20
	2	<20	<20	<20	<20	<20	<20
	3	<20	<20	<20	<20	<20	<20
	4	<20	<20	<20	<20	<20	<20
	5	<20	<20	<20	<20	<20	<20

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 7 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
4-nitroPhenol	1	<40	<40	<40	<40	<40	<40
	2	<40	<40	<40	<40	<40	<40
	3	<40	<40	<40	<40	<40	<40
	4	<40	<40	<40	<40	<40	<40
	5	<40	<40	<40	<40	<40	<40
PentachloroPhenol	1	<40	<40	<40	<40	<40	<40
	2	<40	<40	<40	<40	<40	<40
	3	<40	<40	<40	<40	<40	<40
	4	<40	<40	<40	<40	<40	<40
	5	<40	<40	<40	<40	<40	<40
Phenol	1	<30	<30	<30	<30	<30	<30
	2	<30	<30	<30	<30	<30	<30
	3	<30	<30	<30	<30	<30	<30
	4	<30	<30	<30	<30	<30	<30
	5	<30	<30	<30	<30	<30	<30
Phthalates (µg/kg)							
Bis(2-ethylhexyl)phthalate	1	102	57	108	254	170	127
	2	85	69	82	148	1289	128
	3	40	170	120	278	152	<10
	4	62	112	72	90	131	107
	5	79	115	102	129	176	355
Butyl benzylphthalate	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	23	117
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Di-n-butylphthalate	1	88	47	106	219	115	98
	2	70	52	63	98	113	100
	3	80	43	82	272	127	15
	4	59	57	59	64	96	105
	5	83	51	89	60	145	313
Di-n-octylphthalate	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Diethylphthalate	1	16	19	15	17	13	18
	2	<10	13	<10	16	17	17
	3	10	16	12	16	15	<10
	4	<10	11	16	14	18	14
	5	12	<10	21	12	23	31
Dimethylphthalate	1	<10	<10	<10	<10	<10	<10
	2	<10	<10	<10	<10	<10	<10
	3	<10	<10	<10	<10	<10	<10
	4	<10	<10	<10	<10	<10	<10
	5	<10	<10	<10	<10	<10	<10
Organotins (µg/kg)							
Dibutyltin	1	<1	<1	<1	1.8	<1	<1
	2	<1	<1	<1	1	<1	<1
	3	<1	<1	<1	<1	<1	<1
	4	<1	<2	<1	<1	<1	<1
	5	<1	<1	2.2	<1	<1	<1

Table 16. Summary of bioaccumulation results (wet weight) for *Nephtys caecoides* Worm Tissue. (Page 8 of 8)

Analyte	Replicate	Reference	Area 3	Area 4	Area 5	Area 6	Area 9
Monobutyltin	1	<1	<1	<1	<1	<1	<1
	2	<1	<1	<1	<1	<1	<1
	3	<1	<1	<1	<1	<1	<1
	4	<1	<2	<1	<1	<1	<1
	5	<1	<1	<1	<1	<1	<1
Tetrabutyltin	1	<1	<1	<1	<1	<1	<1
	2	<1	<1	<1	<1	<1	<1
	3	<1	<1	<1	<1	<1	<1
	4	<1	<2	<1	<1	<1	<1
	5	<1	<1	<1	<1	<1	<1
Tributyltin	1	3.2	1.4	2.7	60	2.6	2.3
	2	<1	1.6	2.3	7.9	<1	3.6
	3	1.6	2.7	3.1	11	2.1	<1
	4	1.5	2.3	2.2	16	3.8	11
	5	1.9	2	72	1.1	2	2.5

were not detected in worm tissues.

PAHs measured above detection limits in worm tissues included chrysene, fluoranthrene and pyrene. Chrysene was measured slightly above detection limits in two of the tissue replicates from Area 5. The mean concentration of chrysene from Area 5 (20.2 µg/kg) was not significantly different from one-half the detection limits at the reference site (10.0 µg/kg). Fluoranthrene was measured slightly above detection limits in tissues from one of the five replicates at both Areas 4 and 5. The mean concentrations of fluoranthrene (range 12.4 and 16.6 µg/kg) were not significantly different from one-half the detection limits at the reference site (10.0 µg/kg). Pyrene was detected in most worm tissue replicates from Areas 3, 4, 5, 6, and 9. Mean pyrene concentrations were not significantly higher in tissues from Area 3 (13.0 µg/kg) than that of one-half the detection limits of the reference site (10.0 µg/kg); however, mean concentrations were significantly higher in tissues from the other test areas (range 19.4 to 40.0 µg/kg).

Similar to clam tissue, the only pesticide measured in worm tissue above detection limits was chlordane. Mean concentrations in tissues from Areas 5, 6, and 9 (range 47.8 to 95.2 µg/kg) were significantly higher than the mean of one-half of the detection limits at the reference site (10.0 µg/kg).

Dibutyltin was measured above detection limits in one or more tissue replicates in test Areas 4 and 5, and tributyltin was detected in tissues from most replicates from all areas including the reference site. Mean concentrations of dibutyltin in tissues from Areas 4 and 5 (range 0.8 to 0.9 µg/kg) were not significantly different from one-half the detection limits at the reference site (0.5 µg/kg). Mean concentrations of tributyltin in tissues from the test areas (range 2.0 to 19.2 µg/kg) were not significantly different from that at the reference site (1.7 µg/kg). Although concentrations in tissues from Areas 4 and 5 were substantially higher in some replicates, there was considerable variation in concentrations among the replicates.

Similar to clam tissue, phthalates were detected in worm tissues from all test areas and the reference site. Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were found in the

method blanks and were suspected laboratory contaminants; they are present in many plastic products such as laboratory gloves. The mean concentration of bis(2-ethylhexyl)phthalate in tissues from Area 5 (179.8 µg/kg) was significantly higher than that in tissues from the reference site (73.6 µg/kg). Butyl benzylphthalate was measured above detection limits in tissues from Areas 6 and 9 and their mean concentrations (8.6 and 27.4 µg/kg) were not significantly different from one-half the detection limits of the reference site (5.0 µg/kg). Di-n-butyphthalate was measured above detection limits in all test areas and the reference site. The mean concentration of di-n-butyphthalate was only significantly higher in tissues from Area 6 (119.2 µg/kg) relative to that of the reference site (76.0 µg/kg). Diethylphthalate was measured above detection limits in most tissue replicates from all test areas and the reference site. The only test areas with a significantly higher mean concentration of diethylphthalate than the reference site (9.6 µg/kg) was Areas 5 and 6 (15.0 and 17.2 µg/kg).

No PCBs or phenols were detected in worm tissues.

5.0 QUALITY ASSURANCE/QUALITY CONTROL SUMMARY

5.1 Sediment Chemistry

Laboratory results of sediment chemistry analyses are presented in Appendix C. All target detection limits were met or exceeded. The target detection limit for PCBs (0.001 mg/kg, 1 µg/kg) given in the SAP was in error. The laboratory met the required detection limit of 0.01 mg/kg (10 µg/kg). All method blanks, surrogate recoveries, and matrix spike recoveries were within acceptable ranges with the following exceptions.

Two sets of matrix spike/matrix spike duplicate samples were prepared and analyzed with the sample batch. For one pair of matrix spike/matrix spike duplicate samples recoveries were outside control limits for several PAH compounds. The percent recoveries were biased low for this set of matrix spike/matrix spike duplicate samples. Because the second matrix spike/matrix spike duplicate quality assurance sample set prepared with the sample batch demonstrated acceptable recovery within control limits, and all other quality control

tests were within control limits, the samples batch was accepted. All surrogate recoveries of PAHs in the proposed dredge area and reference samples were within quality control limits.

Organotin matrix spike recoveries were outside control limits for monobutyltin, but were within acceptable limits for dibutyltin and tributyltin. Recovery of monobutyltin is extremely poor by this method in comparison to other butyltin compounds. Organotins were only analyzed as part of the full suite of analyses required for the reference sediments and none were detected in those sediments.

Matrix interferences resulted in recoveries outside control limits for three pesticides, aldrin, 4,4'-DDT, and dieldrin. The detected concentrations were greater than the spiked amount due to matrix interferences. This should not affect the quality of the data for the test sediments. Surrogate recoveries of pesticides were within control limits with the exception of decachlorobiphenyl at Station 22 (bottom layer), Station 25 (bottom layer), and Station 27 (bottom layer).

Bis(2-ethylhexyl)phthalate was detected in the procedural method blank at a level above the detection limit. Phthalates are common laboratory contaminants.

5.2 Bioassay Tests

Laboratory results for suspended-particulate phase, solid phase, and bioaccumulation bioassays are presented in Appendices D, E, and F.

All tests were initiated within one week of sample collection. Sediments were handled, elutriates were prepared, and tests were conducted according to stated protocols with the exception of the following minor deviations.

Water quality readings were within acceptable ranges for all tests with the exception of minor deviations to salinity for some tests. Salinities were up to 2 ppt outside of the recommended ranges (30 ± 2) in the suspended particulate phase bioassay with *Atherinops*

affinis, but did not appear to affect the health of the fish because the control results were normal and there was high survival in the elutriate tests. Similarly, the slightly higher (1 ppt) salinities in the solid phase bioassays with *Mysidopsis bahia* and *Neanthes arenaceodentata* did not affect the health of the organisms because control results were normal and there was high survival in the proposed dredge sediment tests. Salinity excursions of this low magnitude (1 to 2 ppt) are not uncommon due to evaporation of test solutions over time.

Slightly higher than recommended porewater ammonia concentrations were recorded in the solid phase bioassay tests with *Ampelisca abdita*. The final porewater concentrations were below the test requirement (20 mg/L), but exceeded the EPA recommended concentration (12 mg/L) in some of the tests. Ammonia concentrations in overlying water were substantially below 12 mg/L. It is not known to what extent the elevated ammonia concentrations contributed to the mortality of *Ampelisca*. The highest mortality of the amphipod was observed in tests with the highest porewater ammonia concentrations.

Porewater dissolved oxygen for the *Ampelisca* solid phase tests (2.5 to 5.4 mg/L) was somewhat reduced possibly as a result of a high level of aerobic activity (i.e., high BOD) associated with the relatively high amounts of organic debris in the sediments. This probably did not affect *Ampelisca*'s survival to a great extent, however, because this tube-dwelling amphipod is exposed more to overlying water than porewater.

Results of the reference toxicant bioassays were within two standard deviations of the laboratory means; thus, organisms were appropriately sensitive for the bioassay tests.

5.2.1 Tissue Bioaccumulation Chemistry

Laboratory results of tissue chemistry analyses are presented in Appendix G. All detection limits, method blanks, laboratory control samples, and matrix spike recoveries were within acceptable ranges with the following exceptions.

Detection limits for some metals (As, Cu, Ni, Se, Zn) were slightly elevated for some

samples due to sample matrix effects. This did not affect results for most since the detected values exceeded detection limits. Furthermore, quality control analyses were within acceptable control limit criteria.

Several phthalate compounds were detected in the procedural method blank at levels above the detection limits. These compounds, bis(2-ethylhexyl)phthalate and di-n-butylphthalate are common laboratory contaminants. Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were also detected in several of the samples and should be considered possible laboratory introduced contamination.

Several laboratory control sample recoveries were outside control limits for nickel and zinc. A second laboratory control sample was analyzed with the sample batch and found to be within control limits. Additionally, the matrix spike recoveries associated with the same sample batch were found to be within acceptable control limit criteria.

Matrix spike recoveries were outside control limits for two of the six matrix spikes performed with the samples for lead. The matrix spikes were run in duplicate and the duplicate analysis was within control limits; additionally, the laboratory control sample was within control limits. The analytical results of the lead were accepted because the laboratory control samples, matrix spike duplicates, and all other quality control tests were within control limits.

Matrix spike recoveries were outside control limits for arsenic. A repeat analysis of the matrix spike demonstrated that the sample matrix was influencing the recoveries of spiked analytes. Laboratory control samples associated with the sample batch were within control limits. Laboratory control samples were prepared and analyzed in duplicate and used to demonstrate batch method control, precision, and accuracy.

Matrix spike recoveries were outside control limits for one matrix spike sample for silver. The analytical results of the silver were accepted because the laboratory control samples, matrix spike duplicates, and all other quality control tests were within control limits.

Matrix spike recoveries were outside control limits for chromium. A repeat analysis of the matrix spike demonstrated that the sample matrix was influencing the recoveries of spiked analytes. Laboratory control samples associated with the sample batch were within control limits. Laboratory control samples were prepared and analyzed in duplicate and used to demonstrate batch method control, precision, and accuracy.

Organotin laboratory control sample recoveries were outside control limits for monobutyltin, but were within acceptable limits for dibutyltin, tetrabutyltin, and tributyltin. Recovery of monobutyltin is typically poor by this method in comparison to other butyltin compounds; however, results for the laboratory control samples were biased on the high end. Monobutyltin was not detected in the tissues, however, tributyltin and dibutyltin were found in tissue samples. All quality control criteria were within established limits for tributyltin and dibutyltin.

6.0 DISCUSSION

6.1 Sediment Chemistry

Sediment chemistry data (dry weight) indicated elevations of several contaminants in proposed dredge sediments relative to LA-2 reference sediments.

MEC's results for lead (December 1997) were of similar magnitude as previous concentrations (October 1997) reported by Toxscan (1997); i.e., 12 to 440 mg/kg and 71 to 230 mg/kg, respectively.

Other contaminant concentrations were lower in December 1997 than reported by Toxscan (1997). Total detectable PAHs were an order of magnitude lower (50 to 380 µg/kg) in December than in October (1700 to 5900 µg/kg). Pesticide concentrations also were lower in December than October. In December, the highest concentrations ranged up to 28 µg/kg gamma-chlordane, 5µg/kg 4,4'-DDD, 53 µg/kg 4,4'-DDE, 9µg/kg 4,4'-DDT, and 13 µg/kg endosulfan 1. In October, concentrations from the same sampling locations ranged up to 82 µg/kg gamma-chlordane, 83 µg/kg 4,4'-DDD, 88 µg/kg 4,4'-

DDE, and 23 µg/kg 4,4'-DDT (endosulfans were not measured).

Methods and detection limits were similar among the two studies. There was a difference, however, in core depths. Toxscan (1997) tested sediments from the mudline to –24 to –25.5 feet MLLW in most areas; whereas, core depths were from the mudline to –17 or –22 feet MLLW in the present study. The highest contaminant concentrations in the present study were associated with bottom layer (-17 to –22 MLLW) sediments in Area 5.

6.2 Suspended-Particulate Phase Bioassays

All suspended-particulate phase tests on *Mytilus edulis*, *Atherinops affinis*, and *Mysidopsis bahia* had passing control criteria as specified in the Green Book (USEPA/USCOE 1991). Mortality was not sufficient for calculation of LC50 values; thus, acute lethal toxicity is not expected across a broad taxonomic range. Sublethal IC50 survival values were > 100% for most samples, but were 87% for bottom layer sediments (-17 to -22 feet MLLW) in Area 5/6. Sublethal IC50 values were (29 to 75%) for bivalve development, with the lowest values for Areas 3 and 5. These results prompted calculation of the Limiting Permissable Concentration (LPC), which was not exceeded for proposed dredged material from Marina del Rey for the LA-2 Ocean Dredged Material Disposal Site (Table 17).

6.3 Solid Phase Bioassays

All tests on *Ampelisca abdita*, *Mysidopsis bahia*, and *Neanthes arenaceodentata* had passing control criteria as specified in the Green Book (USEPA/USCOE 1991). Significant mortality relative to the control and substantial mortality relative to the LA-2 reference sediments occurred to amphipods (*Ampelisca abdita*) from exposure to the proposed dredge materials. Many of the field collected sediments had a high hydrogen sulfide content and organic debris. These confounding factors were minimized in the laboratory through aeration and water exchanges, as appropriate. Nevertheless, sediment from Area 5 showed the highest porewater ammonia levels throughout the test and the lowest amphipod survival. The high porewater ammonia in proposed dredged sediments

Table 17. Calculation of Limiting Permissable Concentration

Site: **Marina del Rey**
Species: ***Mytilus edulis***
Disposal Site: **LA 2**

Mixing Zone Estimation	**Area 5**
Depth of disposal site (m)=	164
Pi=	3.14159
Width of vessel (m)=	12
Length of vessel(m)=	40
Speed of vessel (m/sec)=	0.5
Time of discharge (sec)=	30
Depth of vessel (m)=	5
Mixing Zone Volume(cu.m)=	7458052

Volume of Liquid Phase	
Bulk density (constant) =	1.3
Particle density (constant) =	2.6
Density of liquid phase (constant) =	1
Vol of disposal vessel (cu.m)=	2400
Liquid phase volume (cu.m)=	1950

Concentration of suspended phase	
Percent Silt=	13.4
Percent Clay=	7.0
Volume of Suspended Phase (cu.m)=	91

Projected Concentration (percent SP) =	0.0012
Lowest LC50 or EC50 from bioassay=	29.5
Factor LC50 or EC 50 X 0.01=	0.295

The factored LC50 or EC50 is higher than the projected concentration; therefore the Limiting Permissible Concentration is not exceeded for dredged material from Marina del Rey for the disposal site specified (LA 2).

could be related to continuing aerobic degradation of organic material in the sediment. It is not known to what extent poor quality organic material may have adversely affected the detritus-feeding amphipods.

No significant mortality occurred to the mysids or polychaete worms.

6.4 Tissue Bioaccumulation

Several chemical constituents were found to be significantly elevated in clam and worm tissues exposed to Marina del Rey test sediments as compared to tissues exposed to LA-2 reference site sediments. The accumulation factors in organisms exposed to test area sediments relative to that of the reference site are summarized in Table 18.

Metals accumulation generally was similar to slightly greater (1.2 to 2.6 times) in clams and worms exposed to test sediments as compared to reference sediments. Lead accumulation was 2.0 to 4.6 times greater in clams exposed to test sediments as compared to reference sediments. There was no significant difference in lead accumulation in worms exposed to test and reference sediments. No FDA action levels have been established for lead.

The polynuclear aromatic hydrocarbon pyrene accumulated in worm tissues exposed to test sediments at levels that were elevated (1.9 to 4.0 times) relative to one-half the detection limits of reference sediment tissues, for all test areas except Area 3. Pyrene was not found to significantly accumlate in clam tissuses. No FDA action levels have been established for pyrene.

The pesticide chlordane accumulated in clams exposed to test sediments from Area 5 at a level that was 2.4 times greater than that in the reference sediments. Accumulation levels were 4.8 to 9.5 times greater in worms exposed to test sediments from Areas 5, 6, and 9 as compared to one-half the detection limits for the reference sediment tissues. All mean tissue concentrations in clams and worms exposed to test area sediments (range < 20 to 94.6 µg/kg, <0.02 to 0.09 mg/kg or ppm) were below the FDA action level (0.3 ppm).

Table 18. Summary of accumulation factors (test area/reference) for chemical constituents that were of significantly higher concentration in tissues exposed to test sediments than in tissues exposed to reference site sediments.

Macoma nasuta clam tissue

Analyte	Area 3	Area 4	Area 5	Area 6	Area 9
Arsenic		1.3			
Lead	3.0	2.0	4.2	4.6	4.5
Zinc	1.7			1.5	1.5
Chlordane			2.4[1,3]		
Bis(2-ethylhexyl) Phthalate	2.2	2.3		2.4	2.8
Di-n-butyl Phthalate					2.0
Diethylphthalate					3.1[2]

Nephtys caecoides worm tissue

Analyte	Area 3	Area 4	Area 5	Area 6	Area 9
Arsenic					1.3
Copper	2.0	1.4		2.6	2.3
Nickel					1.4
Zinc	1.3	1.4		2.6	2.3
Pyrene		1.9[1,3]	4.0[1,3]	3.5[1]	3.1[1]
Chlordane			9.5[1]	4.8[1,3]	9.5[1]
Bis(2-ethylhexyl) Phthalate			2.4		
Di-n-butyl Phthalate				1.6	
Diethylphthalate			1.6[2]	1.8[2]	

[1] All values used in the computation of the mean for the reference area were non-detectable.

[2] All values used in the computation of the mean for the reference area were a combination of detected and non-detectable values.

[3] All values used in the computation of the mean for the test area were a combination of detected and non-detectable values.

Several phthalates accumulated at greater levels (1.6 to 3.1 times) in clams and worms exposed to sediments from several of the test areas than those exposed to reference sediments. Phthalates are common laboratory introduced contaminants.

6.5 Summary

- Lead was the only metal of concern for further testing in sediment samples. Lead concentrations were one to two orders of magnitude higher in proposed dredge sediments from Marina del Rey than in reference sediments. Lead accumulation was 2 to 4.6 times greater in clam tissues exposed to test sediments as compared to those exposed to reference sediments. There was no significant difference in the accumulation of lead in worms exposed to test and reference sediments. Other metals that had significantly higher concentrations in clam and/or worm tissues included arsenic, copper, nickel, and zinc; accumulation factors were 1.3 to 2.6 times higher in animals exposed to test sediments as compared to those exposed to reference sediments.

- Pesticides were one to two orders of magnitude higher in sediments from Areas 3 and 5 than from the reference site. Detectable pesticides included DDTs (4,4'-DDD, -DDE, -DDT), gamma-chlordane, endosulfans (endosulfan I, II, and endosulfan sulfate), endrin, heptachlor epoxide, and methoxychlor. Pesticides were not required by EPA to be tested in sediments from Areas 4, 6, and 9 based on relatively low levels detected in previous testing. Chlordane was the only pesticide that had significantly higher concentrations in organisms exposed to test sediments as compared to those exposed to reference sediments. There was no significant difference in the accumulation of chlordane in clams or worms exposed to test sediments from Area 3. Accumulation was 2.4 times greater for clams and 9.5 times greater for worms exposed to sediments from Area 5 as compared to one-half the detection limits of reference sediment tissues. The accumulation of chlordane also was greater (4.8 and 9.5 times) in worms exposed to sediments from Areas 6 and 9, respectively, as compared to one-half the detection limits of reference sediment tissues. Tissue chlordane concentrations was an order of

magnitude lower than the FDA action level of 0.3 ppm.

- Concentrations of total detectable PAHs were two to three orders of magnitude higher in proposed dredge sediments as compared to the reference sediments. Pyrene was the only PAH that had significantly higher concentrations (1.9 to 4.0 times) in worms exposed to test sediments as compared to one-half the detection limits of reference sediment tissues. There was no significant difference in the accumulation of pyrene in clams exposed to test and reference sediments.

- No PCBs were detected in any of the proposed dredge sediments nor in the clams or worms exposed to those sediments.

- Phthalates accumulated to a greater extent (1.6 to 3.1 times) in clams and worms exposed to test sediments than to those exposed to reference sediments. Several phthalates were detected in the method blanks and are suspected laboratory contaminants.

- All IC50 values were > 100% for the suspended particulate phase bioassay tests on bivalves, fish, and mysids with the exception of the IC50 value obtained for fish survival for Area 5 (87.1%), and the IC50 values for % normal development of bivalve larvae (29 to 75%). The lowest IC50 value from the bivalve test was used for comparison with the Limiting Permissible Concentration (LPC) for the reference site. Based on this comparison, the LPC value was not exceeded for disposal of dredged material from Marina del Rey at the LA-2 reference site.

- Survival was high (81 to 100%) in 10-day solid phase tests for mysids and worms. Significant mortality occurred in the amphipod tests with survival ranging from 0 to 54%.

- Survival was high (82 to 100%) in 28-day bioaccumulation tests for clams and worms.

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