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Newport Bay Sediment Toxicity Studies

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Final Report

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Executive Summary

A three-year investigation of the extent and characteristics of sediment contamination in Newport Bay was conducted. The project consisted of three primary tasks:

- **Assessment of sediment toxicity in Newport Bay.** Sediment samples were collected from multiple locations throughout Newport Bay. Sampling and testing was conducted during both the wet and dry seasons in order to evaluate the impact of stormwater runoff on sediment quality. The results of this task were also used to select locations for subsequent sediment toxicity identification evaluation (TIE) studies.

- **Influence of contaminated sediment on water quality.** This task measured water column toxicity at various sites in Newport Bay during dry weather, when stormwater inputs were not present. The concentration of trace organics (DDTs, PCBs, PAHs) in bay waters was determined at selected locations by the use of *in-situ* sampling pumps. In addition, laboratory tests were conducted to determine whether Newport Bay sediments released toxic materials into the water column.

- **Identification of sediment and water column toxicants.** Research was conducted to determine the cause of sediment-associated toxicity at several locations within Newport Bay.

The spatial surveys conducted in September 2000 and May 2001 showed that sediment toxicity was present at multiple locations throughout the upper and lower portions of Newport Bay. Sediment toxicity was present at 70% of the stations sampled, confirming the 1998 regional monitoring results that indicated sediment toxicity in Newport Bay was more prevalent than in other large developed bays in southern California.

Sediment contamination was prevalent throughout Newport Bay and exceeded several of the sediment quality guidelines used for TMDL development. Nine of the ten stations sampled exceeded the low level sediment quality guideline screening value (TEL) for at least one contaminant, while two stations in the lower bay contained concentrations above guideline values associated with a higher probability of adverse effects (PEL). In most cases, the exceedances were due to elevated concentrations of Cu, Hg, Zn, and DDTs. The overall magnitude of contamination, as indicated by the mean ERM quotient, was relatively low at most stations however. Variations in sediment toxicity were statistically correlated with the concentration of several metals, but not the concentration of DDTs, PCBs, or PAHs. Much of the variation in sediment toxicity (percent amphipod survival) did not appear to correspond with changes in the concentration of individual chemicals, suggesting that sediment toxicity was influenced by additional factors, such as interactions among constituents, unmeasured contaminants, or variations in contaminant bioavailability.

Water column test results from the spatial surveys showed that the surface waters of Newport Bay were toxic to sea urchin gametes, especially in the upper part of the Bay. Toxicity was also detected in the surface waters of Newport Bay following a storm event in January 2001. The

magnitude of toxicity was most severe in samples from the upper bay, where the concentration of stormwater discharge was highest.

Three lines of evidence indicated a linkage between sediment contamination and impaired water quality. First, the sediment-water interface test results from May 2001 demonstrated that toxic constituents were able to diffuse out of surface sediments under laboratory conditions. A second line of evidence was based on a related study of sediment toxicity in the Rhine Channel of Newport Bay. Chemical analysis of the sediment-water interface samples from the Rhine Channel study showed elevations in the concentration of dissolved copper, nickel, mercury, selenium, and zinc compared to a control sample that was not exposed to sediment. A final line of evidence was obtained from the analysis of the concentration of dissolved metals in water column samples from two stations, NB3 (Rhine Channel) and NB10 (upper bay sedimentation basin). These analyses showed elevated concentrations of zinc and copper at NB3 relative to NB10; a trend that corresponded to the sediment metal concentrations at these two sites.

TIE analyses were conducted on 18 samples in order to characterize the toxicants from two locations showing high levels of toxicity, the upper bay (near NB10) and Rhine Channel (NB3 and other stations). Analyses of both the bulk sediment and an aqueous fraction (pore water or sediment-water interface test sample) were conducted for each location. Additional studies are needed to identify specific toxicants, but the results indicate that multiple toxicants of concern are present at each site and that the effects are not due to naturally occurring factors such as sediment grain size and ammonia.

Sediment toxicity to amphipods in the upper bay appears to be associated with unmeasured organic compounds, possibly organophosphorus or pyrethroid pesticides. The concentrations of PCBs, DDTs, and PAHs at this site were well below those expected to cause toxicity to amphipods. More limited evidence suggests that trace metals may contribute to the toxicity to sea urchins measured in pore water from the upper bay study site.

TIE analyses of the Rhine Channel sediment and pore water samples were less effective at characterizing the likely toxicants. Sediments from three stations within Rhine Channel produced different patterns of response to the TIE treatments; none of the TIE treatments were effective at one station and metals or organics were implicated as potential toxicants at two stations. These results suggest that multiple toxicants may be present within Rhine Channel. Similar to the results for the upper bay site, amphipod toxicity in the Rhine Channel did not correspond strongly to the sediment chemistry data, suggesting either that unmeasured contaminants are present or that conventional sediment chemistry analytical methods do not adequately represent the biologically available contaminant fraction.

The toxicant characterization techniques employed in this study represent the first phase in a multi-step, iterative procedure necessary to identify the cause of toxicity. Analyses of additional samples should be conducted in order to demonstrate the consistency of the results to date. The use of other investigative techniques is needed in order to identify specific toxic constituents likely to be the cause of toxicity and to verify that these constituents are active under the conditions present in Newport Bay. The use of TIE techniques to identify the cause of sediment toxicity is a developing field, and standardized techniques are not yet available for the

identification and verification phases. Several methods are available, however, that should be able to provide greater specificity and confidence in the TIE results. The methods suggested for future investigations include: analysis of sediment and pore water for pesticides and polar trace organics, application of TIE methods specific for pesticides, and the chemical fractionation and toxicity measurement of sediment or pore water samples.

Acknowledgements

The authors wish to acknowledge the support of the Santa Ana Regional Water Control Board and U.S. EPA Region IX in funding this study. We also wish to thank the California Department of Fish and Game for providing sampling access to the Upper Newport Bay Ecological Reserve.

This study could not have been conducted without the assistance of many SCCWRP technical staff, especially Ehren Doris, Dario Diehl, Diana Young, Brian Pauley, and Debra Slama.

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Introduction

Newport Bay is an important southern California lagoon, with its upper and lower portions serving different uses. The ecological reserve in the upper bay protects one of the few remaining estuarine habitats in southern California for coastal wetlands wildlife and estuarine marine life. The developed lower bay is the focus of recreational boating and fishing.

The Southern California Coastal Water Research Project (SCCWRP) initiated a project in August 2000 to examine the extent and nature of adverse impacts to Newport Bay resulting from sediment contamination. This project had three objectives: 1) provide a recent assessment of the relative extent of sediment toxicity in Newport Bay, 2) determine whether sediments represent a significant source of toxicity to water column organisms in Newport Bay, and 3) identify which sediment constituents are responsible for adverse biological effects. Results from this study are expected to complement ongoing efforts to develop TMDLs for toxics in Newport Bay by determining which contaminants are adversely impacting marine life in the bay.

In order to accomplish the project's objectives, three research tasks were identified. These tasks were:

- **Task 1. Assessment of sediment toxicity in Newport Bay.** Sediment samples were collected from multiple locations throughout Newport Bay. Sampling and testing was conducted during both the wet and dry seasons in order to evaluate the impact of stormwater runoff on sediment quality. The results of this task were also used to select locations for the sediment toxicity identification evaluation (TIE) studies conducted in Task 3.

- **Task 2. Influence of contaminated sediment on water quality.** This research element measured water column toxicity at various sites in Newport Bay during dry weather, when stormwater inputs were not present. The concentration of trace organics (DDTs, PCBs, PAHs) in bay waters was determined at selected locations by the use of *in-situ* sampling pumps. In addition, laboratory tests were conducted to determine whether Newport Bay sediments released toxic materials into the water column.

- **Task 3. Identification of sediment and water column toxicants.** Research was conducted to determine the cause of sediment-associated toxicity at several locations within Newport Bay.

Over the course of two years, multiple sampling and testing series were conducted to complete these tasks (Table 1). This report summarizes the results from all three tasks. The results of each sampling event are presented in separate sections, followed by a discussion of the combined results of the project.

Table 1. Sampling activities and analysis from Newport Bay sediment toxicity studies.

Date	Activity	# Stations	Toxicity	Chemistry
9/19/00	Toxicity of dry weather surface water	9	F, E	
9/19/00	Toxicity analysis of sediment core samples and dry weather surface water	5	M, FI, EI	
9/19/00	Chemistry and toxicity analysis on whole sediment	10	A	I, O, G
1/11/01	Toxicity analysis on receiving water samples following storm event	3	M, F,E	
4/23/01	*In-situ* water column sampling for chemistry	2		O
5/7/01	Toxicity analysis of dry weather surface water, sediment core and whole sediment	10	F, FI, M, A	
5/7/01	Chemical analysis of whole sediment	10		I, O, G
11/28/01	Toxicity identification and chemistry on dry weather surface water, whole sediment, pore water and core samples	2	F, FI, A	I, O, G
3/12/02	Toxicity identification on dry weather surface water, whole sediment, pore water and core samples	6	F, FI, A	
3/12/02	Chemistry analysis of whole sediment	6		I, O, G

Analysis codes:
M= Mysid 7 day growth and survival
F= Purple sea urchin fertilization
E= Purple sea urchin embryo development
FI= Sediment water interface with sea urchin fertilization
EI= Sediment water interface with sea urchin embryo development
A= Amphipod (*Eohaustorius estuarius*) survival
I= Metals
O= Organics
G= Grain size

Spatial Survey Sampling: September 2000 and May 2001

Study Design

Sediment from 10 locations in Newport Bay was collected on September 19-21, 2000 for chemistry and toxicity analyses (Figure 1). The station locations were selected after review of chemistry and toxicity results from the Bight'98 regional survey and OCPFRD monitoring programs. Station locations were selected to achieve continuity with past and planned monitoring activities and also to obtain information about impacts from significant runoff discharges into the upper bay.

In order to add a temporal component to the survey, the same set of stations that were sampled in September 2000, were re-sampled in May 2001. Based on the results from the September sampling, some changes were made to the toxicity testing design. The sea urchin embryo test was not employed for the second set of samples and the mysid test was only used for four selected water column samples. Chemistry samples were taken as during the previous collection.

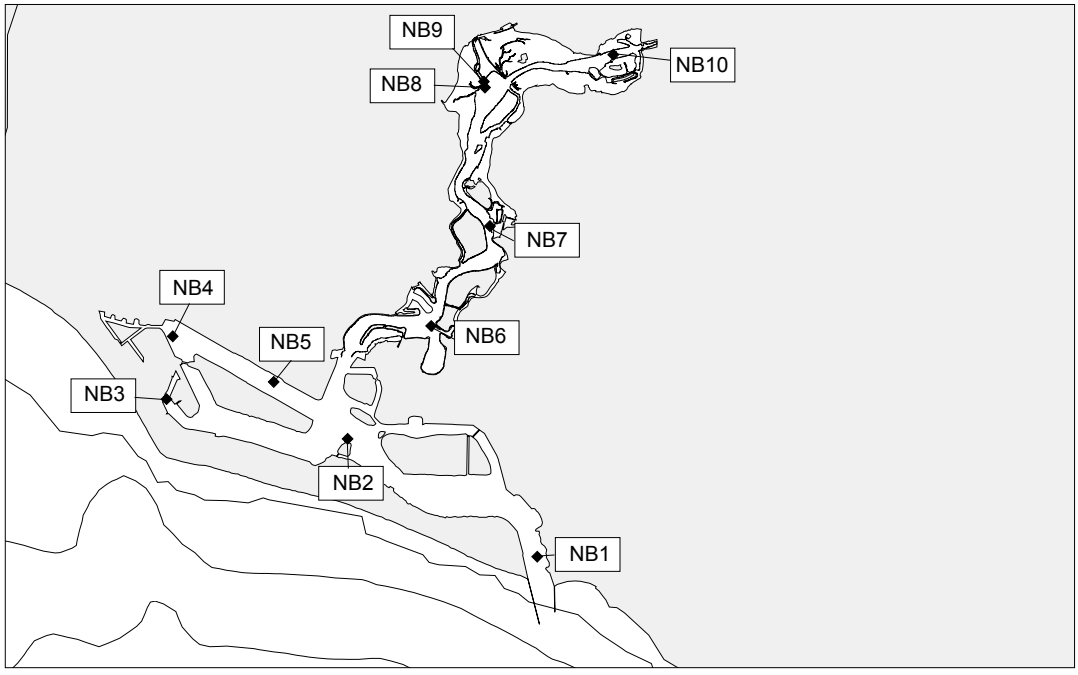

Figure 1. Location of Newport Bay sediment and water samples collected during the September 19-21 sampling event.

Methods

Sample Collection

For both sampling efforts, water column samples for toxicity testing were collected using an ISCO pump from a depth of 2 to 3 meters. The samples were collected unfiltered and were stored in 1 gallon amber, glass bottles at 5 °C until tested. No chemical analyses were performed on the water column samples.

For the September 2000 survey, sediment samples were collected using a Van Veen grab. The top 2 cm of sediment was removed from multiple grabs and homogenized together. Subsamples for sediment chemistry and whole sediment toxicity were taken from the homogenized composite sample. The samples for chemistry were frozen at –20 °C until analyzed. Samples for sediment toxicity and grain size were stored at 5 °C until analyzed. Core samples were taken from a grab at five of the stations by manually pressing a plastic core tube into the sediment so that an undisturbed sample was obtained. The depth of sediment in the core tubes was at least 5 cm. Four cores were collected from each station. The cores were stored at 15 °C with overlying water and used for toxicity tests of the sediment-water interface.

In May 2001, samples for whole sediment chemistry and toxicity and water column toxicity were collected at all ten stations that were sampled in September 2000 . Due to logistical problems, no water sample was collected from NB1. For the lower Bay stations (NB1-5), samples of bulk sediment and cores were collected using the same methods as described above. For the upper Bay stations, divers using hand cores collected samples of whole sediment. Divers also collected the sediment-water interface test samples, using core tubes that were pushed directly into the sediment. Sediment-water interface core samples were only collected from stations NB1, NB3, NB5, NB8 and NB10.

Toxicity Testing

Sea Urchin Fertilization Test

The purple sea urchin fertilization test was used to evaluate the water column and sediment-water interface samples for toxicity (U. S. Environmental Protection Agency 1995) for both collections. This test measures toxic effects on sea urchin sperm, which are expressed as a reduction in their ability to fertilize eggs. Purple sea urchins (*Strongylocentrotus purpuratus*) used in the tests were collected from the intertidal zone in northern Santa Monica Bay or from the central California coast. The test consisted of a 20 minute exposure of sperm to the samples. Eggs were then added and given 20 minutes for fertilization to occur. The eggs were then preserved and examined later with a microscope to assess the percentage of successful fertilization. Toxic effects are expressed as a reduction in fertilization percentage. The tests were conducted in glass shell vials containing 10 mL of solution at a temperature of 15 °C. Four or five replicates were tested for each sample.

Sea Urchin Embryo Development Test

The purple sea embryo development test was used to evaluate the water column and sediment-water interface samples for toxicity for the September 2000 survey (U. S. Environmental Protection Agency 1995). Purple sea urchins (*Strongylocentrotus purpuratus*) used in the tests were collected from the intertidal zone in northern Santa Monica Bay or from the central California coast. The test consisted of a 72 hour exposure of fertilized sea urchin eggs to the aqueous sample. At the end of the exposure period, the embryos were preserved and examined later with a microscope to assess the percentage of normally developed embryos. Toxic effects are expressed as a reduction in percentage of normally developed embryos. The tests were conducted in glass shell vials containing 10 mL of solution at a temperature of 15 °C. Four replicates were tested for each sample.

Mysid Survival and Growth Test

Water column samples from stations NB1, NB3, NB5, NB9 and NB10 in September 2000 and NB3, NB5, NB8 and NB 10 in May 2001 were tested using the mysid 7-day survival and growth test (U. S. Environmental Protection Agency 1994b). Five day old test animals (*Americamysis bahia*) were purchased from Aquatic Biosystems in Fort Collins, CO. After 1 day of acclimation, five animals were added to each 250 mL plastic beaker containing 200 mL of sample. The exposure period was 7 days at a temperature of approximately 26 °C and a salinity of 30 g/kg. Eight replicates were tested for each sample. Each day, most of the water was changed in each chamber. The mysids were fed newly hatched *Artemia* twice daily. At the end of the exposure period, the number of surviving animals was counted and then the survivors were rinsed in DIW, placed in tared, tin weigh boats and dried at 60 °C for 24 hours. The boats containing the dried animals were weighed on a microbalance and dry weight per mysid was calculated. The number of survivors and dry weight from the Newport Bay samples was compared to laboratory control water exposed animals to determine whether toxic effects had occurred.

Amphipod Survival Test

The amphipod survival test was used to evaluate the toxicity of whole sediment samples from all stations in both surveys (U. S. Environmental Protection Agency 1994a). The amphipods, *Eohaustorius estuarius*, were collected from Yaquina Bay near Newport, Oregon. The animals were held in the laboratory on their native sediment for four days before testing began. The test was conducted in 1 liter glass jars with approximately 2 cm of sediment and 700 mL of seawater adjusted to 20 g/kg. The overlying water was aerated and the exposure was conducted at 15 °C. Twenty amphipods were added to each chamber for an exposure period of 10 days. Five replicates were tested for each sample. At the end of the exposure period, the number of amphipods surviving in each jar was counted. Water quality parameters (temperature, pH, dissolved oxygen, ammonia, and salinity) were measured on the overlying water and pore water at the start and end of the exposure period.

Sediment-Water Interface Testing

Undisturbed sediment cores were used for testing toxicity at the sediment-water interface using methods described by Anderson *et al*. (1996). For the September 2001 samples, the water over the sediment was changed three days after collection. The overlying water was then allowed to equilibrate for four days before testing was initiated. Testing was performed using both sea urchin fertilization and embryo development tests. For the development test, fertilized eggs were added to a polycarbonate tube with a 37 um mesh Nitex screen in the bottom that was resting on the surface of the sediment in the core tube. After the 72 hr exposure period, the screen tube was removed and the embryos rinsed into a glass shell vial. The embryos were then preserved and examined later with a microscope to assess the percentage of normally developed embryos. For the fertilization test, a sample of the overlying water was taken from the core tube after the equilibration period. Samples from each core tube were tested as individual replicates. This sample was then tested following the fertilization test procedure stated above.

For the May 2001 sampling, two sediment cores from each station were used for the sediment water interface testing. The overlying water on each core was changed on arrival to the

laboratory and the new water was allowed to equilibrate for 17 hr at 15 °C with gentle aeration. The overlying water was then siphoned off and used for testing with the sea urchin fertilization method. Water from each core was tested separately at 100% and 50% concentrations, with the lower concentration achieved by dilution with laboratory seawater.

Chemistry

For both sampling efforts, organic chemical analysis of the sediment was performed by SCCWRP. The sediments were extracted by microwave using EPA Method 3546. Analysis of the extracts was performed by a modification of EPA Method 8270 on a Varian Model 3800 gas chromatograph with a Saturn 2000 mass spectrometer.

For both surveys, analysis of metals and sediment grain size were performed by Columbia Analytical Services. Trace metals were digested from the sediment by EPA Method 3050B: acid digestion and hydrogen peroxide digestion. The digested samples were analyzed by method 6010B on a Thermo Jarrell Ash ICAP-61 or Thermo Jarrell Ash IRIS Inductively Coupled Plasma Atomic Emission Spectrometer (ICP) for most constituents. Graphite Furnace Atomic Absorption (GFAA) on a Varian Zeeman 300 Spectrophotometer was used for analysis of lead, arsenic, and selenium by EPA methods 7421, 7060A, and 7740 respectively. Mercury analysis was conduct by EPA Method 7471A, cold-vapor atomic absorption, on a CETAC M-6000A Mercury Analyzer. Sediment grain size was measured according to ASTM Method D422, a standard sieve and gravimetric analysis procedure.

Results

<u>September 2000</u>

Toxicity

Reduced amphipod survival was measured at all but three of the ten stations tested (Figure 2, Table 2). Sediment from station NB10, located in the upper bay near the mouth of San Diego Creek, had the greatest toxicity to amphipods; only 1% of the amphipods survived at this stations. High toxicity was also measured at NB3, located in the Rhine Channel; only 21% of the amphipods survived at this station.

The sea urchin fertilization test indicated toxicity in the water column at five of the nine stations tested (Figure 3, Table 2). The sample from station NB2 was lost during handling. In contrast, the sea urchin embryo development test found only one of the nine water column samples to be toxic and the mysid test did not find toxicity at any station.

Two of the five sediment-water interface samples were highly toxic to sea urchin embryos. The percentage of normal embryos present in the interface samples from stations NB3 and NB10 was 28% and 7%, respectively. All of the toxicity detected with the embryo test appeared to be due to ammonia released by the sediment samples. Dissolved ammonia concentrations in the toxic interface samples ranged from 0.045 mg/L to 0.278 mg/L. Laboratory experiments have shown that ammonia concentrations in excess of 0.033 mg/L are usually toxic to sea urchin embryos and concentrations in excess of 0.067 mg/L can cause all of the embryos to develop abnormally. None of the interface samples demonstrated toxicity using the sea urchin fertilization test. The

fertilization test is less sensitive to ammonia and all ammonia concentrations were below levels of concern for this test.

Station NB3 had the greatest number of tests indicating toxicity, with one test method in each matrix (whole sediment, water column, and sediment-water interface) indicating toxicity (Table 2). Stations NB1 and NB9 did not have toxicity detected by any test method.

Chemistry

Stations NB3 and NB4, both located in the developed lower bay, contained the highest sediment concentrations of copper, lead, and zinc (Figure 4). The concentration of copper at station NB3 (634 mg/kg) was at least four times greater than the concentration measured at any other station (9-130 mg/kg). All but two of the ten stations had copper concentrations that were greater than the threshold effects level (TEL) sediment quality guideline (MacDonald *et al.* 1996). The concentration of lead exceeded the TEL at NB3 and NB4 only. All but one of the lower bay stations exceeded the zinc TEL, while only stations NB6 and NB10 in the upper bay exceeded this guideline (Figure 4). The concentration of cadmium fell between the TEL and PEL at every station where it was detected, NB2, NB4-6 and NB10 (Figure 5). Chromium was detected at all stations, but was always below the TEL. Nickel was detected at all statons except NB9, and was between the TEL and PEL at stations NB2, NB4, NB5 and NB10. Mercury was only detected at stations NB3 and NB4, but was above the PEL in both cases.

Total PAHs were detected in the sediments at seven stations, with concentrations ranging from 69 µg/kg to 844 µg/kg. None of the stations exceeded the PAH TEL. Total PCBs were detected at two stations, with NB3 having by far the greatest concentration (Figure 6), and exceeding the TEL by a factor of three.

Total DDTs were detected all ten stations, with similar values found at stations NB2, NB4, NB5 and NB8. All but three stations had concentrations that exceeded the TEL (Figure 6).

Table 2. Toxicity results of Newport Bay spatial survey samples collected in September 2000. Data are expressed as mean percent of control response ± standard deviation. A value surrounded by a box indicates that it is significantly different from the control and therefore considered to be toxic.

	Sediment Toxicity	Water Column Toxicity			Interface Toxicity	
	Amphipod	Sea Urchin		Mysid	Sea Urchin	
Station	Survival	Fert.	Dev.	Growth	Fert	Dev.
NB1	98 ± 6.7	101 ± 0.5	104 ± 2.6	115 ± 9.8	90 ± 10	102 ± 1.0
NB2	79 ± 11					
NB3	21 ± 32	91 ± 3.8	99 ± 3.9	118 ± 13	98 ± 16	29 ± 33[a]
NB4	68 ± 15	72 ± 26	103 ± 1.9			
NB5	44 ± 12	97 ± 4.3	90 ± 12	115 ± 11	79 ± 11	99 ± 1.8
NB6	45 ± 21	41 ± 26	104 ± 2.3			
NB7	98 ± 4.3	52 ± 34	105 ± 1.1			
NB8	58 ± 40	43 ± 28	103 ± 4.7			
NB9	99 ± 2.8	68 ± 31	102 ± 2.8	121 ± 18	74 ± 22	82 ± 26
NB10	1 ± 2.3	79 ± 24	101 ± 3.3	113 ± 12	99 ± 6.6	7.3 ± 7.7[a]

[a] All toxicity detected to sea urchin embryos was caused by dissolved ammonia. See Appendix for additional information.

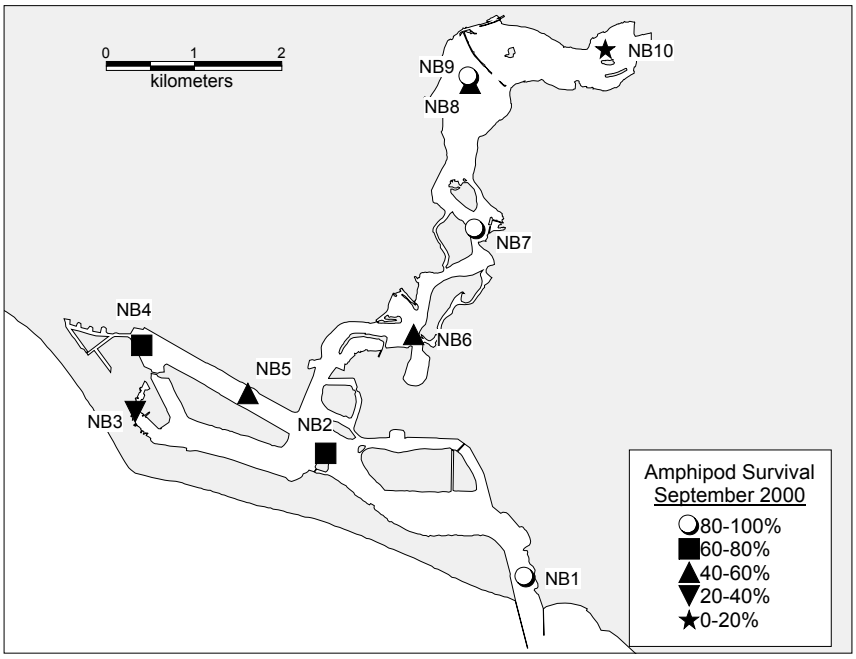

Figure 2. Results of whole sediment toxicity test using amphipod survival on samples collected from Newport Bay in September 2000. Symbols express the results in percent of control survival.

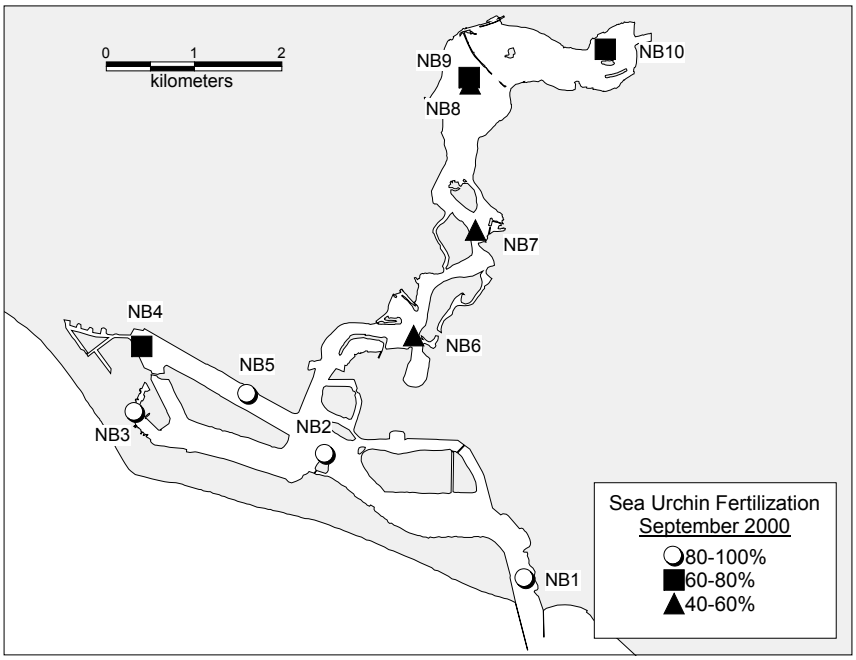

Figure 3. Results of water column toxicity testing using sea urchin fertilization on samples collected from Newport Bay in September 2000. Symbols express the results in percent of control fertilization.

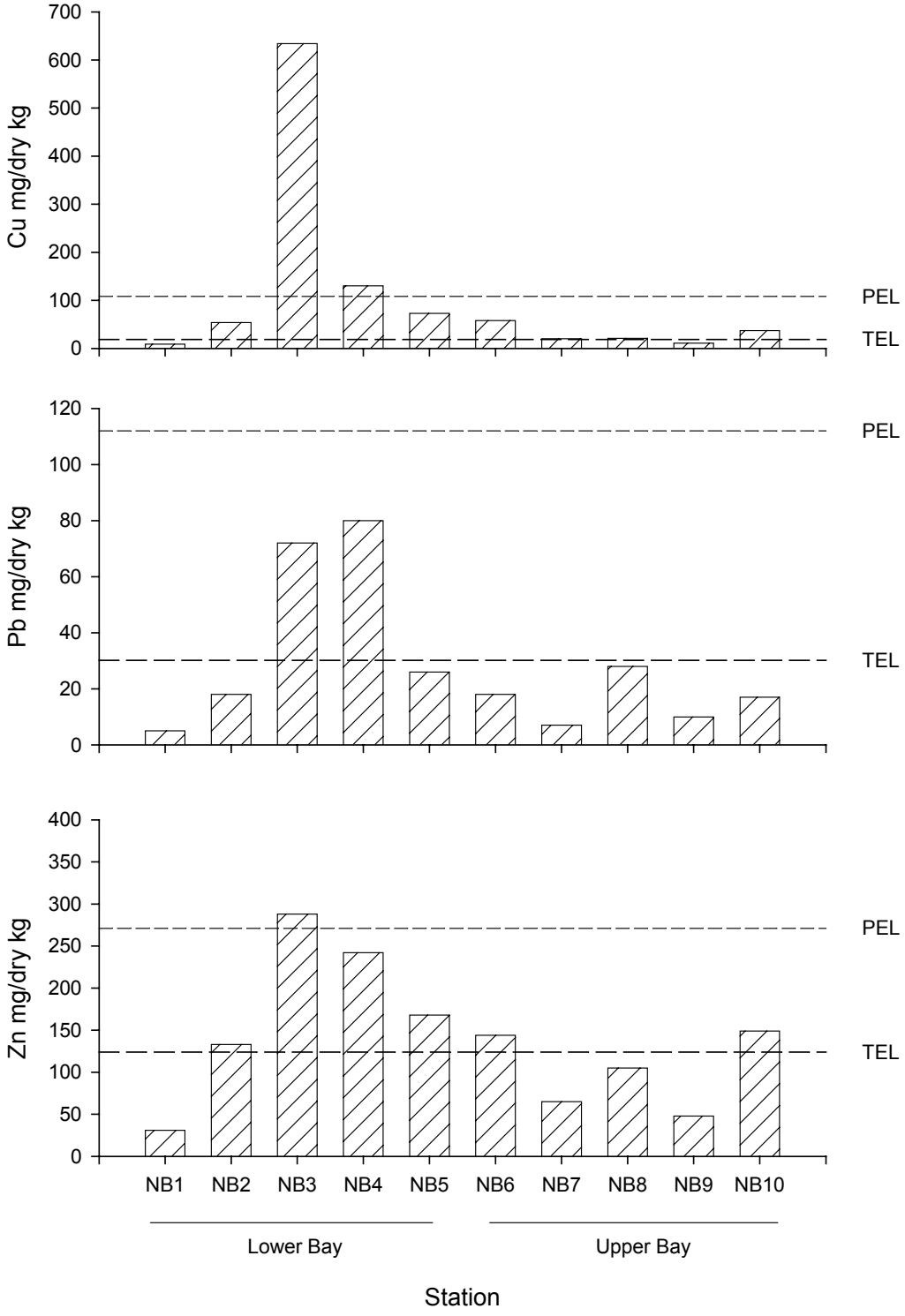

Figure 4. Concentrations of copper, lead, and zinc in September 2000 samples of sediment from Newport Bay.

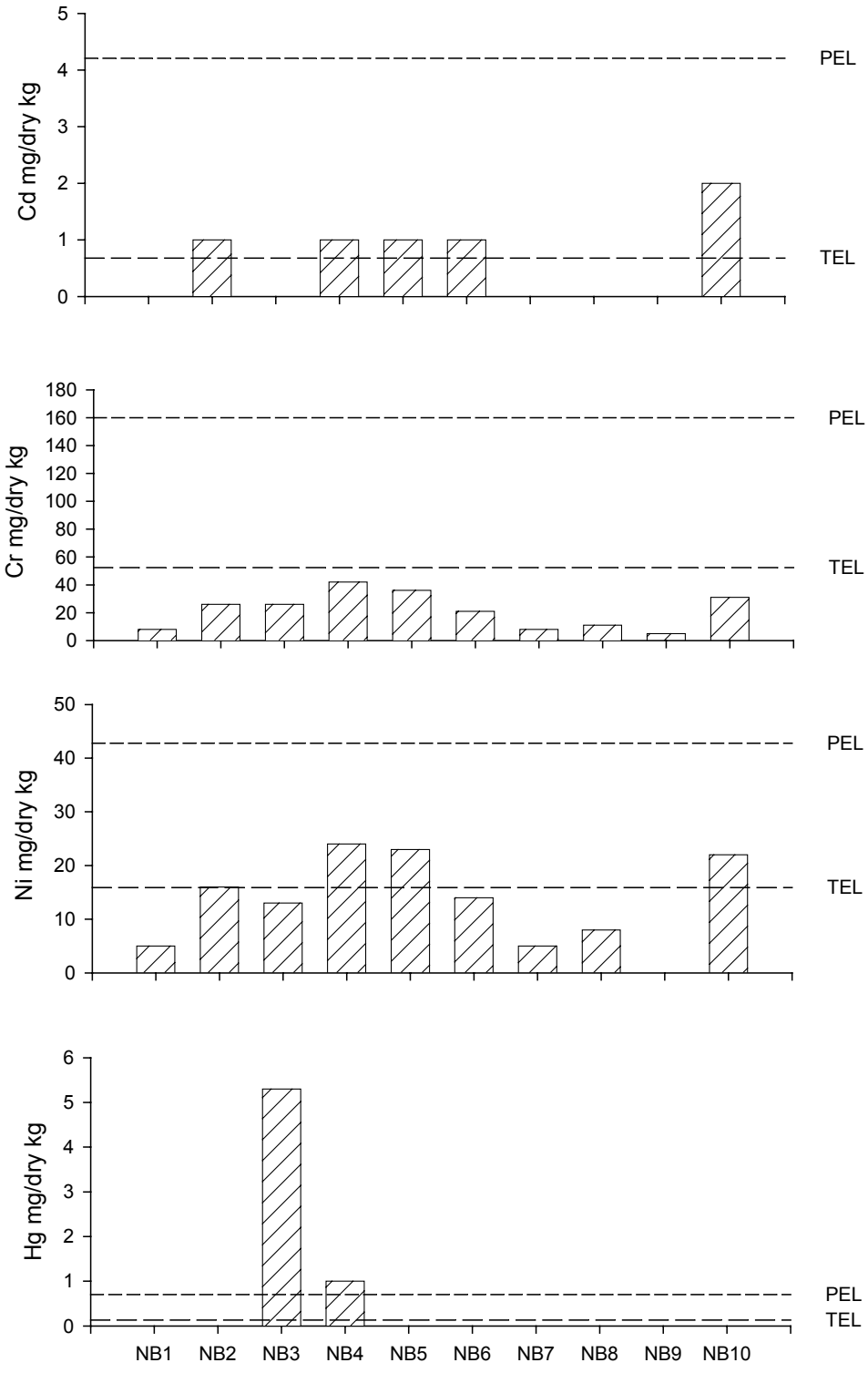

Figure 5. Concentrations of cadmium, copper, nickel and mercury in September 2000 samples of sediment from Newport Bay.

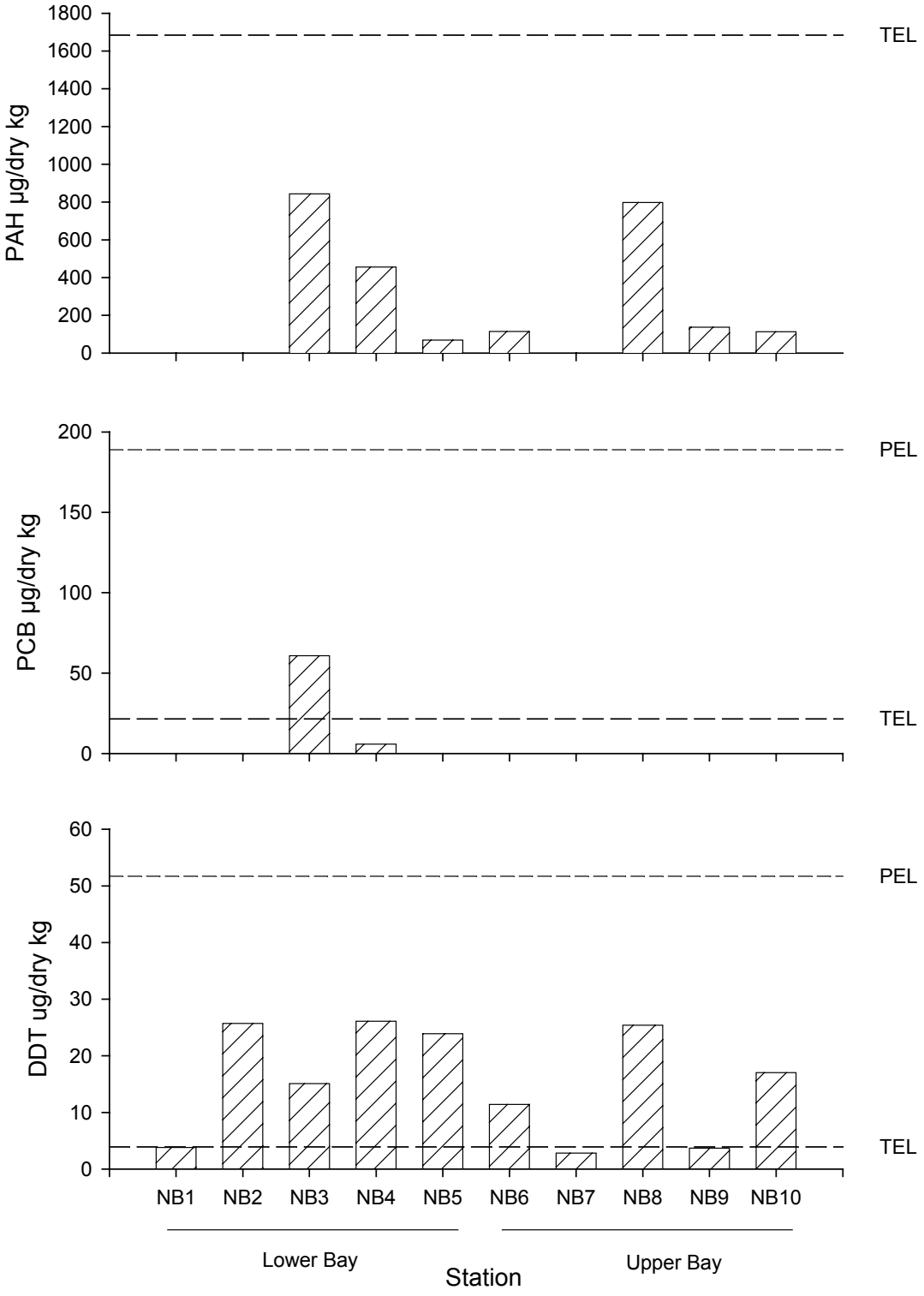

Figure 6. Concentrations of total PAHs, PCBs and DDTs in September 2000 samples of sediment from Newport Bay.

May 2001

Toxicity

As in the September 2000 sampling, the amphipod survival test identified seven of the ten stations tested to be toxic (Figure 7, Table 3). As in the previous sampling, the amphipod test did not find toxicity at stations NB1, NB7 and NB9. Toxicity at NB2, NB6 and NB10 was very strong, with a mean of less than 20% survival at those stations.

As in September 2000, the sea urchin fertilization test identified water column toxicity at five of the nine stations sampled (Figure 8, Table 3). However, the pattern of which stations showed toxicity differed between the two sampling events. Stations NB4, NB6, NB7, and NB8 were found to have water column toxicity to the fertilization test for both sampling periods. Toxicity was also detected for stations NB9 and NB10, which were nontoxic in the September 2000 survey. None of the stations exhibited extreme toxicity, with all stations having greater than 40% fertilization. Again, as in September, the mysid test did not find toxicity in any of the five samples tested (Table 3).

Four of the five sediment-water interface samples were toxic to sea urchin sperm. Toxicity was detected at stations NB3, NB5, NB8, and NB10. Moderate effects on fertilization were present in these samples, with the percent fertilization in the toxic samples ranging from 54% to 87% (Table 3).

Chemistry

The pattern of metals concentrations was similar to the September sampling. Stations NB3 and NB4 again had the highest concentrations of copper, lead, and zinc (Figure 9). For copper, only NB1 had a concentration below the TEL. Again the concentration of copper at NB3 was greater than the TEL by more than an order of magnitude. The lead concentration exceeded the TEL at NB3, NB4, and NB9. All but one of the lower bay stations exceeded the zinc TEL. A small change occurred for zinc in the upper bay with an increased concentration at NB9, relative to September 2000, and a relatively lower concentration of zinc at NB10 (Figure 9). Cadmium was detected at more stations in May than September with only NB8 having none detected (Figure 10). As in May all stations with detectable quanities fell between the TEL and PEL. Chromium was again found at all stations, but for this collection stations NB4 and NB5 slightly exceeded the TEL. Nickel was also detected at all stations with NB2-6 and NB9 having concentrations between the TEL and PEL. Mercury was detected at low concentrations at several stations, but at NB3 the level once again greatly exceeded the PEL, while at NB4 the concentrations was about equal to the PEL.

Detectable concentrations of PAHs were found at all of the 10 stations, but were well below the TEL value (Figure 11). PAH concentrations at some stations, such as NB9, were higher than those measured in September 2000. PCBs were detected at three stations with NB4 slightly greater than the TEL and NB3 exceeding the guideline by nearly a factor of five. DDTs were detected at all ten stations with the TEL being exceeded at all locations but NB1. The concentrations of DDTs were generally similar to those measured in September 2000. NB4 had the highest concentration and a ten-fold exceedance of the TEL.

Table 3. Toxicity results of Newport Bay spatial survey samples collected in May 2001. Data are expressed as mean percent of control response ± standard deviation. A value surrounded by a box indicates that it is significantly different from the control and therefore considered to be toxic.

	Sediment Toxicity	Water Column Toxicity		Interface Toxicity
	Amphipod	Sea Urchin	Mysid	Sea Urchin
Station	Survival	Fert.	Growth	Fert
NB1	97 ± 5.9	NS		100 ± 2.6
NB2	**14 ± 8.7**	96 ± 2.1		
NB3	**58 ± 35**	94 ± 2.3	104 ± 7.8	**72 ± 8.1**
NB4	**62 ± 14**	**50 ± 19**		
NB5	**66 ± 13**	96 ± 3.0	112 ± 11	**89 ± 9.4**
NB6	**18 ± 7.9**	**78 ± 2.9**		
NB7	83 ± 5.2	**91 ± 2.4**		
NB8	**38 ± 11**	**80 ± 6.1**	112 ± 7.3	**88 ± 3.3**
NB9	90 ± 15	**50 ± 8.6**		
NB10	**3.1 ± 4.7**	**63 ± 7.1**	109 ± 12	**79 ± 26**

NS= Station not sampled

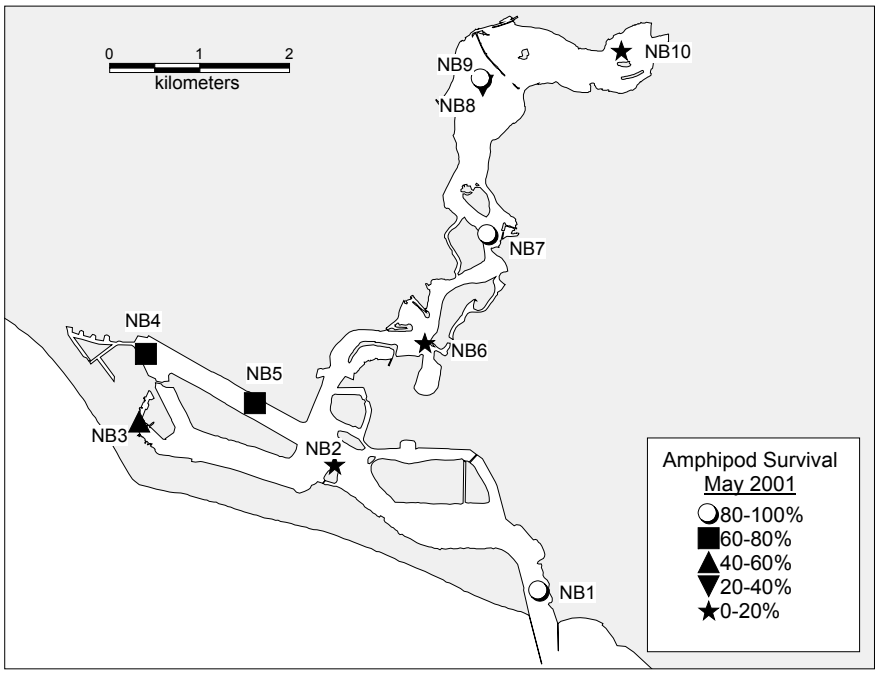

Figure 7. Results of whole sediment toxicity test using amphipod survival on samples collected from Newport Bay in May 2001. Symbols express the results in percent of control survival.

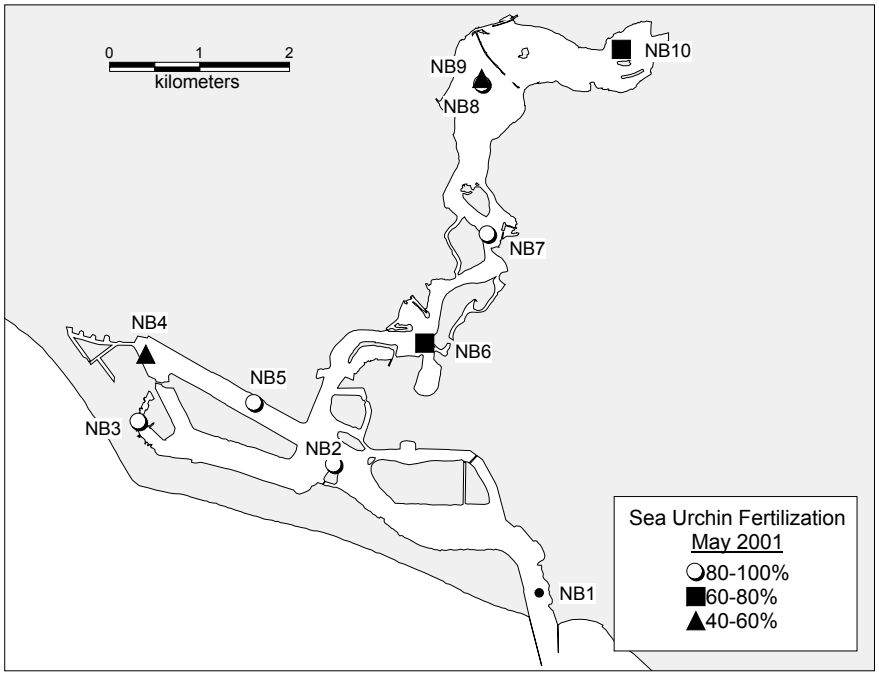

Figure 8. Results of water column toxicity testing using sea urchin fertilization on samples collected from Newport Bay in May 2001. Symbols express the results in percent of control fertilization.

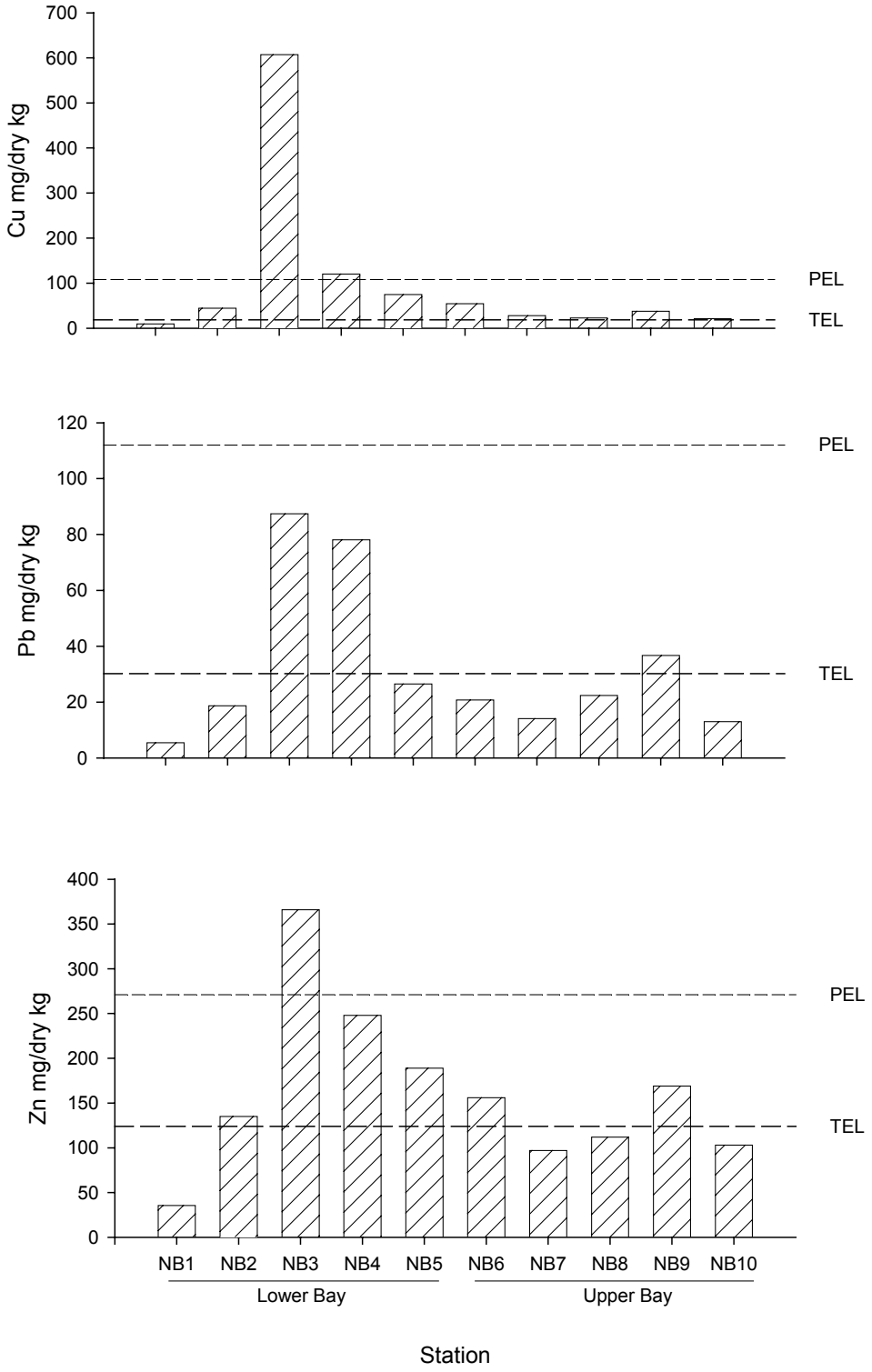

Figure 9. Concentrations of copper, lead, and zinc in May 2001 samples of sediment from Newport Bay.

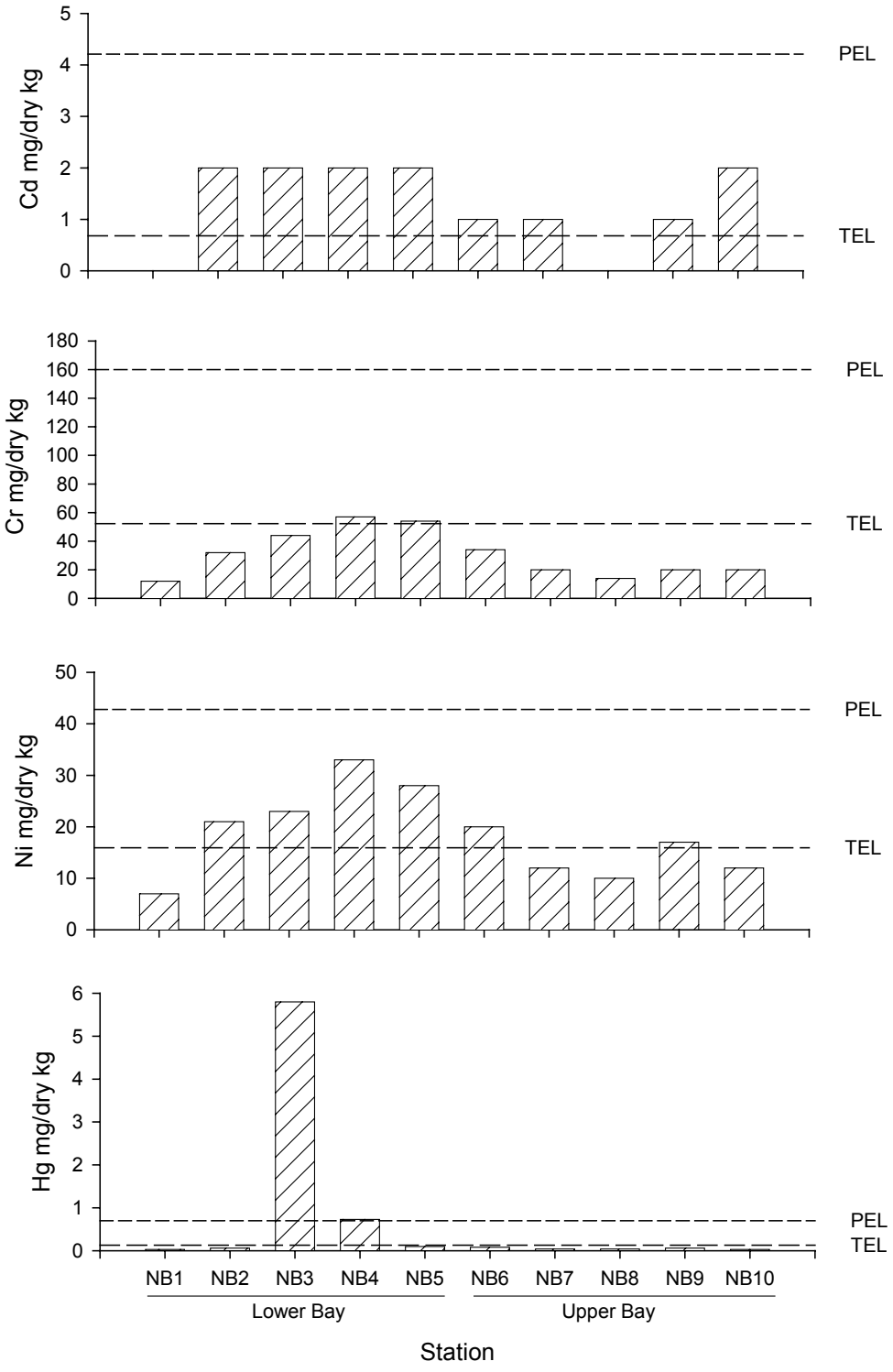

Figure 10. Concentrations of cadmium, chromium, nickel and mercury in May 2001 samples of sediment from Newport Bay.

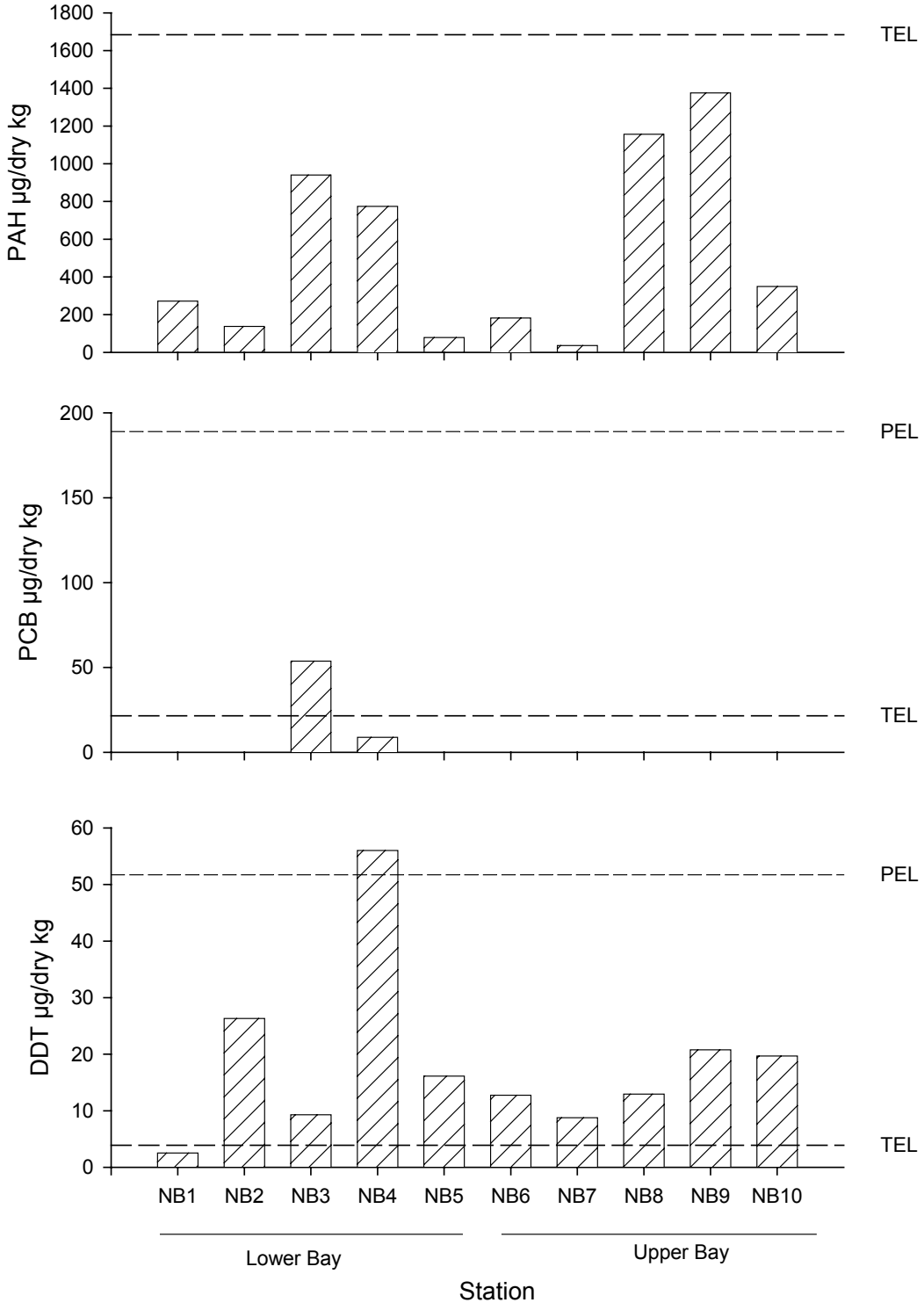

Figure 11. Concentrations of total PAHs, PCBs and DDTs in May 2001 samples of sediment from Newport Bay.

Wet Weather Water Column Toxicity Testing: January 2001

Study Design

Following periods of rainfall, the upper bay is greatly affected by freshwater runoff. This runoff may carry both dissolved and particle-associated contaminants. To determine if there was toxicity in the water column following a storm, surface water samples were collected from three locations in the bay and measured for toxicity. The Orange County Public Facilities and Resources Department, as part of their NPDES monitoring program, collected the samples. Because this sampling was conducted as part of another program, the locations of these samples were not the same as for the spatial sediment survey component. The wet weather station locations were similar to sediment collection stations NB2, NB8, and NB10.

Methods

Sample Collection

Surface water grab samples were collected from three stations in upper Newport Bay following a rainfall event on January 11, 2001 (Figure 12). The samples were stored in 10 L glass carboys at 5º C until they were tested on January 17.

Toxicity Testing

All three water column samples were tested using the sea urchin fertilization and embryo development tests as described previously. The salinity of each of the samples was adjusted with hypersaline brine to a salinity of approximately 34 g/kg before testing.

The three stations were also tested using the mysid 7-day survival and growth test using the same methods described earlier. The salinity was adjusted to the nominal test salinity using commercial sea salts. Eight replicates were tested for stations LNBHIR and UNBSDC, but due to a reduced volume of sample available, UNBJAM was tested with only five replicates.

Results

All three stations contained mostly freshwater, with stations UNBJAM and UNBSDC containing 99% freshwater and station LNBHIR containing 67% freshwater. Neither of the sea urchin tests detected toxicity at any of the stations (Table 4); the fertilization or development for each station was greater than or equal to the control value. The mysid test found both decreased survival and growth at stations UNBJAM and UNBSDC, but not at LNBHIR (Figure 12). Toxicity was greatest in the UNBJAM sample, which produced 52% mysid survival.

The concentrations of TSS and trace metals in the water column at each station was measured by OCPFRD as part of their monitoring program. These data show that a gradient of TSS and total metals was present throughout the bay, with higher concentrations in the upper bay (Table 5). The concentrations of dissolved metals were below detection limits for these samples, with the exception of copper and zinc (LNBHIR only). The chemistry data indicate that stormwater discharge into the bay during the storm preceeding the January 11 sampling had a marked effect on water quality in the bay, with elevated concentrations of suspended solids and metals in areas

containing the greatest concentration of stormwater (as indicated by the salinity or electrical conductivity data).

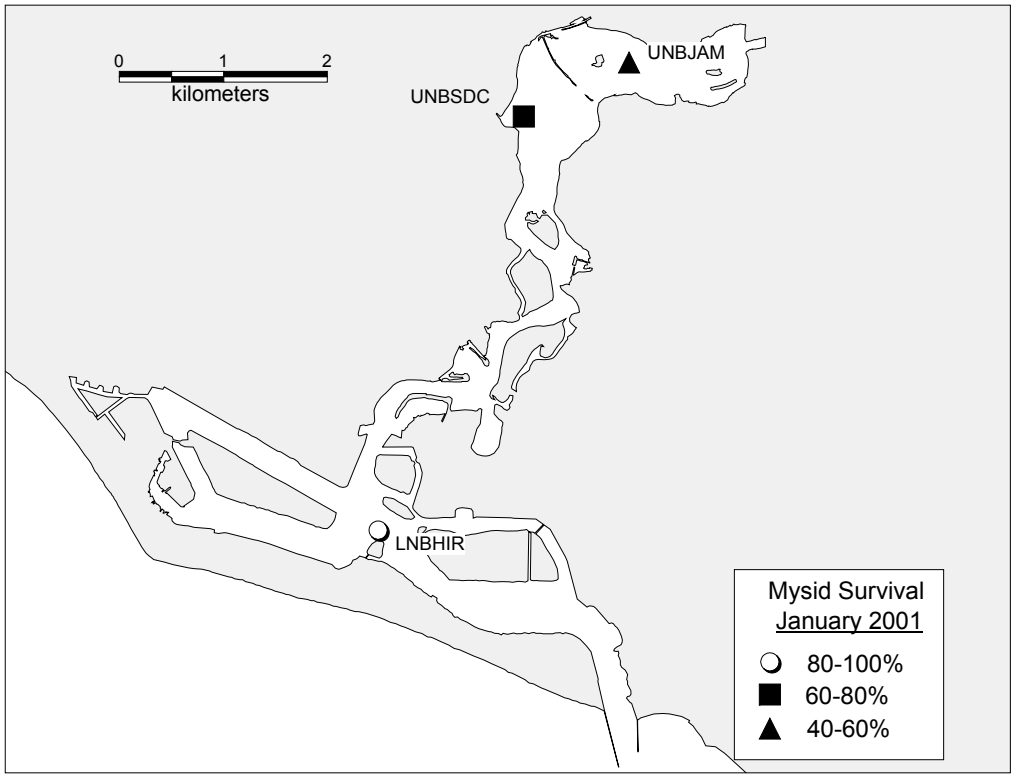

Figure 12. Results of mysid survival following exposure to Newport Bay receiving water collected after a storm event in January 2001.

Table 4. Final results of Newport Bay surface water wet weather plume samples collected January 11, 2001. Data is expressed as mean percent of control response ± standard deviation. A value surrounded by a box indicates that it is significantly different from the control and therefore considered to be toxic.

Station	Sea Urchin Fert.	Sea Urchin Devel.	Mysid Survival	Mysid Growth	%Freshwater
UNBJAM	100 ± 1	103 ± 1	53 ± 31	69 ± 11	99
UNBSDC	101 ± 1	102 ± 1	69 ± 19	85 ± 12	99
LNBHIR	100 ± 1	102 ± 2	99 ± 7	93 ± 6	67

Table 5. Metals, conductivity (EC), and total suspended solids (TSS) data provided by OCPFRD from Newport Bay water column samples collected January 11, 2001. Samples were depth integrated and represent the entire water column at each station.

	UNBJAM		UNBSDC		LNBHIR	
Constituent	Total	Dissolved	Total	Dissolved	Total	Dissolved
Cadmium (μg/L)	3.7	<1	<1	<1	<1	<1
Chromium (μg/L)	40	<8	9.1	<8	9.3	<8
Copper (μg/L)	48	28	20	2.7	23	13
Lead (μg/L)	26	<2	8.1	<2	4.3	<2
Nickel (μg/L)	36	<4	11	<4	4.3	<4
Silver (μg/L)	<2	<2	<2	<2	<2	<2
Zn (μg/L)	250	<10	88	<10	46	17
EC (μmhos)	500	-	700	-	19,100	-
TSS (mg/L)	1090	-	360	-	19	-

Water Column Sampling with *in-situ* pumps: April 2001

Study Design

Dissolved and particle-associated contaminants in the water column represent a potentially important route of contaminant exposure and transport. During periods of wet weather, concentrations of contaminants in the water column are greatly affected by stormwater runoff. Much of the contaminant load is ultimately deposited in the sediments. In order to determine the concentrations of pollutants in the water column during dry weather, *in-situ* sampling pumps were deployed at two locations in the bay and the concentration of trace organics on the dissolved and particulate fractions was measured. Trace metals were not measured because the pump and sample concentration system did not collect a sample that was suitable for this type of analysis. The station locations for the pump sampling differed from those used in the spatial survey because of constraints related to water depth and vessel traffic. Shallow water prevented the location of a pump in the upper bay; one pump was located just below the Pacific Coast Highway Bridge in order to reflect water column conditions in the upper bay. The second pump was located in a turning basin within the lower bay; this location was selected to provide data on conditions in the lower bay and avoid disrupting vessel traffic.

Methods

Axys Infiltrex 100 *in-situ* pumps were deployed at two stations in Newport Bay on April 23, 2001. According to NOAA precipitation data, 0.27" of rain fell in the Newport Beach area on April 21, 2001, two days before the in-situ pump deployment. Before that, there was no measurable rain back to April 9, on which 0.13" fell.

One pump was placed near the Pacific Coast Highway Bridge at a depth of 4.9 meters and the other in the turning basin at a depth of 6.7 meters (Figure 13). Each pump was suspended 1.5 meters above the bottom by the use of floats and cables. The pumps collect samples by drawing water first through a series of 8 Whatman GF/F glass microfiber filters to remove particles, then through a Teflon column filled with Supelpak 2 adsorbent resin to remove dissolved organic compounds. The pumps were set at an initial flow rate of 400 mL/min for a maximum of five days. The pumps were programmed to shutdown if the filters clogged enough to drop the flow rate below 30 mL/min for 60 seconds, since the pump cannot accurately measure flow below this rate.

Particles from the filter disks were analyzed for total suspended solids (TSS), total organic carbon (TOC), PCBs and pesticides. The column contents were analyzed for PAHs, PCBs and pesticides. All analyses were performed at SCCWRP. TSS was estimated gravimetrically from the contents of the filters. TOC was measured using a Carlo Erba EA1108 CHN Elemental Analyzer. The organic compounds were analyzed using methods described earlier in this report.

Results

Due to the filters becoming clogged, both pumps shut down after 1-2 days (Table 6). However, sufficient sample was collected at both locations for the chemical analyses to be performed. Due

to technical problems, PAH concentrations were not analyzed for the particulate phase at either station.

Only a few PCB congeners were detectable for either the dissolved or particulate phase at both stations (Table 7). The dissolved fraction contained 0.15-0.23 ng/L of total PCBs and accounted for greater than 90% of the total concentration in the water column.

Metabolites of DDT were detected in both the water and particulate phase at both stations, but no parent compound was detected at either station (Table 8). Again, the dissolved phase accounted for the majority of the total DDT concentration in the water column. Low concentrations of chlordane and nonachlor were detected in the particles, but not in the dissolved phase.

Several PAH compounds were detected in the dissolved phase at both stations (Table 9). The PAH compounds detected tended to be mostly in the lower molecular weight class. The compounds detected and concentrations at each station were very similar between stations.

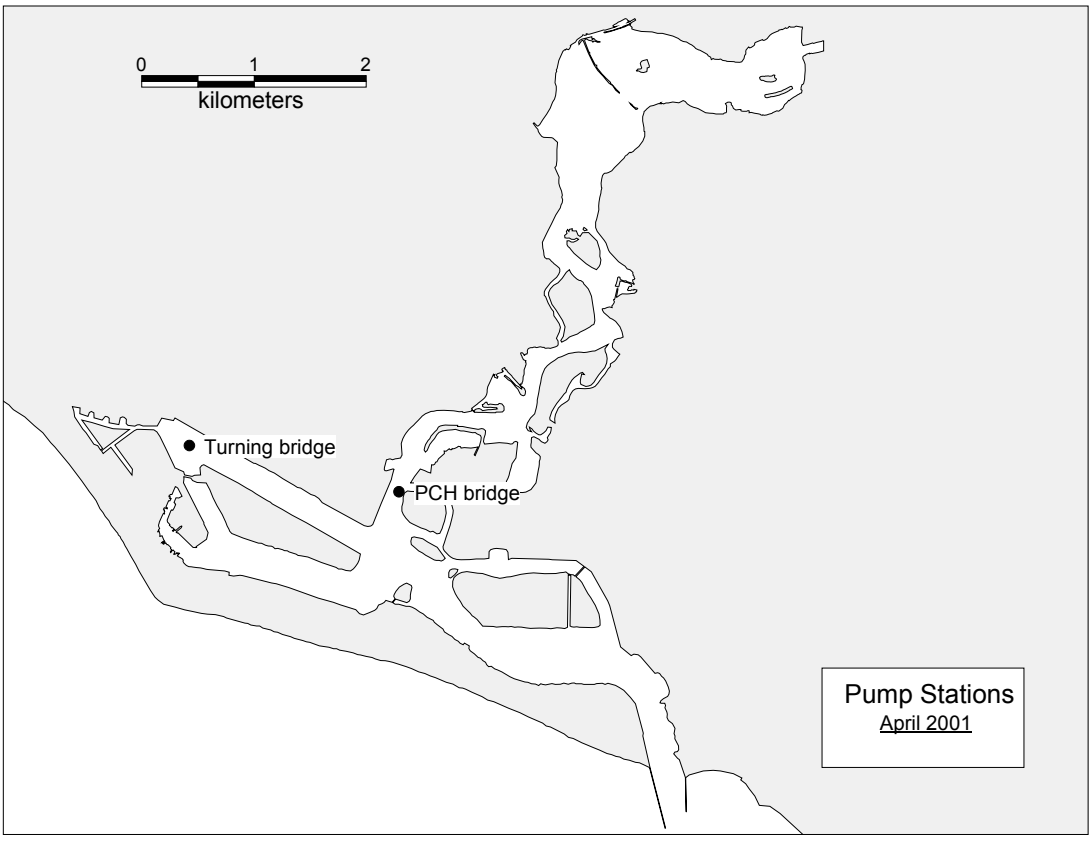

Figure 13. Locations of in-situ pump stations for April 2001 deployment.

Table 6. Physical parameters from the in-situ pump sampling of Newport Bay water column in April 2001.

Station	Total time (hrs:min:sec)	Volume (L)	Avg TSS mg/l	Paarticle TOC %
PCH Bridge	29:44:51	555	6.4	3.4
Turning Basin	45:37:16	748	6.4	2.6

Table 7. PCB congener concentrations for water and particulates collected by *in-situ* pump deployment in April 2001. The concentrations for the particles are expressed both based on the volume of water passing through the pumps and the dry weight of the particles.

Compound	Turning Basin Water (ng/L)	Turning Basin Particles (ng/L)	Turning Basin Particles (μg/g)	PCH Bridge Water (ng/L)	PCH Bridge Particles (ng/L)	PCH Bridge Particles (μg/g)
PCB18	0.0340	nd	nd	nd	nd	nd
PCB28	0.0329	nd	nd	0.0240	nd	nd
PCB52	0.0448	0.00155	2.41	0.0355	nd	nd
PCB49	nd	nd	nd	nd	nd	nd
PCB44	0.0345	nd	nd	0.0402	nd	nd
PCB37	nd	nd	nd	nd	nd	nd
PCB74	nd	nd	nd	nd	nd	nd
PCB70	nd	nd	nd	nd	nd	nd
PCB66	nd	nd	nd	nd	nd	nd
PCB101	nd	0.00145	2.27	0.131	nd	nd
PCB99	nd	0.00131	2.05	nd	nd	nd
PCB119	nd	nd	nd	nd	nd	nd
PCB87	nd	nd	nd	nd	nd	nd
PCB110	nd	nd	nd	nd	nd	nd
PCB81	nd	nd	nd	nd	nd	nd
PCB151	nd	nd	nd	nd	nd	nd
PCB77	nd	nd	nd	nd	nd	nd
PCB149	nd	0.00136	2.13	nd	nd	nd
PCB123	nd	nd	nd	nd	nd	nd
PCB118	nd	nd	nd	nd	nd	nd
PCB114	nd	nd	nd	nd	nd	nd
PCB153/68	nd	nd	nd	nd	nd	nd
PCB105	nd	nd	nd	nd	nd	nd
PCB138	nd	nd	nd	nd	nd	nd
PCB158	nd	nd	nd	nd	nd	nd
PCB187	nd	nd	nd	nd	nd	nd
PCB183	nd	nd	nd	nd	nd	nd
PCB126	nd	nd	nd	nd	nd	nd
PCB128	nd	nd	nd	nd	nd	nd
PCB167	nd	nd	nd	nd	nd	nd
PCB177	nd	nd	nd	nd	nd	nd
PCB200	nd	nd	nd	nd	nd	nd
PCB156	nd	nd	nd	nd	nd	nd
PCB157	nd	nd	nd	nd	nd	nd
PCB180	nd	nd	nd	nd	nd	nd
PCB170	nd	nd	nd	nd	nd	nd
PCB201	nd	nd	nd	nd	nd	nd
PCB169	nd	nd	nd	nd	nd	nd
PCB189	nd	nd	nd	nd	nd	nd
PCB194	nd	nd	nd	nd	nd	nd
PCB206	nd	nd	nd	nd	nd	nd
Total PCB	0.146	0.00567	8.86	0.231	0	0

Table 8. Pesticide concentrations from water and particulates collected by *in-situ* pump deployment in April 2001.

Compound	Turning Basin Water (ng/L)	Turning Basin Particles (ng/L)	Turning Basin Particles (µg/g)	PCH Bridge Water (ng/L)	PCH Bridge Particles (ng/L)	PCH Bridge Particles (µg/g)
o,p-DDE	nd	nd	nd	nd	nd	nd
p,p-DDE	0.336	0.0980	15.2	0.252	0.112	17.5
o,p-DDD	0.0919	nd	nd	nd	nd	nd
o,p-DDT	nd	nd	nd	nd	nd	nd
p,p-DDD	0.867	nd	nd	0.785	0.0548	8.52
p,p-DDT	nd	nd	nd	nd	nd	nd
total DDTs	1.29	0.0980	15.2	1.04	0.167	26.0
gamma Chlordane	nd	nd	nd	nd	nd	nd
alpha-Chlordane	nd	nd	nd	nd	nd	nd
trans-Nonachlor	nd	nd	nd	nd	nd	nd
cis-Nonachlor	nd	nd	nd	nd	nd	nd
Diazinon	na	nd	nd	na	nd	nd
Chlordene	na	nd	nd	na	nd	nd
Aldrin	na	nd	nd	na	nd	nd
Chloropyrifos	na	nd	nd	na	nd	nd
Oxichlordane	na	nd	nd	na	nd	nd
Dieldrin	na	nd	nd	na	nd	nd
Endrin	na	nd	nd	na	nd	nd

nd = not detected

na = constituent not analyzed.

Table 9. PAH concentrations from water collected by *in-situ* pump deployment in April 2001. All concentrations are in ng/L, relative to the original sample filtered.

Compound	Turning Basin Water	PCH Bridge Water
Naphthalene	0.91	0.83
Naphthalene-2-methyl	0.64	0.88
Naphthalene-1-methyl	0.54	0.34
Biphenyl	0.36	0.38
Naphthalene-2,6-dimethyl	0.53	0.35
Acenaphthylene	nd	nd
Acenaphthene	nd	nd
Naphthalene-2,3,6-trimethyl	0.58	0.54
Fluorene	0.45	0.36
Phenanthrene	0.88	0.58
Anthracene	nd	nd
Phenanthrene-2-methyl	nd	0.41
Phenanthrene-1-methyl	nd	nd
Phenanthrene-3,6-dimethyl	nd	nd
Fluoranthene	0.89	1.16
Pyrene	0.89	1.00
11H-Benzo[b]fluorene	nd	nd
Benz[a]anthracene	nd	nd
Chrysene	nd	nd
Benzo[b]fluoranthene	nd	nd
Benzo[k]fluoranthene	nd	nd
Benzo[e]pyrene	nd	nd
Benzo[a]pyrene	nd	nd
Perylene	nd	nd
Anthracene-9,10-diphenyl	nd	nd
Indeno[1,2,3-cd]pyrene	nd	nd
Dibenz[a,h]anthracene	nd	nd
Benzo[ghi]perylene	nd	nd
Total PAH	6.67	6.83

Sediment Toxicity Identification Evaluation Studies

Study Design

Two sets of TIE studies were conducted. These studies were conducted at two areas (Figure 14), the Rhine Channel (e.g., station NB3) and the upper bay sedimentation basin (e.g., station NB10). These areas were selected for study because they exhibited consistent and strong toxicity to multiple species and they were located in regions of Newport Bay influenced by different sources of contamination. Sampling for the first set of studies occurred in November 2001, with the focus being on the link between toxicity in the sediment and water column toxicity. Water column, sediment core (for sediment-water interface testing), and sediment grab samples were collected from two stations (NB3 and NB10). Pore water was extracted from the whole sediment and tested for toxicity. TIEs were performed on all sediment-water interface, pore water, and whole sediment samples. Sediment chemistry was measured for both stations. The second sampling was conducted in March 2002. The focus of the March sampling was to verify the November results and to test for small-scale spatial variability. Multiple stations were sampled in March near NB3 and NB10 and tested for water column, pore water and whole sediment toxicity and chemistry. TIEs were performed on selected samples of pore water and whole sediment, based on preliminary test results. Sediment chemistry samples were collected at each station.

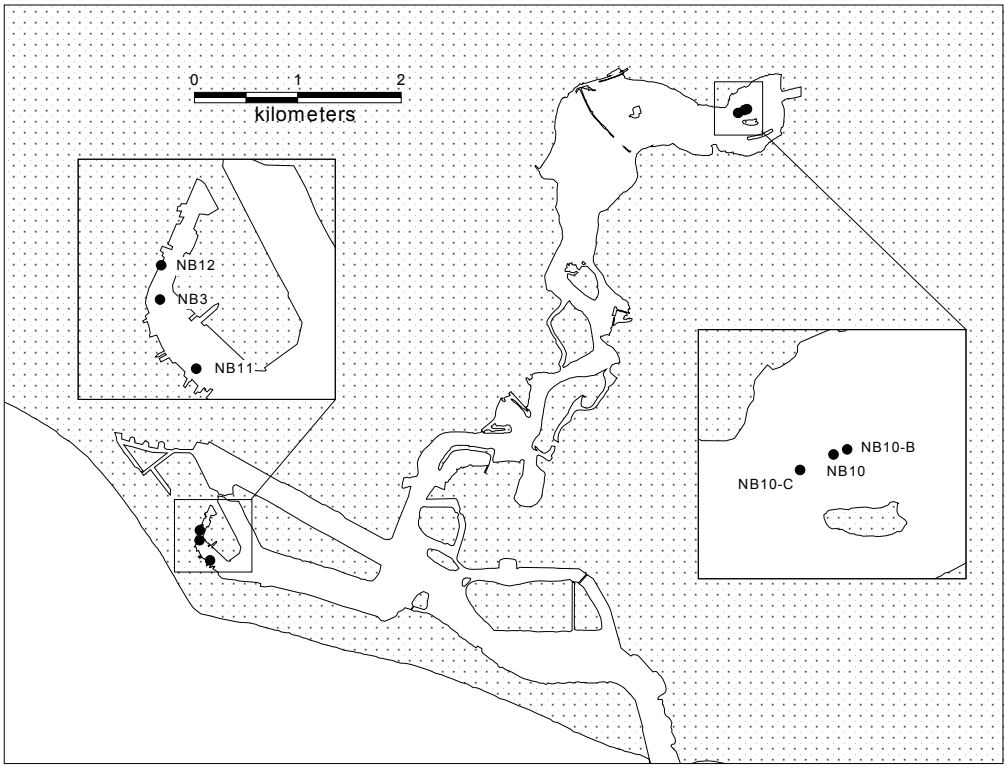

Figure 14. Locations of sediment and water column sampling stations in Newport Bay for November 2001 and March 2002 toxicity identification studies.

Methods

Sample Collection and Handling

Water column samples for toxicity testing, metals and organics analyses were collected using an ISCO pump from a depth of 2 to 3 meters. The toxicity and organics samples were collected unfiltered and were stored in 1 gallon amber bottles at 5 °C until tested. Water samples for metals analysis were collected using EPA recommended clean techniques. Samples for dissolved metals were passed through a 0.45 μm filter attached to the pump. Samples for total metals and methyl mercury were collected unfiltered and not acidified in the field. All water column samples were stored at 5 °C in Teflon bottles and transported to the chemistry laboratory for analysis within 24 hrs of collection. The water samples were acidified prior to analysis.

Sediment samples were collected using a Van Veen grab. The top 2 cm from multiple grabs were homogenized together. Subsamples for sediment chemistry and whole sediment toxicity were taken from the homogenized composite sample. The samples for chemistry were frozen at –20 °C until analyzed. Samples for sediment toxicity and grain size were stored at 5 °C until analyzed. For the November 2001 collection, core samples for sediment-water interface tests were taken from a grab by manually pressing a plastic core tube into the sediment so that an undisturbed sample was obtained. The depth of sediment in the core tubes was at least 5 cm. Ten cores were collected from each station. The cores were stored at 15 °C with overlying water.

Pore water was obtained from the homogenized whole sediment sample by centrifuging an aliquot at 3000 X g for 30 minutes. Pore water was extracted the day before toxicity testing and was stored at 5 °C.

Sediment-water interface (SWI) samples from the November 2001 collection were prepared for testing as follows. The water overlying the sediment in the cores was removed and replaced with laboratory seawater the day after collection. After 48 hr of equilibration, the overlying water was removed from each core and a composite of overlying water from all cores from each station was made. The composite samples were then tested for toxicity using the sea urchin fertilization test.

Sea Urchin Fertilization Test

The purple sea urchin fertilization test was used to evaluate the pore water, water column, and sediment-water interface samples for toxicity. The methods used were the same as those described earlier. Three to five replicates were tested for each sample.

Amphipod Survival Test

The amphipod survival test was used to evaluate the toxicity of pore water and whole sediment samples. The amphipods, *Eohaustorius estuarius*, were collected from Yaquina Bay near Newport, Oregon. The animals were held in the laboratory on their native sediment for up to a week before testing began. The pore water tests were conducted in glass vials containing 10 mL of solution at a temperature of 15 °C. Five amphipods were added to each vial for an exposure period of 10 days. Three to five replicates were tested for each sample. At the end of the exposure period, the number of amphipods surviving in each vial was counted. Notes on survival were also made after 4 and 7 days of exposure. Samples of laboratory water at both 20

and 33 g/kg salinity were tested as negative controls. Water quality parameters (temperature, pH, dissolved oxygen, ammonia, and salinity) were measured on the pore water at the start and end of the exposure period.

The whole sediment tests were conducted in 250 mL glass beakers containing approximately 40 mL of sediment and 160 mL of water. Ten amphipods were added to each beaker and were exposed for 10 days. The overlying water was adjusted to a salinity of 20 g/kg, the beakers were gently aerated and the exposures were conducted at 15 °C. The beakers were monitored daily for visible changes to the sediment or death of the animals. At the end of the exposure period, the sediment from the beakers was passed through a sieve to recover the animals. The number of surviving animals was recorded. Samples of amphipod home sediment were tested as negative controls. Water quality parameters (temperature, pH, dissolved oxygen, ammonia, and salinity) were measured on the pore water or overlying water samples.

Pore Water and Sediment-Water Interface Toxicity Characterization
Phase I TIE procedures were performed on the SWI and pore water samples from both stations sampled in November 2001 and on selected pore water samples from the March 2002 sampling (Figure 14). Ethylenediaminetetraacetic acid (EDTA), a chelator of metals, was added to produce a concentration of 60 mg/L in the test samples. Sodium thiosulfate (STS), a treatment that reduces oxidants such as chlorine and also decreases the toxicity of some metals, was added to a final concentration of 50 mg/L to separate portions of each sample. Both of these treatments were given at least one hour to interact with the sample before the animals were added. For the SWI samples, an aliquot was centrifuged at 3000 X g for 30 min to remove particles. Centrifuged SWI and pore water samples were passed through a Varian Mega Bond Elut C-18 solid phase extraction column in order to remove nonpolar organic compounds (U. S. Environmental Protection Agency 1996). C-18 columns have also been found to remove some metals from aqueous solutions. After treatment, the pore water samples were tested for toxicity using both the sea urchin fertilization and the amphipod survival tests. For each TIE treatment, a sample of laboratory seawater was also subject to the manipulation to verify that treatment itself was not causing toxicity. In cases where the intital toxicity testing was not conductly concurrently with the TIE treatments, an untreated sample was tested to verify that toxicity had not reduced during storage and to establish a baseline to compare the treatments against. The SWI samples were tested using the sea urchin fertilization test.

Sediment toxicity characterization
Phase I sediment TIE manipulations were also performed on the whole sediment from each station for both samplings. While the objective of the sediment TIEs is to remove toxicity, as in the aqueous samples, alternate methods must be used because of the sediment matrix. Three different manipulations were performed on each sample (Figure 15). To one aliquot of sediment, cation exchange resin (ResinTech SIR-300) was added at a concentration of 20% by weight to bind metals (Burgess *et al.* 2000). To a second aliquot, coconut charcoal was added at a concentration of 15% by weight to bind organics (Lebo *et al.* 1999). After addition of the modifying agent for each treatment, the sample was stirred vigorously with a glass rod for 1 minute. The final treatment consisted of adding clean home sediment to a third aliquot at a concentration of 20% by weight. This treatment was used to test for any dilution or aeration effect that the other treatments might be having. The

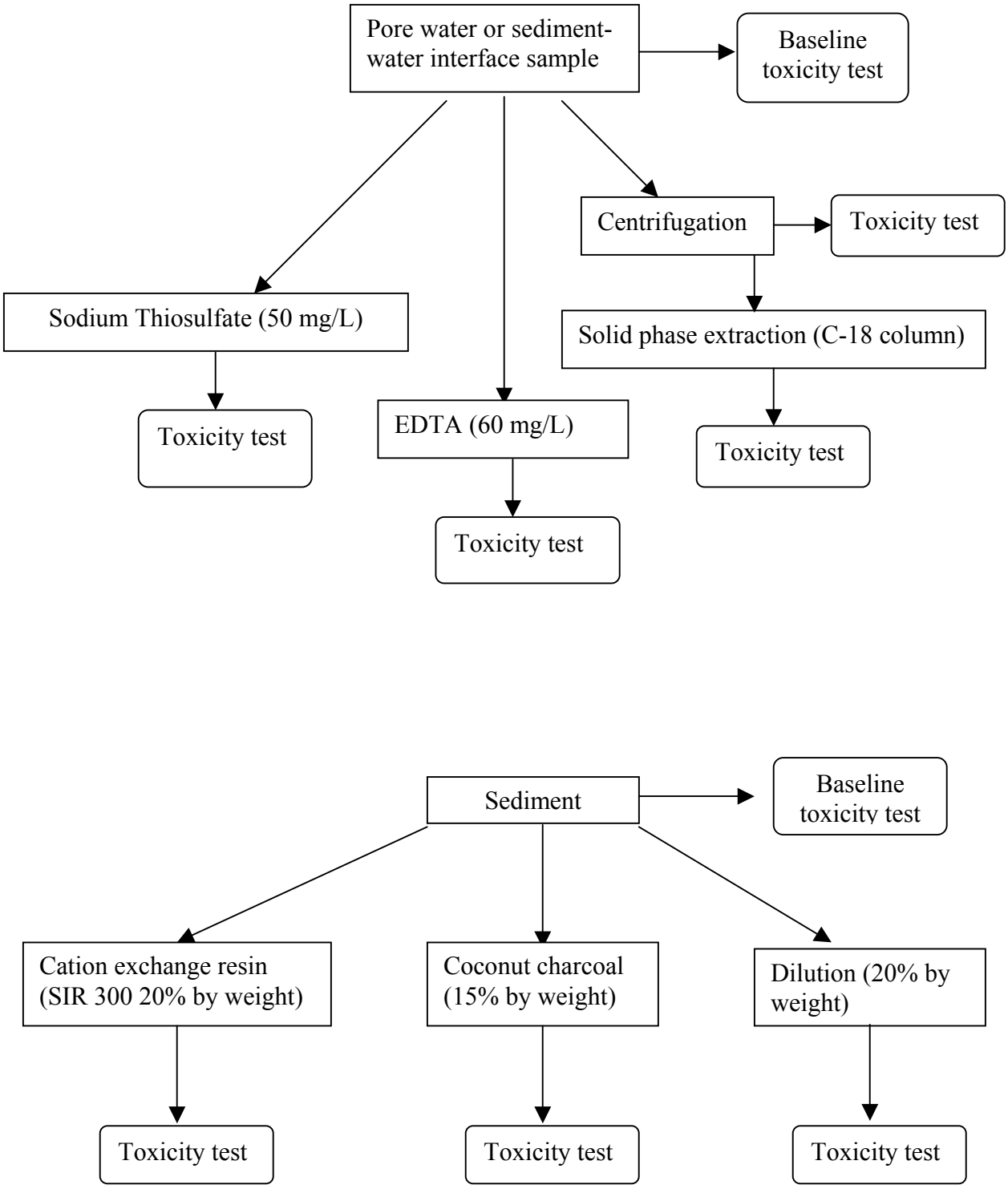

Figure 15. Schematic of sediment water interface, pore water and sediment TIE treatments.

samples were allowed to equilibrate overnight before addition of the animals. For each TIE treatment, a sample of laboratory seawater was also subject to the manipulation to verify that treatment itself was not causing toxicity. In cases where the intital toxicity testing was not conductly concurrently with the TIE treatments, an untreated sample was tested to verify that toxicity had not reduced during storage and to establish a baseline to compare the treatments against. All sediment samples were tested for toxicity using the amphipod survival method described above.

Chemical analysis
All chemical measurements were performed at CRG Marine Laboratories. Trace organics were extracted from the water column using EPA Method 3510: methylene chloride extraction by separatory funnel. The extracts were then analyzed by EPA Method 625 on an HP 6890/5972 GCMS.

Trace metals were extracted from the water column and SWI samples using EPA Method 1640: APDC and FePD chelation. The extracts were analyzed by means of EPA Method 200.8 on an HP 4500 Inductively Coupled Plasma Mass Spectrometer (ICPMS).

Trace organic compounds were extracted from the sediment samples using Modified EPA Method 3540: methylene chloride extraction by roller table. The extracts were analyzed by EPA Method 8270 on an HP 6890/5972 GCMS.

Trace metals were digested from the sediments using EPA Method 6020: strong acid digestion using microwave. The digested samples were analyzed on an HP 4500 ICPMS.

Acid Volatile Sulfides (AVS) were measured by taking a 1-5 grams aliquot of wet sediment and adding deionized water to make a total volume of 48 mL. Next, 2 mL of 1:1 HCl was added and the sample was immediately capped and centrifuged. A 25 mL aliquot of water was then placed into a cuvet, reagents were added and the H_2S concentration was measured using a spectrophotometer programmed at 665nm. Simultaneously Extracted Metals (SEM) were also measured on the AVS samples. A 10 mL aliquot of water from the acidified sample was centrifuged, spiked with internal standard, and analyzed directly using a Hewlett Packard 4500 ICPMS.

Laboratory blanks were processed and analyzed with each batch of samples. All samples for organic analysis were spiked with recovery surrogates.

Results

November 2001 Samples
The November 2001 samples were collected from the two stations that had been previously identified as having consistent toxicity, NB3 and NB10. Samples from the water column, whole sediment and sediment cores were taken. Since it was assumed that toxicity would be detected in the whole sediment and pore water samples, intitial and TIE testing was conducted simultaneously. The water column samples were tested for toxicity with the intent of conducting TIEs if toxicity was observed.

Upper Bay

Toxicity

No toxicity to the sea urchin fertilization test was observed in the water column samples (Table 10) for NB10. The fertilization percentage just below the control value of 90%. Since no toxicity was observed in the water column, no TIE testing of this matrix was performed.

The SWI sample from NB10 was found to have marginally reduced fertilization with a mean of 75% (Table 10). Results of the TIE for this sample indicated that both addition of EDTA and extraction with the C-18 column were very effective at removing toxicity with nearly 100% fertilization for both treatments. There is some indication that the STS and centrifugation treatments reduced toxicity for NB10 (Figure 16).

The sediment from NB 10 was extremely toxic, with no amphipods surviving (Table 10). The cation exchange resin and dilution treatments did not reduce the toxicity of NB10 sediment (Figure 17). The addition of coconut charcoal was very effective, however; all of the toxicity was removed, with 100% survival of the amphipods in each of the replicates (Figure 17).

Pore water from NB10 was not toxic to sea urchin sperm, but a moderate toxic effect on amphipod survival was measured (Table 10). The only treatment that had any effect on NB10 sediment was the C-18 extraction, which increased survival to 87% (Figure 18).

Chemistry

Sediment chemistry concentrations followed similar trends to previous samplings. A complete listing of all chemical constituent concentrations can be found in the appendix tables. The concentrations of organic constituents were higher for both stations from the November sampling than the previous collection in May 2001, but these differences may be due to analytical variation between laboratories. For NB10, the concentration of total DDTs in the November sample exceeded the PEL value of 51.7 ug/kg (MacDonald *et al.* 1996) (Table 11). The concentrations of cadmium, copper, mercury, nickel and zinc at NB10 were between the TEL and PEL values for those constituents. A complete list of TEL and PEL values can be found in Appendix Table C1.

Measurements of AVS and SEM were performed on sediments from both stations. AVS levels far exceeded the amount of SEM present (Table 12), indicating that toxicity from SEM is unlikely. Note that due to the much less rigorous extraction technique used for this analysis, the concentrations of metals range from less than 1% to around 33% of the values observed in the bulk metals analysis (Table 12). Zinc accounted for more than 85% of the SEM for both stations.

Whole water column samples (unfiltered) were analyzed for PCBs, chlorinated pesticides and PAHs. Trace organics were not detected in the water column samples from either station.

Water column samples were also analyzed for both total and dissolved metals. Levels of aluminum, iron, and manganese were considerably higher at NB10 than for NB3 (Table 13). For most of the metals at both stations, the dissolved fraction of the water accounted for almost all of the total concentration.

The SWI dissolved metals concentrations followed the same pattern as the water column and sediment with NB10 having lower concentrations of zinc and copper (Table 13). Concentrations of most constituents were similar in the SWI and the water column samples.

Rhine Channel

Toxicity

No toxicity to the sea urchin fertilization test was observed in the water column samples (Table 10) for NB3. The fertilization percentage was above the control value of 90%. Since no toxicity was observed in the water column, no TIE testing of this matrix was performed.

Moderate toxicity (a mean fertilization of 52%) was observed for the SWI sample from NB3. Results of the TIE for this samples indicated that both addition of EDTA and extraction with the C-18 column were very effective at removing toxicity with nearly 100% fertilization for both treatments (Figure 16).

The whole sediment sample from NB3 was not toxic to amphipods (Table 10).

Pore water from NB3 was not toxic to sea urchin sperm, but a moderate toxic effect on amphipod survival was measured (Table 10). Each of the TIE treatments reduced toxicity for NB3, resulting in a mean amphipod survival of 93% (Figure 18).

Chemistry

NB3 had high levels of mercury, copper, zinc, lead, PAHs, and total PCBs relative to NB10 (Table 11). The concentrations of mercury and copper at NB3 were above the PEL values of 0.7 and 108 mg/kg, respectively. The concentrations of arsenic, zinc, lead, total DDTs, total PAHs, and total PCBs fell between the TEL and PEL values for those constituents.

The concentrations of metals in the water column showed a similar pattern to the sediment results with higher concentrations of zinc and copper at NB3 compared to NB10 (Table 13).

The SWI dissolved metals concentrations followed the same pattern as the water column and sediment with NB3 having higher concentrations of zinc and copper (Table 13). Concentrations of most constituents were similar in the SWI and the water column samples. The zinc concentration of 50.7 µg/L for NB3 was the only SWI metal concentration that was high enough to be expected to cause toxicity in the sea urchin fertilization test.

Table 10. Initial toxicity test results for samples collected from Newport Bay in November 2001. Data are expressed as mean ± standard deviation.

			Percent Response	
Organism	Endpoint	Matrix	NB3	NB10
sea urchin	fertilization	water column	96 ± 3.3	88 ± 7.9
sea urchin	fertilization	pore water	97 ± 1.3	98 ± 0.5
sea urchin	fertilization	SWI	52 ± 25.3	75 ± 14.9
amphipod	survival	pore water	67 ± 11.5	60 ± 20.0
amphipod	survival	whole sediment	90 ± 7.1	0 ± 0

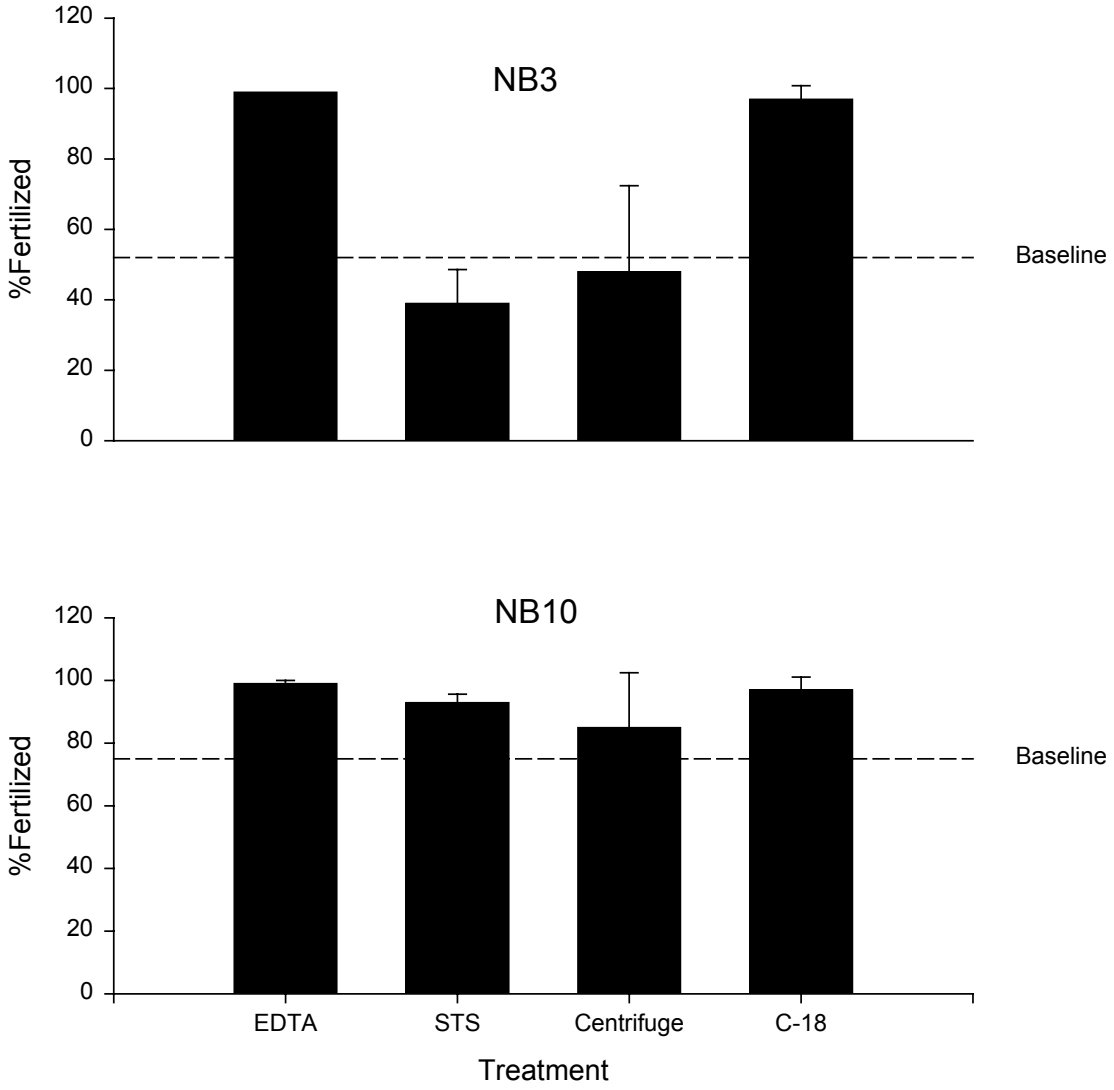

Figure 16. Results of toxicity identification evaluation treatments for November 2001 sediment-water interface samples from Newport Bay. Results for the sea urchin fertilization test are expressed as mean + standard deviation.

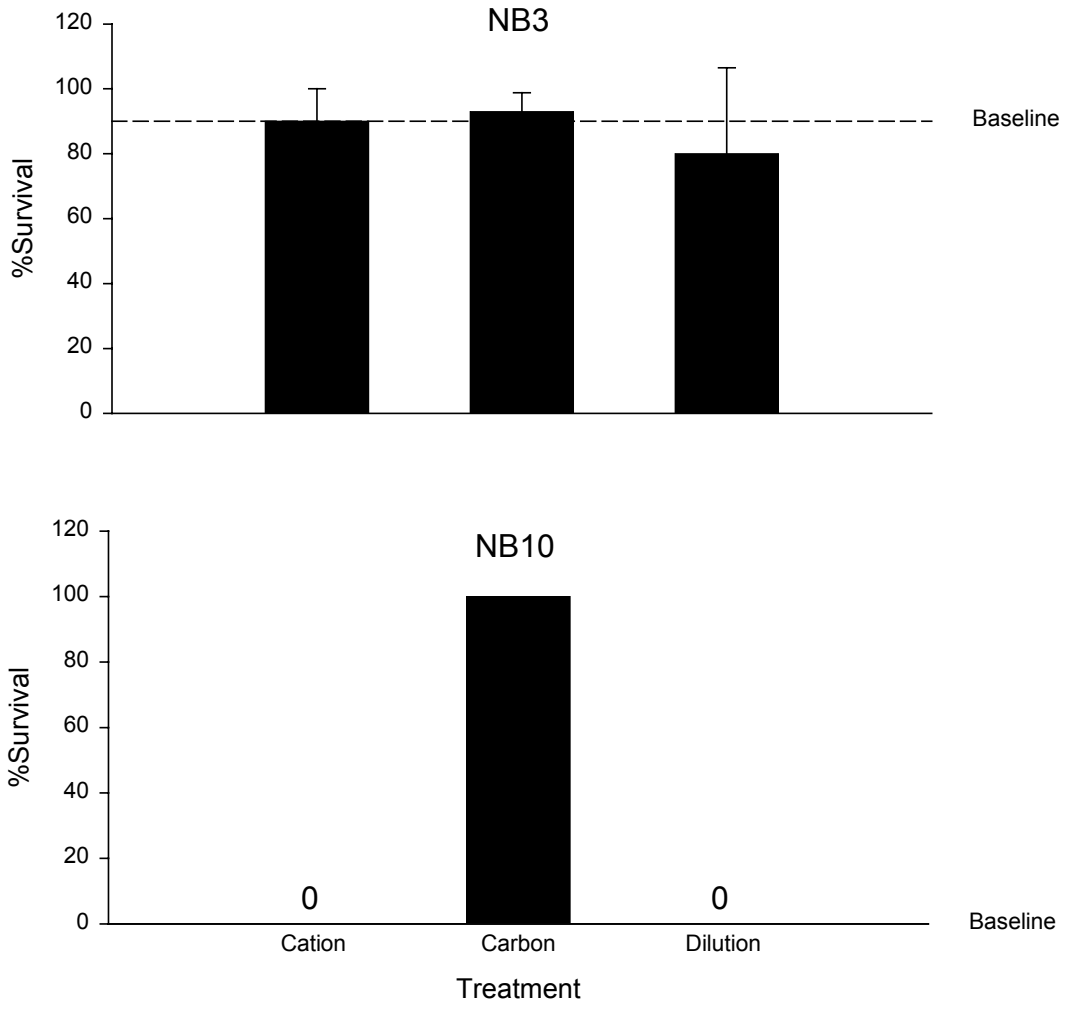

Figure 17. Results of toxicity identification evaluation treatments for November 2001 whole sediment samples from Newport Bay. Results for the amphipod survival test are expressed as mean + standard deviation.

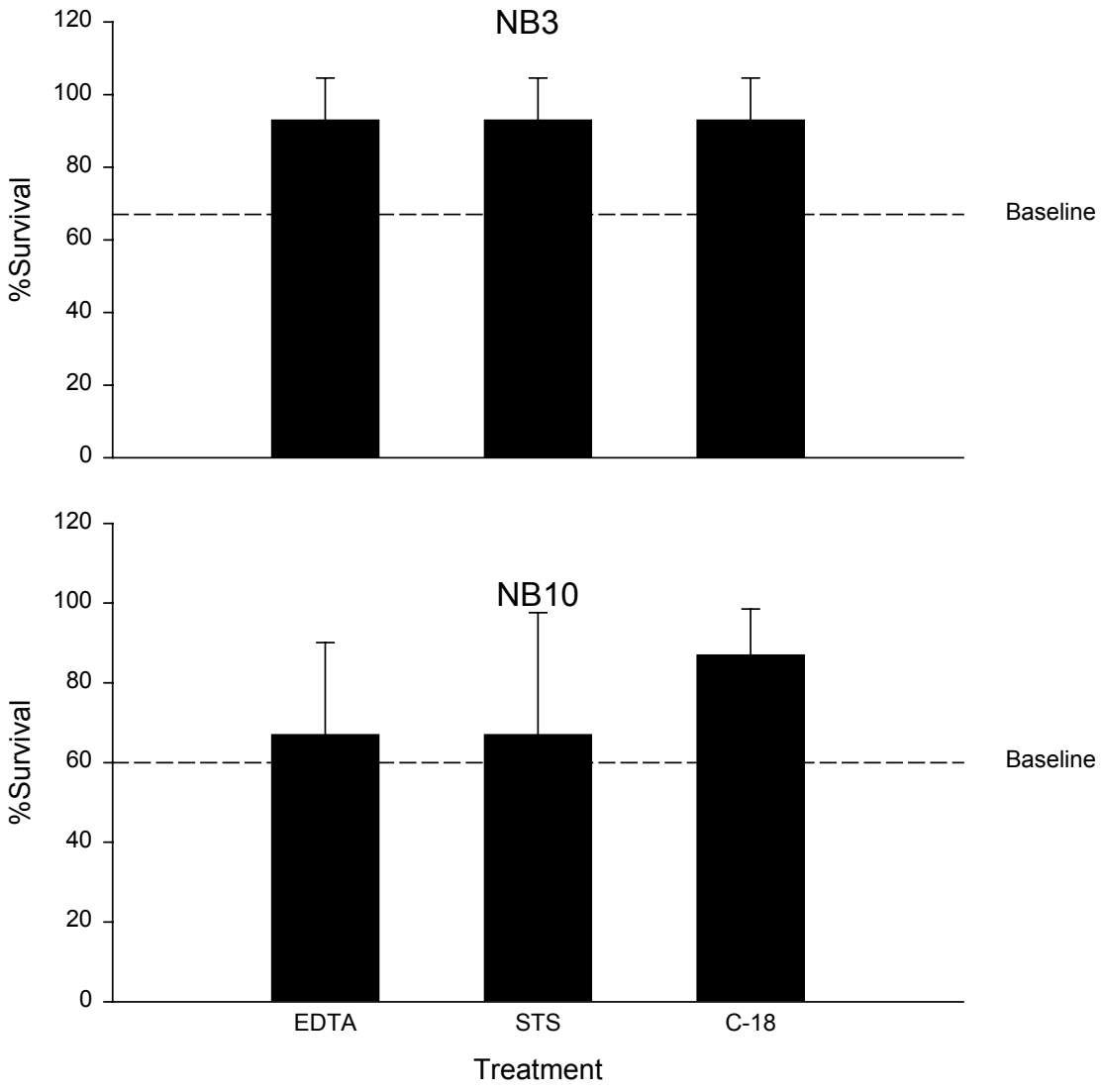

Figure 18. Amphipod survival test results for toxicity identification evaluation treatments on November 2001 sediment pore water samples from Newport Bay. The results are expressed as mean + standard deviation.

Table 11. Newport Bay selected sediment chemistry concentrations from a previous sampling (May 2001) and the November 2001 sampling for TIE.

		May 2001		November 2001	
Constituent	MDL	NB10	NB3	NB10	NB3
Metals	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum (Al)	1	15800	27300	46400	30450
Antimony (Sb)	0.05	ND	ND	0.820	0.755
Arsenic (As)	0.05	5	12	6.13	8.61
Barium (Ba)	0.05	119	92	160	80.9
Beryllium (Be)	0.01	NA	NA	0.785	0.560
Cadmium (Cd)	0.01	2	2	1.53	0.505
Chromium (Cr)	0.05	20	44	41.2	38.8
Cobalt (Co)	0.01	NA	NA	8.36	5.70
Copper (Cu)	0.01	21	607	38.5	540
Iron (Fe)	1	18800	33700	33100	27950
Lead (Pb)	0.01	13	87	15.8	57.0
Manganese (Mn)	0.05	219	216	326	200
Mercury (Hg)	0.005	0.03	5.8	0.24	4.95
Molybdenum (Mo)	0.05	NA	NA	2.90	4.71
Nickel (Ni)	0.01	12	23	19.6	15.1
Selenium (Se)	0.05	ND	ND	1.75	1.28
Silver (Ag)	0.01	ND	ND	0.35	0.30
Strontium (Sr)	0.05	NA	NA	86.0	90.2
Thallium (Tl)	0.01	NA	NA	0.40	0.27
Tin (Sn)	0.05	ND	ND	2.87	7.20
Titanium (Ti)	0.05	NA	NA	2270	1505
Vanadium (V)	0.05	NA	NA	95.7	71.1
Zinc (Zn)	0.05	103	366	160	238
Organics	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Total PCBs	1	ND	93.1	ND	158
Total PAHs	1	350	940	847	1970
Toxaphene	10	NA	NA	ND	ND
Chlordane-alpha	1	1.1	0.4	ND	ND
Chlordane-gamma	1	1.2	ND	ND	ND
Total DDTs	1	17.4	7.5	76.3	36.1

MDL = Method reporting limit
ND = Not detected
NA = Not analyzed

Table 12. Newport Bay sediment simultaneously extracted metals (SEM) and acid volatile sulfide (AVS) values from samples collected in November 2001.

Constituent	NB10 (μmoles/g)	NB10 (mg/kg)	NB3 (μmoles/g)	NB3 (mg/kg)
SEM				
Cadmium	0.00512	0.575	0.00126	0.142
Copper	0.000755	0.048	0.00464	0.295
Lead	0.0151	3.12	0.0516	10.7
Nickel	0.0273	1.6	0.0125	0.732
Zinc	0.489	32.0	1.22	79.7
Total SEM	0.54	37.3	1.29	91.5
AVS	54.9	1760	60.2	1930

Table 13. Water metals concentrations from November 2001 sampling. Values are from water column and sediment-water interface samples. All concentrations are in μg/L.

		Water Column				SWI	
		Total		Dissolved		Dissolved	
Metal	MDL	NB10	NB3	NB10	NB3	NB10	NB3
Aluminum	0.01	533	71.0	9.87	10.0	4.15	4.51
Antimony	0.01	0.165	0.165	0.251	0.207	0.419	0.276
Arsenic	0.01	2.07	1.71	1.80	1.72	1.70	1.33
Beryllium	0.005	ND	ND	ND	ND	ND	ND
Cadmium	0.005	0.124	0.151	0.116	0.183	0.168	0.298
Chromium	0.005	1.15	0.460	0.272	0.448	0.225	0.197
Cobalt	0.005	0.123	ND	0.00	ND	0.141	ND
Copper	0.005	2.02	12.4	1.31	10.8	0.519	5.78
Iron	0.01	237	42.0	9.15	3.41	47.6	16.6
Lead	0.005	0.266	0.168	0.051	0.053	0.040	0.162
Manganese	0.005	178	23.4	155	22.8	232	21.1
Mercury	0.005	ND	ND	ND	ND	ND	ND
Molybdenum	0.005	11.8	11.6	12.0	11.8	11.9	13.1
Nickel	0.005	1.95	1.42	1.76	1.35	1.64	1.20
Selenium	0.01	ND	ND	ND	ND	0.336	ND
Silver	0.005	ND	ND	ND	ND	ND	ND
Strontium	0.01	89.8	83.5	101	93.4	147	98.2
Thallium	0.005	ND	ND	ND	ND	0.009	0.018
Tin	0.005	ND	0.01	ND	ND	ND	0.02
Titanium	0.005	23.7	4.06	0.627	0.495	0.392	0.208
Vanadium	0.005	5.05	3.62	3.74	3.58	3.55	2.05
Zinc	0.005	12.9	34.6	10.0	33.8	9.65	50.7

ND= Not detectable.

March 2002 Samples

The March sampling was designed to both confirm the November results by resampling the same stations (NB3 and NB10) and to test for small scale spatial variability by sampling additional stations in Rhine Channel near NB3 (NB11 and NB12, 220 and 96 m from NB3, respectively) and in the upper bay near NB 10 (NB10B and NB10C, 26 and 66 m from NB10, respectively), as shown in Figure 14. Samples for water column, whole sediment, and pore water toxicity testing were collected. Sediment core samples for SWI testing were not taken due to time constraints. TIE tests on the pore water samples were performed on a subset of the samples, which were selected on the basis of the initial toxicity test results. For those pore water samples chosen for a TIE, the untreated sample was retested to assess any changes in toxicity that may have occurred during storage and to establish a baseline for the evaluation of TIE treatment effectiveness. Whole sediment TIEs were carried out on samples from all of the stations.

Upper Bay Stations

Toxicity

The water column samples had no effect on the sea urchin fertilization test at any of the NB10 stations (Table 14). All three stations had 98% or greater fertilization. Due to the lack of a toxic effect, no TIE treatments were performed on the water column samples.

Pore water from station NB10C was found to be toxic to the sea urchin fertilization test, with less than 10% of the eggs fertilized (Table 14). For stations NB10 and NB10B fertilization was 100% successful. The pore water from all three of the upper bay stations was very toxic to amphipods, with no animals surviving in any of the replicates after 10 days of exposure.

The whole sediment samples from all three stations in the upper bay were highly toxic to amphipods (Table 14). No amphipods survived a 10-day exposure to sediment from any of the three stations.

Toxicity characterization

When the TIE was performed on pore water from NB10C using the sea urchin fertilization test, it was found that the toxicity of the baseline sample was much less than had been observed in the initial sample. All of the TIE treatments increased fertilization success to at or near 100% (Figure 19).

TIEs were also performed on pore water from NB10 and NB10C using the amphipod survival test. C-18 extraction was the only treatment that reduced toxicity for NB10 at the end of the 10-day exposure (Figure 20). None of the treatments reduced toxicity for NB10C. Amphipod survival for the porewater TIE was also recorded after 4 days of exposure and showed a somewhat different response pattern. The baseline samples for NB10 and NB10C still showed no survival. However, C-18 extraction greatly improved survival for both stations and the STS treatment produced a small increase in survival for NB10C.

Whole sediment TIEs were performed on all three upper bay stations. The only TIE treatment that removed toxicity was the addition of coconut charcoal, which increased survival to greater than 70% for all three stations (Figure 21).

Table 14. Initial bioassay results for samples collected from Newport Bay in March 2002. Data expressed as mean ± standard deviation of the percent response for each endpoint.

			Upper Bay			Rhine Channel		
Organism	Endpoint	Matrix	NB10	NB10B	NB10C	NB3	NB11	NB12
sea urchin	fertilization	water	99 ± 1.3	98 ± 1.3	98 ± 0.5	82 ± 0.8	74 ± 2.3	76 ± 1.8
sea urchin	fertilization	PW	100 ± 0.5	100 ± 0.0	9 ± 5.1	2 ± 0.8	12 ± 3.3	97 ± 1.0
amphipod	survival	PW	0 ± 0	0 ± 0	0 ± 0	60 ± 13	35 ± 10	55 ± 30
amphipod	survival	sed	0 ± 0	0 ± 0	0 ± 0	56 ± 20	30 ± 24	54 ± 34

Matrix codes: water = water column; PW = pore water; sed = whole sediment

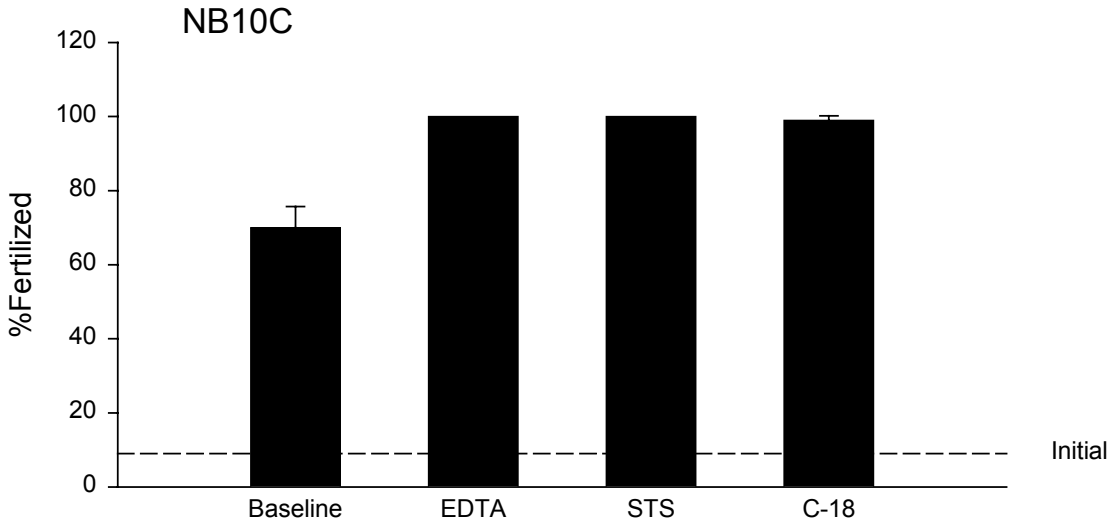

Figure 19. Results of TIE treatments for the March 2002 sediment pore water sample from upper Newport Bay. The sea urchin fertilization test results are expressed as mean + standard deviation.

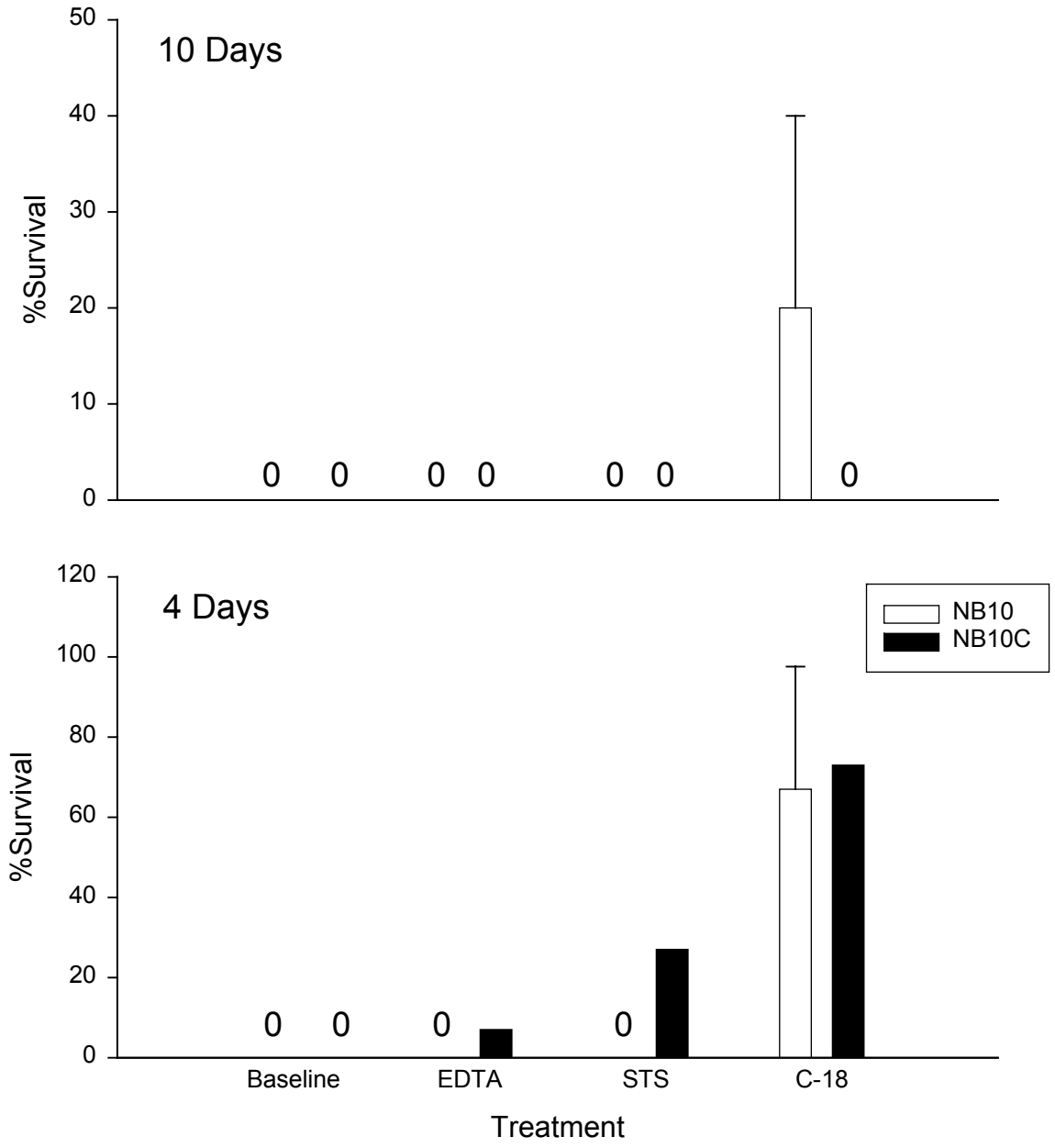

Figure 20. Amphipod survival test results for TIE treatments of March 2002 pore water samples from upper Newport Bay. Data are shown for the final 10-day exposure endpoint and for observations made after 4 days of exposure. Results are expressed as mean + standard deviation.

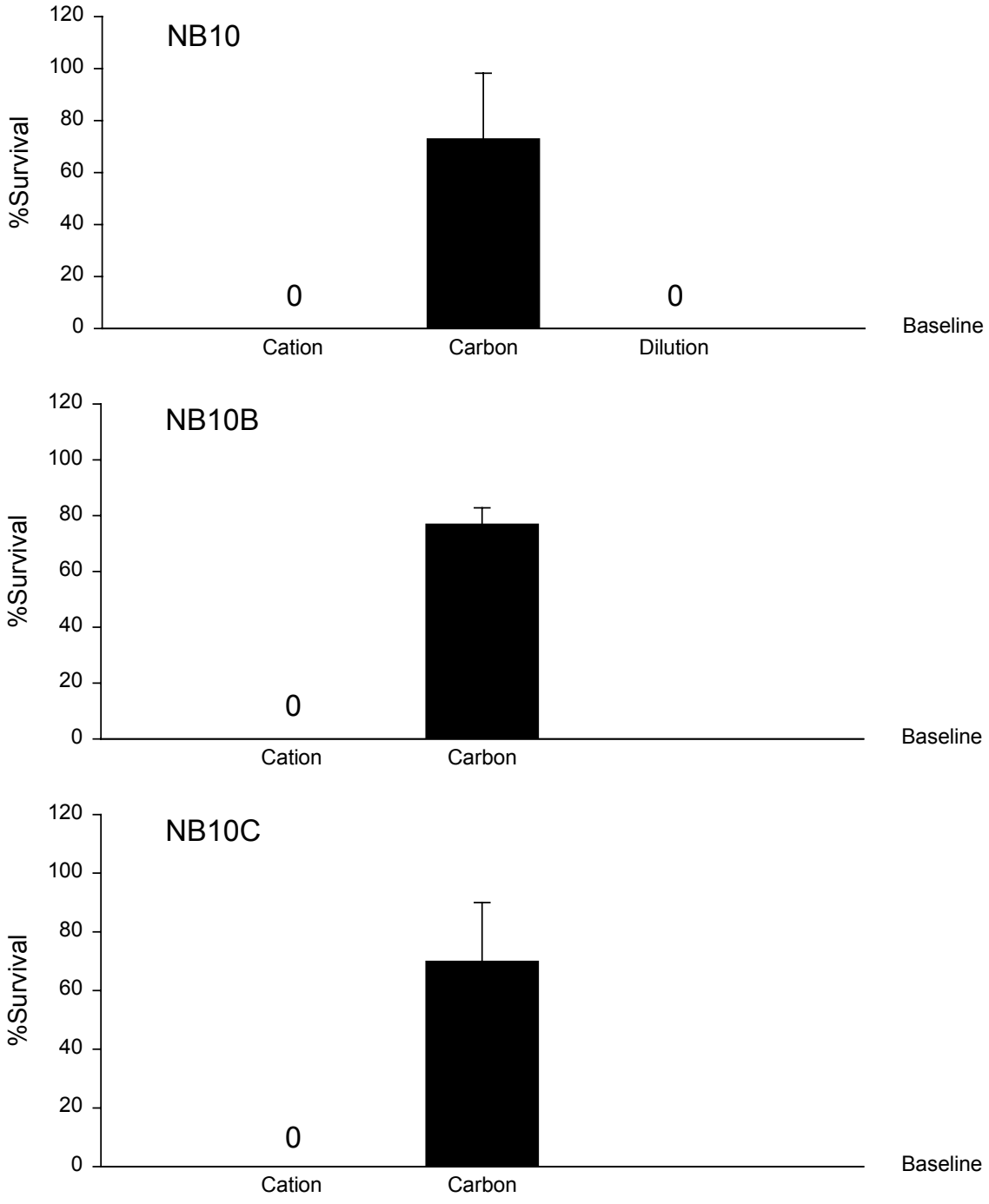

Figure 21. Amphipod survival test results for TIE treatments of March 2002 whole sediment samples from upper Newport Bay. Results are expressed as mean + standard deviation.

Sediment chemistry

Bulk sediment metals analysis was performed only on station NB10 (Table 15). Metals concentrations were similar to those observed in the previous sampling (Table 11). As before, cadmium, copper, mercury, nickel, and zinc fell between the TEL and PEL guidelines.

The concentrations of most trace organics were similar among the three upper bay stations (Table 15) and also were similar to concentrations previously measured for NB10 (Table 11). An exception to this similarity was noted for total PAHs, where the concentration for station NB10 was about a factor of two higher than the concentration for the other two stations. The concentration of total PAHs at NB10 were also about 50% greater than in the November 2001 sample, but were still below the TEL value. All three stations had total DDT concentrations that exceeded the PEL value.

Measurement of AVS/SEM again found that the AVS concentration substantially exceeded the concentration of SEM for all of the stations (Table 16). Zinc again accounted for most of the SEM value.

Water chemistry

The concentration of metals in the total and dissolved phases of the water column was measured for NB10 (Table 17). The concentrations of all metals were quite similar to those from the November 2001 sampling (Table 12). None of the metals were present at concentrations high enough to be expected to cause toxicity in the NB10 sample. A discrepancy in the reported concentrations of cadmium for station NB10 was present; the dissolved concentration was three times that of the total. The analytical laboratory checked these data and verified that they were correct and no quality control deviations were associated with the analysis. Additional sample was not available for reanalysis. It is assumed that the discrepancy in the cadmium data was due to variability associated with subsampling of the water sample, as different aliquots were analyzed for total and dissolved metals.

Rhine Channel Stations

Toxicity

The water column samples for NB3, NB11 and NB12 caused minor reductions in sea urchin fertilization, with means ranging from 74 to 82% (Table 14). Due to the lack of a strong toxic effect, no TIE treatments were performed on the water column samples.

Pore water from both NB3 and NB11 was very toxic to sea urchin sperm and produced only 2-12% successfully fertilized eggs (Table 14). NB12 pore water was not toxic to sea urchin sperm; fertilization was 97% at this station. Moderate toxicity of pore water to amphipods was measured for all three Rhine Channel stations with mean survival ranging from 35% to 60% (Table 14).

Sediment from all three of the Rhine Channel stations produced toxicity to amphipods. The mean survival for these stations ranged from 30 to 56% (Table 14). Between replicate variability was higher than expected for these stations, with standard deviations ranging from 19 to 34.

Toxicity characterization

TIEs conducted using the sea urchin fertilization test on pore water from NB3 and NB11 showed that toxicity had completely disappeared from the baseline samples during storage (Figure 22). All of the TIE treatments also produced high fertilization, as would be expected from the baseline test results. No information regarding the characteristics of water column toxicants was obtained from this experiment.

A TIE was also performed on pore water from NB11 using the amphipod survival test. None of the TIE treatments were successful at removing toxicity (Figure 23). The baseline survival for this test was similar to that measured in the initial toxicity test.

Sediment TIE treatments were conducted at all three Rhine Channel stations. The cation exchange resin removed some of the toxicity from NB11, but had little effect on the other two stations (Figure 24). Addition of carbon increased amphipod survival for both NB11 and NB12, but did not completely remove the toxicity. None of the treatments had an effect on amphipod survival for NB3 sediment.

Sediment Chemistry

Sediment bulk metals concentrations were measured for NB3 and followed the previously observed pattern of having higher concentrations of copper, lead, and zinc compared to NB10 (Table 15). The concentrations of most constituents in NB3 sediment were similar to the November 2001 sample (Table 11). The concentrations of copper and mercury exceeded the PEL guidelines by more than a factor of five, while zinc was only slightly over the value. Arsenic, chromium, lead, nickel and zinc concentrations fell between the TEL and the PEL.

Concentrations of organic compounds were higher at NB11 than the other two Rhine Channel stations (Table 15). As seen in previous samplings, the stations in Rhine Channel had higher PCB and PAH concentrations than those in upper Newport Bay. The upper bay stations contained higher concentrations of total DDTs than the Rhine Channel stations, however. Stations NB11 had a total DDTs concentration that exceeded the PEL, while the total DDTs concentrations at NB3 and NB12 were between the TEL and PEL. The concentrations of total PCBs and total PAHs at all three stations were between the TEL and PEL.

Sediment AVS concentrations greatly exceeded the concentration of SEM for all three Rhine Channel stations (Table 18). Zinc again accounted for greater than 80% of the SEM concentration.

Water chemistry

Water column chemistry was measured for station NB3. The concentrations of copper and zinc in the water column were greater than the concentrations measured for NB10 (Table 17). As seen in previous samples, the dissolved fraction of the water sample accounted for almost all of the total concentration for most of the metals. The concentration of dissolved zinc at station NB3 was 29 µg/L, which was above the concentration likely to cause partial toxicity in the sea urchin fertilization test. The concentrations of the other metals were below levels associated with toxicity to sea urchin sperm. A discrepancy in the reported concentrations of cadmium for station NB3 was present; the dissolved concentration was twice that of the total. The analytical

laboratory checked these data and verified that they were correct and no quality control deviations were associated with the analysis. Additional sample was not available for reanalysis. It is assumed that the discrepancy in the cadmium data was due to variability associated with subsampling of the water sample, as different aliquots were analyzed for total and dissolved metals.

Table 15. Concentrations of sediment constituents in samples from the March 2002 Newport Bay sampling.

		Upper Bay			Rhine Channel		
Constituent	MDL	NB10	NB10B	NB10C	NB3	NB11	NB12
Metals (mg/kg)							
Aluminum	1	50700	NA	NA	39700	NA	NA
Antimony	0.05	0.845	NA	NA	0.675	NA	NA
Arsenic	0.05	7.14	NA	NA	10.2	NA	NA
Barium	0.05	184	NA	NA	125	NA	NA
Beryllium	0.01	0.925	NA	NA	0.810	NA	NA
Cadmium	0.01	1.90	NA	NA	0.635	NA	NA
Chromium	0.05	50.0	NA	NA	53.0	NA	NA
Cobalt	0.01	9.54	NA	NA	7.54	NA	NA
Copper	0.01	60.0	NA	NA	532	NA	NA
Iron	1	38850	NA	NA	36050	NA	NA
Lead	0.01	21.4	NA	NA	85.0	NA	NA
Manganese	0.05	351	NA	NA	251	NA	NA
Mercury	0.005	0.295	NA	NA	6.69	NA	NA
Molybdenum	0.05	3.31	NA	NA	4.71	NA	NA
Nickel	0.01	23.4	NA	NA	19.8	NA	NA
Selenium	0.05	2.36	NA	NA	1.52	NA	NA
Silver	0.01	0.405	NA	NA	0.39	NA	NA
Strontium	0.05	124	NA	NA	82.0	NA	NA
Thallium	0.01	0.44	NA	NA	0.37	NA	NA
Tin	0.05	3.74	NA	NA	9.66	NA	NA
Titanium	0.05	2340	NA	NA	1770	NA	NA
Vanadium	0.05	112	NA	NA	98.2	NA	NA
Zinc	0.05	219	NA	NA	294	NA	NA
TOC (%)		1.1	2.1	2.3	1.6	1.6	1.7
Organics (µg/kg)							
Total PCBs	1	ND	7	6	157	183	126
Total PAHs	1	1220	791	558	1810	4460	1360
Toxaphene	10	ND	ND	ND	ND	ND	ND
Chlordane-alpha	1	ND	2	3	ND	ND	ND
Chlordane-gamma	1	ND	2	3	ND	ND	ND
Total DDTs	1	73	106	112	41	88	48

NA=Not analyzed.
ND=Not detected.

Table 16. Sediment acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) data for three upper bay stations from the March 2002 sampling.

	μmoles/g			mg/kg		
Constituent	NB10	NB10B	NB10C	NB10	NB10B	NB10C
SEM						
Cadmium	0.00483	0.0066	0.0056	0.543	0.742	0.630
Copper	0.00016	0.0001	0.0004	0.102	0.062	0.028
Lead	0.0191	0.0197	0.0153	3.96	4.08	3.16
Nickel	0.0230	0.0315	0.0291	1.35	1.85	1.71
Zinc	0.703	1.02	0.674	46.0	67.0	44.1
Total SEM	0.750	1.08	0.72	52.0	73.7	49.6
AVS	66.7	106	81.4	2140	3400	2610

Table 17. Water column metals concentrations from March 2002 sampling. All concentrations are in μg/L.

		Total		Dissolved	
Description	MDL	NB10	NB3	NB10	NB3
Aluminum	0.01	318	48.7	ND	ND
Antimony	0.01	0.200	0.255	0.230	0.160
Arsenic	0.01	1.48	1.33	1.38	1.37
Beryllium	0.005	ND	ND	ND	ND
Cadmium	0.005	0.06	0.05	0.18	0.11
Chromium	0.005	0.63	0.39	0.25	0.28
Cobalt	0.005	0.155	ND	0.11	ND
Copper	0.005	1.98	8.24	1.39	7.94
Iron	0.01	177	24.4	0.05	ND
Lead	0.005	0.260	0.130	0.010	0.040
Manganese	0.005	54.9	16.7	48.8	16.2
Mercury	0.005	ND	ND	ND	ND
Molybdenum	0.005	11.4	10.3	11.6	10.9
Nickel	0.005	0.945	0.475	0.800	0.500
Selenium	0.01	0.180	0.055	0.170	0.040
Silver	0.005	ND	ND	ND	ND
Strontium	0.01	79.4	121	83.8	207
Thallium	0.005	0.010	0.010	0.010	0.010
Tin	0.005	0.020	0.055	0.010	0.030
Titanium	0.005	19.3	3.87	0.050	0.060
Vanadium	0.005	4.59	2.96	3.66	2.74
Zinc	0.005	9.63	29.8	7.23	29.3

ND=Not detected.

Table 18. Sediment acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) data for three Rhine Channel stations from the March 2002 sampling.

	µmoles/g			mg/kg		
Constituent	NB3	NB11	NB12	NB3	NB11	NB12
SEM						
Cadmium	0.0014	0.0022	0.0012	0.152	0.244	0.136
Copper	0.0349	0.017	0.0018	2.22	1.08	0.116
Lead	0.0709	0.0956	0.0429	14.7	19.8	8.89
Nickel	0.0104	0.0189	0.010	0.613	1.11	0.588
Zinc	1.28	1.84	1.35	84.0	120	88.6
Total SEM	1.40	1.97	1.41	102	142	98.3
AVS	36.8	73.3	47.4	1180	2350	1520

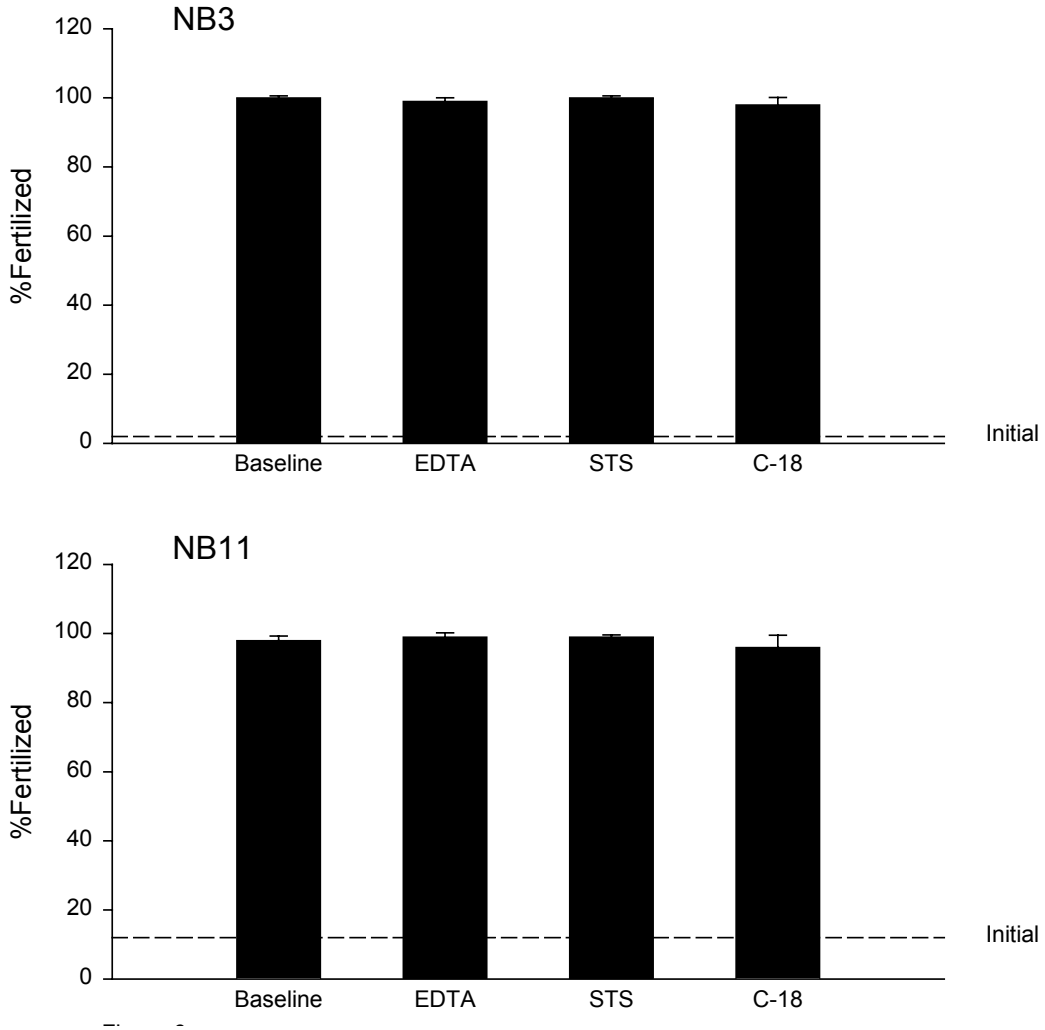

Figure 22. Results of TIE treatments for March 2002 sediment pore water samples from the Rhine Channel. The sea urchin fertilization test results are expressed as mean + standard deviation.

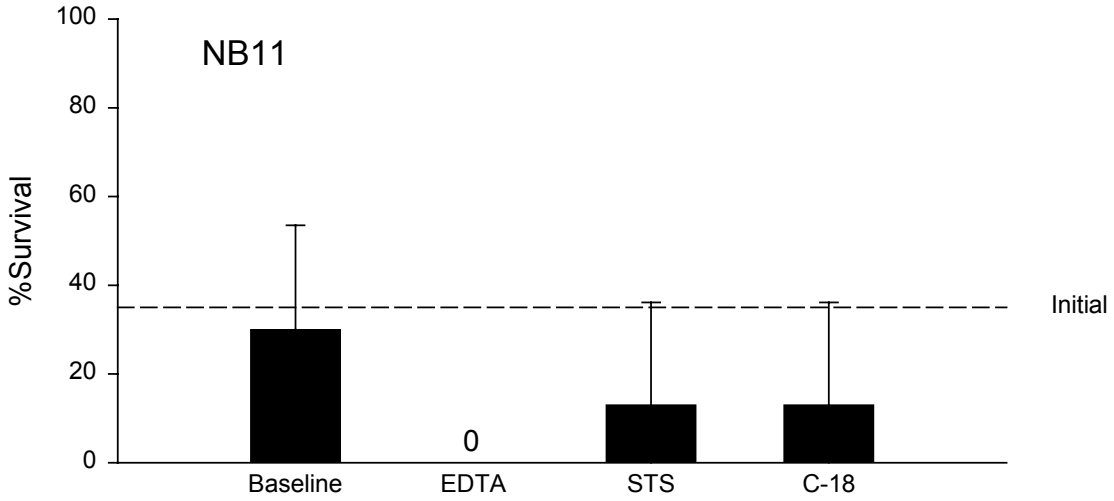

Figure 23. Amphipod survival test results for TIE treatments to the March 2002 pore water sample from Rhine Channel. Results are expressed as mean + standard deviation.

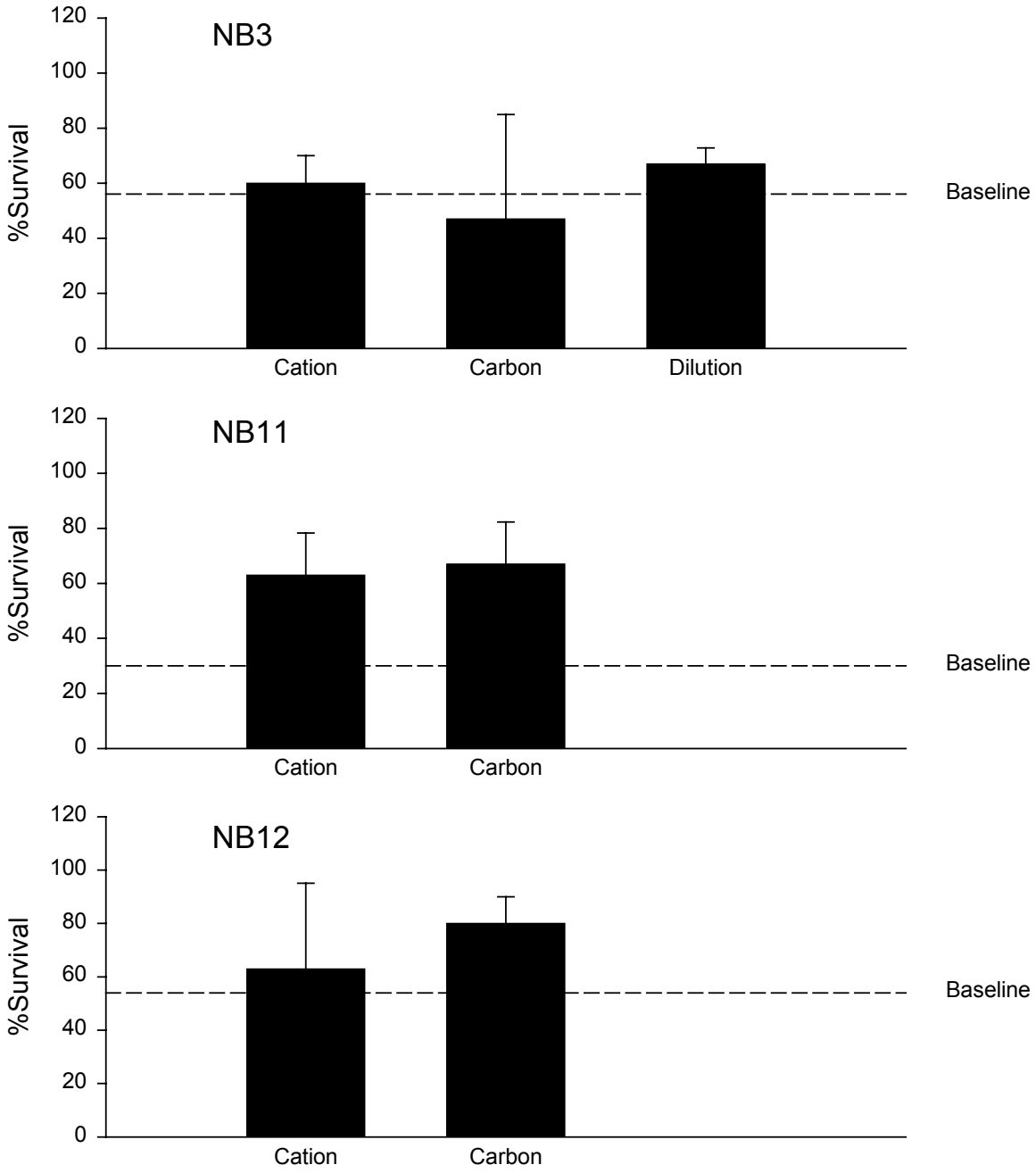

Figure 24. Results of TIE treatments for March 2002 whole sediment samples from Rhine Channel. The amphipod survival test results are expressed as mean + standard deviation.

Discussion

This project has produced a wealth of new information regarding the toxicity and characteristics of the sediments and water column of Newport Bay. The information presented in this report is relevant to many issues of concern regarding the status of Newport Bay. This study was successful in addressing the three primary objectives of the project: 1) provide a recent assessment of the extent of sediment toxicity and contamination in Newport Bay, 2) determine whether sediments represent a significant source of toxicity to water column organisms in Newport Bay, and 3) identify which sediment constituents are responsible for adverse biological effects. The relevance of the results to these objectives is discussed in the following sections.

Sediment Toxicity and Contamination in Newport Bay

The results of the two spatial surveys confirm that sediment toxicity is prevalent throughout Newport Bay. The amphipod toxicity test results indicated that the same spatial pattern of toxicity was present in September 2000 and May 2001 (Tables 2 and 3), suggesting that toxicity is persistent year-round and not strongly influenced by seasonal factors such as temperature and salinity. These results also show that sediment toxicity is widespread in the upper portion of Newport Bay, an ecological reserve and important resource for wildlife.

The sediment toxicity results are similar to those obtained in the 1998 Southern California Bight regional monitoring survey (Bay *et al.* 2000). The 2000-2001 spatial surveys found toxicity at 70% of the stations, with 80% of the lower bay stations toxic. In 1998, the Bight survey analyzed sediments from 11 stations in the lower bay and detected toxicity at 82% of the sites. The 2000-2001 results confirm the finding of the 1998 Bight study that sediment toxicity in Newport Bay is more extensive and severe than in other developed southern California Bays. For comparison, the 1998 Bight survey detected toxicity in 16% of the samples from San Pedro Bay and 5% of the samples from San Diego Bay. All of these toxicity tests used the same species, *Eohaustorius estuarius*, and comparable standardized methods.

Sediment contamination was prevalent throughout Newport Bay and exceeded several of the sediment quality guidelines used for TMDL development. Nine of the ten stations exceeded the low level sediment quality guideline screening value (Florida Threshold Effects Level, TEL) for at least one contaminant, while only two stations (NB3 and NB4) contained concentrations above guideline values associated with a higher probability of adverse effects (Florida Probable Effects Level, PEL). In most cases, the exceedances were due to elevated concentrations of Cu, Hg, Zn, and DDTs (see Appendix for summary of guideline exceedances).

Sediment contamination patterns in Newport Bay are complex and bulk measurements of sediment chemistry or chemical specific-sediment guidelines were found to have a low correspondence with the measurements of sediment toxicity. The complexity of the contamination patterns is illustrated by the results of a correlation analysis of the chemistry and sediment toxicity data (Table 19). Most of the metals showed a relatively high negative correlation with sediment toxicity, indicating that survival tended to decrease as concentration increased. However, the concentrations of most trace metals were also highly correlated with each other, indicating that these elements share common sources. For example, copper, lead, and

zinc were strongly correlated with each other (r=0.82-0.95). High correlations were also usually present between trace metals and grain size (% fines) or iron, indicating that some of the variation in metal concentrations is due to geological characteristics. Relatively low correlations were present between sediment toxicity and the concentration of trace organics (PCBs, PAHs, or DDTs).

Plots of amphipod survival versus grain size (% clay) or selected contaminants demonstrate that none of the measured chemical constituents appears to be individually responsible for the bulk of the sediment toxicity observed. Sediment grain size is recognized as a potentially confounding factor in some toxicity tests. The percent of clay ranged from less than 3% to 57% in this study and did not show a consistent relationship with toxicity that would suggest a substantial interference with the test results (Figure 25). Toxicity versus concentration plots for selected metals (arsenic, cadmium, and copper) illustrate the general trend found for most metals: a wide range of toxic and nontoxic samples at relatively low concentrations accompanied by intermediate toxic responses at the highest concentrations (Figures 26-28). In most cases (e.g., arsenic, cadmium, and copper) the samples with metal concentrations below the TEL had a similar range of toxicity values as those exceeding the guideline. A less consistent pattern is present for the measured organic constituents, such as total DDT (Figure 29).

Due to the highly intercorrelated nature of most contaminated sediments, calculation of a summary measure of the overall magnitude of contamination, such as the mean ERM (NOAA Effects Range Median) quotient often provides a more reliable indication of the potential for biological effects (Long *et al.* 2000). Chemical contamination levels at most of the 10 stations resulted in mean ERM quotients that were less than 0.1 and indicative of a low probability of sediment toxicity (Figure 30). Overall contamination was most severe at stations NB3 (mean ERM quotient = 0.56-0.61) and NB4 (mean ERM quotients = 0.16-0.18) and these stations were consistently toxic to amphipods. Stations NB3 and NB4 are located in blind channels of the lower bay, areas where reduced water circulation and marine-related activities tend to encourage the accumulation of sediment-associated contaminants (Figures 31-32). The mean ERM quotient was relatively highly correlated with reduced amphipod survival, but this summary value still provided little ability discriminate among most of the toxic and nontoxic sediments of Newport Bay, as shown in Figure 30.

Influence of Sediment Contamination on Water Column Toxicity

The results of this study indicate that sediment contamination is a contributing, but not the only, factor affecting water column toxicity in Newport Bay. Water samples collected from most of the stations were toxic to sea urchin sperm during both of the spatial surveys (Tables 2 and 3). Both sediment and water column toxicity was widespread throughout Newport Bay, which makes it difficult to identify an association with sediment contamination solely on the basis of the location of the toxic samples.

Three other lines of evidence suggest that sediment characteristics influence water column toxicity in Newport Bay. First, the sediment-water interface test results from May 2001 detected toxicity in four of the five samples tested. These test results confirm that toxic constituents are able to diffuse out of surface sediments under laboratory conditions. A second line of evidence is available from the results of a related study on the toxicity of sediments from the Rhine

Channel (Bay and Brown 2003). The Rhine Channel study conducted sediment-water interface tests on sediments from multiple locations and detected toxicity at many of the sites. Chemical analysis of the overlying water from these tests showed elevations in the concentration of dissolved copper, nickel, mercury, selenium, and zinc compared to a control sample that was not exposed to sediment. A final line of evidence is obtained from the results of the TIE investigations conducted for the present study. TIE sampling in March 2002 included analysis of the concentration of dissolved metals in water column samples from two stations, NB3 and NB10. These analyses showed elevated concentrations of zinc and copper at NB3, relative to NB10; a trend that corresponded to the sediment metal concentrations at these two sites.

The present study also provides evidence that water column toxicity is strongly influenced by urban runoff. Analyses of water samples collected following a January 2001 storm event detected toxicity in the upper Bay where the runoff discharge plume was most concentrated. A difference in the species-specific pattern of toxic response to the wet and dry weather samples was present. Both sets of samples were tested using two species, the purple sea urchin (fertilization and development tests) and a mysid (survival and growth tests). The dry weather samples were toxic only to the sea urchin, while the wet weather samples were toxic only to the mysid. These results indicate that the constituents of concern for water column toxicity differ between stormwater and dry weather samples.

Based on prior TIE studies of runoff from the Newport Bay watershed and the relative sensitivity of mysids and sea urchins to specific contaminants, organophosphorus pesticides and metals are likely to have been the principal toxic constituents for the wet weather and dry weather samples, respectively. This preliminary conclusion cannot be verified by the data presented in this report, however, because TIE studies of the water column samples were not conducted.

Characterization of Toxicants

TIE analyses were conducted on 18 samples from two locations, the upper bay (near NB10) and Rhine Channel (NB3 and other stations). Analyses of both the bulk sediment and an aqueous fraction (pore water or water from the sediment-water interface) were conducted for each location. Additional studies are needed to identify specific toxicants, but the results indicate that multiple toxicants of concern are present at each site and that the effects are not due to naturally occurring factors such as sediment grain size and ammonia. The results also indicate that the cause of toxicity is partially dependent upon the type of exposure matrix (i.e., sediment or water) studied.

Sediment Toxicity

Relatively consistent results from the toxicity characterization tests of sediment from the upper Bay (stations NB10, 10B, and 10C) were obtained (Table 20). In all cases, addition of powdered carbon to the sediment was highly effective at reducing toxicity to amphipods, suggesting that nonpolar organic constituents were the dominant type of toxicant present. Carbon is a relatively nonspecific treatment that has the capacity to bind many types of constituents including metals, but the lack of effectiveness of the concurrent cation exchange resin treatment suggests that metals were not a principal cause of the observed toxicity. The AVS/SEM analyses (Tables 12 and 16) also indicated that metals are not likely to be biologically available to the amphipods.

Review of the analytical chemistry results suggests that the trace organic constituents measured in this study are not likely to be responsible for the toxicity at the upper bay site. The concentrations of DDTs, PCBs, and PAHs in the upper bay samples were less than the concentrations associated with consistent toxicity in other regions (e.g., Washington Apparent Effects Threshold, AET) (Barrick *et al.* 1988). In addition the very strong toxic response by the amphipods at this site (<5% survival) has not been observed at other locations throughout Newport Bay, suggesting that an unmeasured contaminant with a source related to runoff discharge is responsible. An organic pesticide in current use, such as an organophosphorus or pyrethroid compound, is a likely candidate. This speculation cannot be confirmed by this study, however, because these pesticide groups were not measured.

TIE analyses of the Rhine Channel sediments were less effective at characterizing the likely toxicants. Sediments from three stations within Rhine Channel produced different patterns of response to the TIE treatments (Table 20). Addition of the cation exchange resin was partially effective at two stations, suggesting that metals may be a contributing factor. Neither carbon nor cation exchange resin addition reduced the toxicity at station NB3, however. These results suggest that multiple toxicants may be present within Rhine Channel. Amphipod toxicity in the Rhine channel does not correspond strongly to the sediment chemistry data, suggesting either that unmeasured contaminants are present or that the conventional sediment chemistry analytical methods do not adequately represent the biologically available contaminant fraction.

Porewater and Sediment-Water Interface Toxicity

Results from the TIE analyses of pore water from the upper bay stations are consistent with the results for bulk sediment and indicate that the toxicity to amphipods is due to a nonpolar organic compound. This conclusion is based upon the results of a total of three TIE analyses, conducted on two dates and at two different locations. Extraction of the pore water using a C-18 column was the only effective treatment in each case (Table 21). A single TIE analysis of a pore water sample using the sea urchin fertilization test yielded a different pattern of response; the EDTA, sodium thiosulfate, and C-18 treatments were all effective. This pattern of response is suggestive of a trace metal or a mixture of toxicant types, which indicates that the sea urchin sperm are responding to a different type of toxicant than the amphipods. Greater specificity regarding the cause of toxicity to either amphipods or sea urchins cannot be obtained with the existing data.

The TIE results for pore water or SWI samples from the Rhine Channel sediments were less consistent than those from the upper bay. Toxicity of the SWI and pore water samples from station NB3 was reduced by both EDTA and C-18 column extraction (Table 21), suggesting that the predominant cause of toxicity was either a metal that was also removed by the C-18 column or a mixture of toxicants. Laboratory studies have demonstrated that extraction by a C-18 column can reduce the toxicity of seawater spiked with copper or zinc, presumably by nonspecific adsorption to the resin particles (Schiff *et al.* 2003). Toxicity characterization of three Rhine Channel porewater samples from the March 2002 collection were not successful, due to either the loss of toxicity upon storage of the sediment or the ineffectiveness of the treatments (Table 21). The inability of the TIE treatments to reduce the toxicity of the porewater sample from station NB11 suggests that the toxicant was not a trace metal, as the EDTA treatment is usually highly effective at neutralizing the toxicity of dissolved metals at the concentrations likely to be encountered in the field. The nature of the toxicant in the NB11 sample cannot be

discerned without further testing, but it is possible that a polar organic compound may responsible; such a compound would be poorly retained by the C-18 column and would not be neutralized by EDTA treatment.

Recommendations for Toxicant Identification

The TIE analyses were successful in identifying the key characteristics of some of the toxicants present in Newport Bay sediments. The characterization techniques employed in this study represent the first phase in a multi-step, iterative procedure. Additional research is needed in order to identify specific toxic constituents likely be the cause of toxicity and to verify that these constituents are active under the conditions present in Newport Bay. The use of TIE techniques to identify the cause of sediment toxicity is a developing field, and standardized techniques are not yet available for the identification and verification phases. Several methods are available, however, that should be able to provide greater specificity and confidence in the TIE results. The following activities are recommended to increase the understanding of the causes of sediment toxicity in Newport Bay:

- **Conduct additional toxicant characterization studies in the Rhine Channel and upper bay**
  Many of the TIE samples from the Rhine Channel yielded inconclusive results due to a lack of toxicity. Characterization results from additional samples of bulk sediment and pore water are needed in order to effectively guide the more costly toxicant identification and procedures. TIE results for a single porewater sample from station NB10C indicated that metals might be contributing to the toxicity to sea urchin sperm. Additional pore water characterization studies are needed to confirm this result.

- **Include TIE procedures specific for pesticides**
  The amphipod TIE results for pore water and bulk sediment suggest that an organic toxicant other than DDTs, PCBs, or PAHs is present. TIE procedures for pore water that are effective in identifying organophosphorus and possibly pyrethroid pesticides (e.g., ELISA chemical analysis and the use of metabolic inhibitors/synergists) are available and should be included in future studies. Similar methods for sediment have not yet been developed, however.

- **Analyze the sediments for additional organic compounds; including pesticides in current use**
  The presence of high toxicity to amphipods in both the sediment and porewater experiments suggests that an organic compound with relatively high water solubility is responsible. Other than some of the PAHs, these constituents are not typically analyzed for in sediments and specialized methods may be needed. The analysis suite should include pesticides in current use throughout the watershed.

- **Measure the porewater concentration of metals and selected organics**
  Measurement of dissolved metal concentrations in the pore water from the upper bay stations is needed to verify initial results suggesting that trace metals are partially responsible for the porewater toxicity to sea urchins. Analysis of the pore water for polar and nonpolar organics would also help identify the constituents causing amphipod mortality, as this aqueous matrix is likely to include those compounds with the greatest bioavailability to the test organisms.

- **Use fractionation procedures to identify candidate nonpolar and polar toxic organic compounds**
  The presence of multiple unknown compounds in sediment extracts may mask or complicate the analysis of some toxic constituents. The use of HPLC or selective extraction techniques followed by toxicity analysis of the fractions may identify specific contaminant groups that are associated with the toxicity but are not measured when conventional analytical methods are used.

Table 19. Relationship between sediment chemistry and toxicity for Newport Bay stations sampled in September 2000 and May 2001 (n=20). The top number in each box is the Spearman rank correlation coefficient, while the bottom number represents the level of significance (p value). Non-detect values were treated as equal to 0.

Label	% Fines	% TOC	As	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn	Total PCBs	Total PAHs	Total DDTs	Mean ERMq
%TOC	0.35 0.13															
As	0.73 0.00	0.59 0.01														
Cd	0.67 0.00	0.42 0.07	0.63 0.00													
Cr	0.85 0.00	0.54 0.01	0.94 0.00	0.73 0.00												
Cu	0.68 0.00	0.61 0.00	0.94 0.00	0.47 0.04	0.88 0.00											
Fe	0.89 0.00	0.56 0.01	0.93 0.00	0.74 0.00	0.99 0.00	0.86 0.00										
Hg	0.30 0.21	0.60 0.01	0.67 0.00	0.39 0.09	0.63 0.00	0.68 0.00	0.57 0.01									
Mn	0.95 0.00	0.44 0.05	0.78 0.00	0.80 0.00	0.88 0.00	0.66 0.00	0.92 0.00	0.33 0.16								
Ni	0.90 0.00	0.58 0.01	0.88 0.00	0.77 0.00	0.97 0.00	0.82 0.00	0.98 0.00	0.55 0.01	0.93 0.00							
Pb	0.49 0.03	0.87 0.00	0.76 0.00	0.34 0.14	0.71 0.00	0.82 0.00	0.69 0.00	0.70 0.00	0.49 0.03	0.70 0.00						
Zn	0.63 0.00	0.78 0.00	0.91 0.00	0.53 0.02	0.86 0.00	0.95 0.00	0.85 0.00	0.71 0.00	0.68 0.00	0.84 0.00	0.90 0.00					
Total PCBs	0.15 0.54	0.58 0.01	0.67 0.00	0.16 0.51	0.51 0.02	0.70 0.00	0.49 0.03	0.72 0.00	0.20 0.39	0.42 0.07	0.68 0.00	0.70 0.00				
Total PAHs	-0.11 0.65	0.79 0.00	0.21 0.37	0.06 0.81	0.14 0.56	0.28 0.24	0.12 0.61	0.58 0.01	-0.03 0.91	0.15 0.54	0.64 0.00	0.45 0.04	0.49 0.03			
Total DDTs	0.72 0.00	0.55 0.01	0.52 0.02	0.47 0.04	0.57 0.01	0.48 0.03	0.62 0.00	0.23 0.33	0.72 0.00	0.66 0.00	0.59 0.01	0.52 0.02	0.22 0.36	0.22 0.34		
Mean ERMq	0.65 0.00	0.77 0.00	0.92 0.00	0.56 0.01	0.88 0.00	0.94 0.00	0.87 0.00	0.75 0.00	0.70 0.00	0.86 0.00	0.88 0.00	0.99 0.00	0.70 0.00	0.47 0.04	0.53 0.02	
Amphipod survival	-0.42 0.06	-0.44 0.05	-0.51 0.02	-0.47 0.04	-0.43 0.06	-0.39 0.09	-0.47 0.03	-0.20 0.41	-0.55 0.01	-0.42 0.06	-0.30 0.20	-0.40 0.08	-0.09 0.70	-0.26 0.26	-0.45 0.05	-0.43 0.06

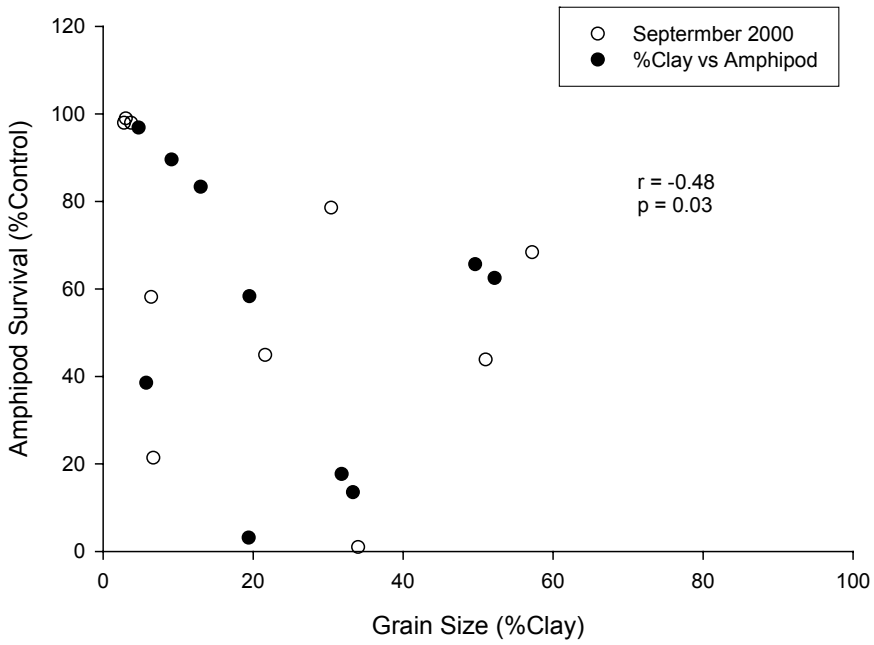

Figure 25. Relationship between amphipod survival and sediment grain size (% clay) in Newport Bay sediment samples.

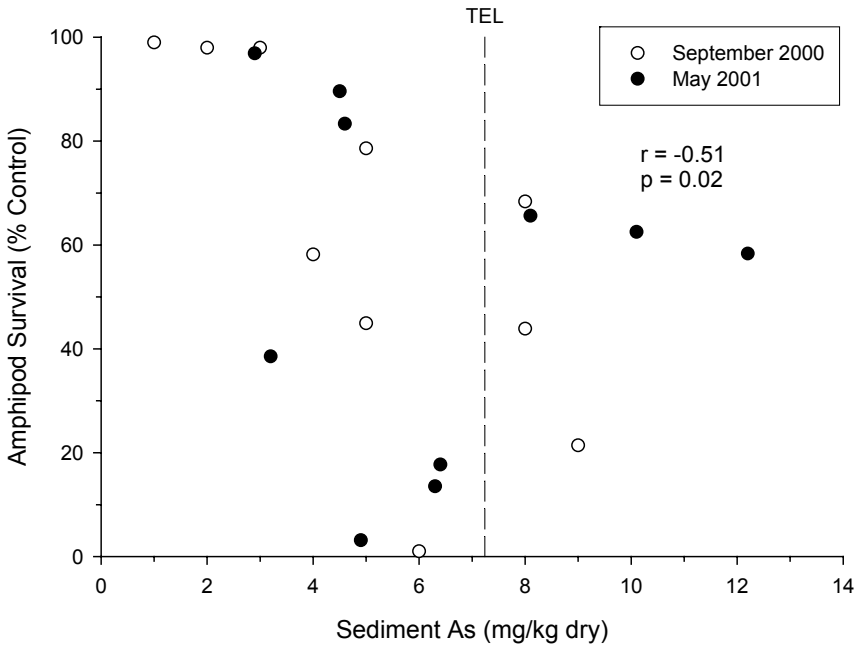

Figure 26. Relationship between amphipod survival and concentration of arsenic in Newport Bay sediment samples.

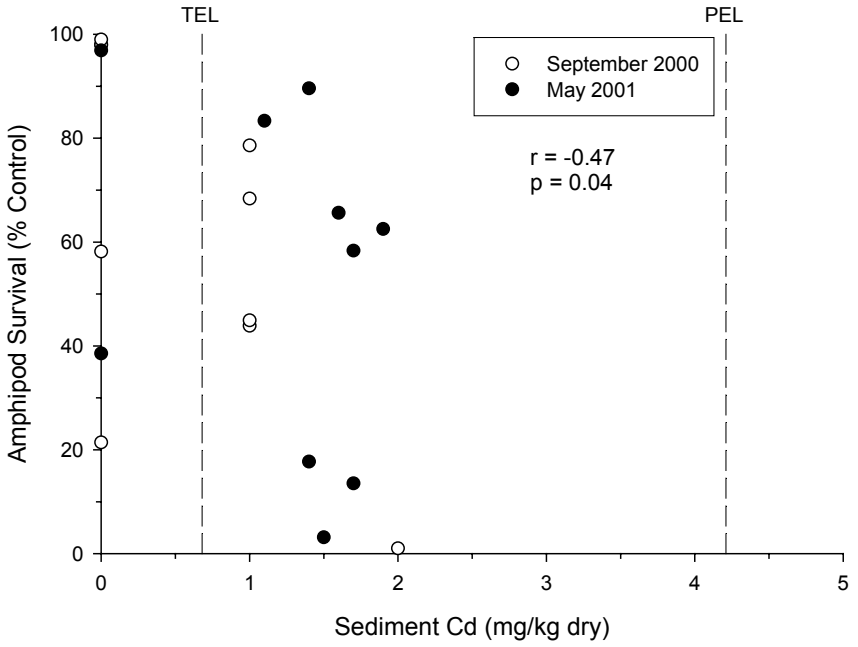

Figure 27. Relationship between amphipod survival and concentration of cadmium in Newport Bay sediment samples.

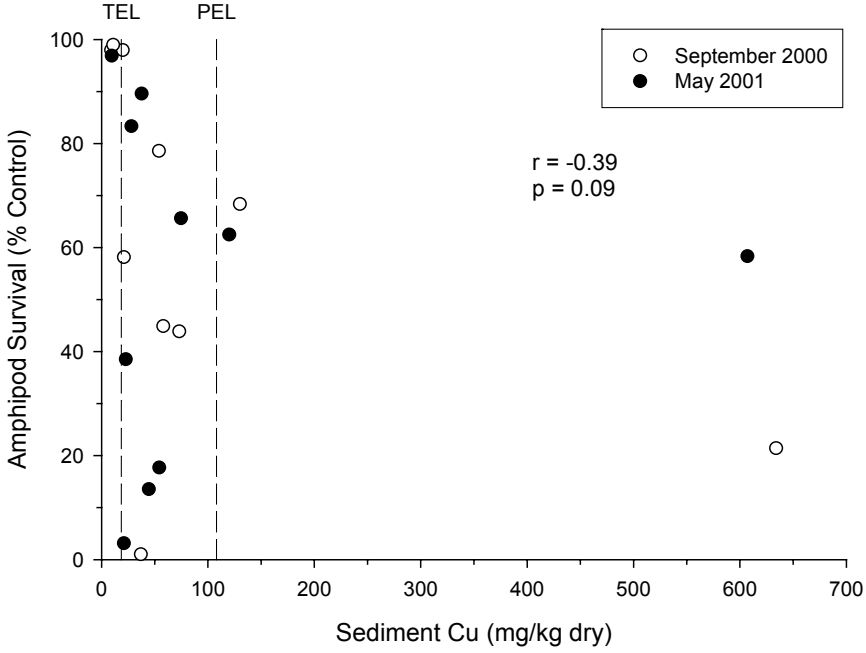

Figure 28. Relationship between amphipod survival and concentration of copper in Newport Bay sediment samples.

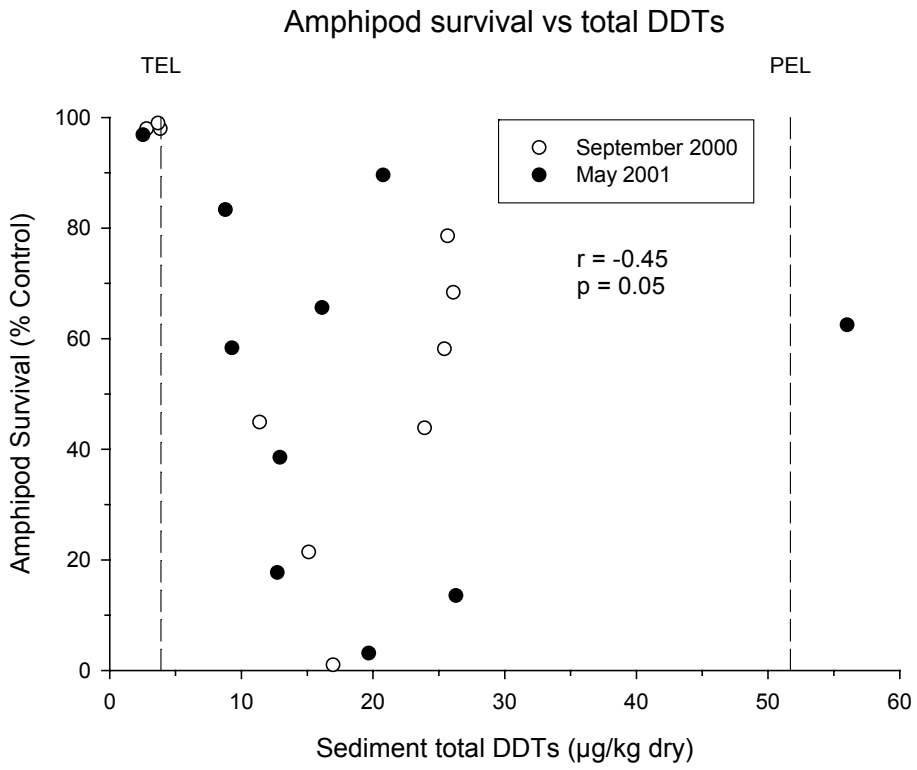

Figure 29. Relationship between amphipod survival and concentration of DDTs in Newport Bay sediment samples.

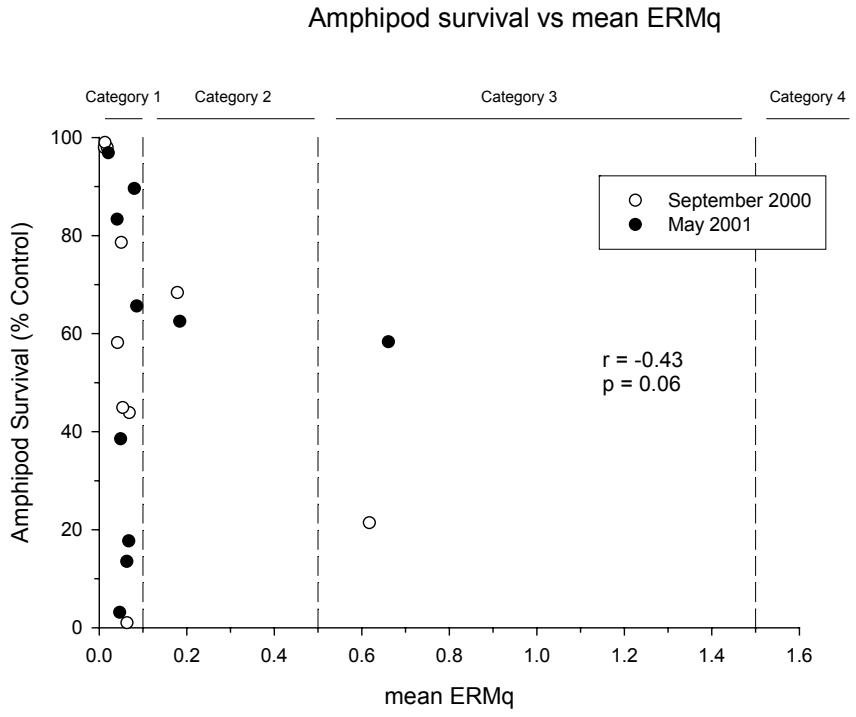

Figure 30. Relationship between amphipod survival and the mean ERM quotient (ERMq) values for Newport Bay sediment samples.

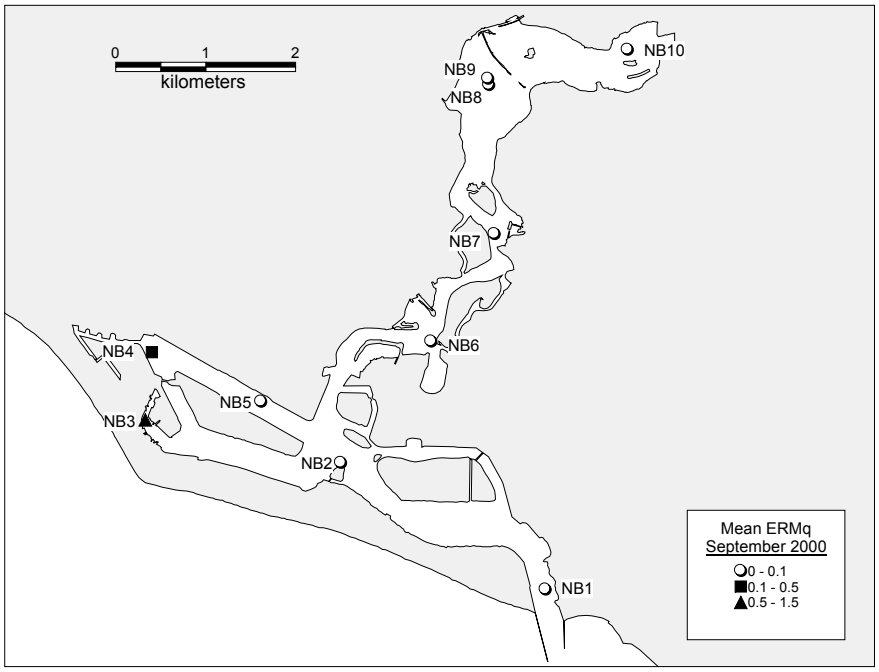

Figure 31. Mean ERM quotient of sediment samples collected in September 2000.

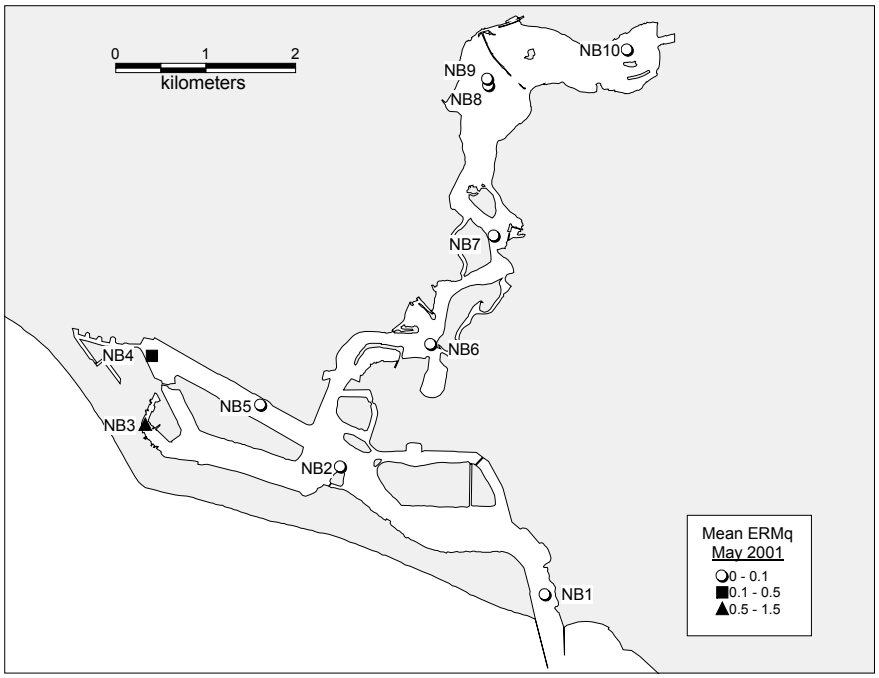

Figure 32. Mean ERM quotient of sediment samples collected in May 2001.

Table 20. Summary of the effectiveness of whole sediment TIE treatments on samples from Newport Bay. The presumed contaminant types indicated by each treatment are shown in parentheses.

Station	Date	Carbon (organics)	Cation Exchange (metals)
NB3	Nov. 2001	?	?
NB 10	Nov. 2001	+	0
NB 10	Mar. 2002	+	0
NB10 B	Mar. 2002	+	0
NB 10 C	Mar. 2002	+	0
NB3	Mar. 2002	0	0
NB11	Mar. 2002	+0	+0
NB12	Mar. 2002	0	+0

+ = Treatment effective
+0= Treatment slightly effective
? = Effectiveness could not be determined
0 = Treatment ineffective
NT=Not tested

Table 21. Summary of the effectiveness of aqueous TIE treatments on samples from Newport Bay. Sediment water interface testing used the sea urchin fertilization test. The presumed contaminant types indicated by each treatment are shown in parentheses.

Station	Sample Type	Date	EDTA (metals)	STS (oxidants/metals)	C-18 (organics/metals)
NB3	SWI	Nov. 2001	+	-	+
NB10	SWI	Nov. 2001	+	+0	+
NB3	PWA	Nov. 2001	+	+	+
NB10	PWA	Nov. 2001	0	0	+
NB10	PWA	Mar. 2002	0	0	+0
NB10C	PWA	Mar. 2002	0	0	+0
NB10C	PWF	Mar. 2002	+	+	+
NB3	PWF	Mar. 2002	?	?	?
NB11	PWF	Mar. 2002	?	?	?
NB11	PWA	Mar. 2002	0	0	0

PWA= Pore water test with amphipods
PWF= Pore water test with sea urchin fertilization
+ = Treatment effective
+0= Treatment slightly effective
? = Effectiveness could not be determined
0 = Treatment ineffective

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Appendices

A. Sediment Chemistry Data

Table A1. Newport Bay sediment metals concentrations from September 2000 sampling. Concentrations are in mg/dry kg, except total solids and grain size, which are expressed as a percentage.

Constituent	MRL	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
Total Solids		69.8	55.3	36.7	36.2	37.3	54.8	56.5	64.9	76.1	41.7
Gravel, Medium		0.1	0	0	0	0	0	0	2.42	0.49	0
Gravel, Fine		0.09	0.06	2.29	0.08	0.19	0.31	0.27	1.45	9.13	0.06
Sand, Very Coarse		0.15	0.43	4.07	0.16	0.06	0.78	1.74	2.42	28.1	0.19
Sand, Coarse		0.23	0.52	4.49	0.17	0.22	0.96	4.38	2.45	33.7	0.18
Sand, Medium		1.65	1.09	12.1	0.3	0.28	1.99	25.8	8.99	12.5	0.25
Sand, Fine		71.2	3.99	37.8	0.77	0.35	24.2	51.9	57.8	4.72	1.96
Sand, Very Fine		14.2	6.2	5.24	0.69	0.12	1.9	2.89	9.49	0.64	3.39
Silt		7.62	57.8	27.6	43.1	48.8	39.1	7.68	24.3	7.29	48.5
Clay		2.79	30.4	6.69	57.2	51	21.6	3.72	6.41	3.03	34
Aluminum	10	3490	16400	11600	24000	22300	13000	4740	5660	3160	21000
Antimony	10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	1	2	5	9	8	8	5	3	4	1	6
Barium	1	24	115	61	116	132	90	30	43	17	146
Cadmium	1	nd	1	nd	1	1	1	nd	nd	nd	2
Chromium	2	8	26	26	42	36	21	8	11	5	31
Copper	2	9	54	634	130	73	58	20	21	11	37
Iron	4	6440	23900	21800	36800	32500	20200	7520	10100	5420	29300
Lead	1	5	18	72	80	26	18	7	28	10	17
Manganese	1	91	233	158	287	300	200	83	133	58	348
Mercury	0.2	nd	nd	5.3	1	nd	nd	nd	nd	nd	nd
Nickel	4	5	16	13	24	23	14	5	8	nd	22
Selenium	1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Silver	2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tin	10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	2	31	133	288	242	168	144	65	105	48	149

Table A2. Newport Bay sediment PCB congener concentrations from September 2000 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 1 µg/dry kg.

Compound	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
PCB18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB28	nd	nd	**4.33**	nd	nd	nd	nd	nd	nd	nd
PCB52	nd	nd	**3.87**	nd	nd	nd	nd	nd	nd	nd
PCB49	nd	nd	**3.57**	nd	nd	nd	nd	nd	nd	nd
PCB44	nd	nd	**2.63**	nd	nd	nd	nd	nd	nd	nd
PCB37	nd	nd	**4.52**	nd	nd	nd	nd	nd	nd	nd
PCB74	nd	nd	**2.50**	nd	nd	nd	nd	nd	nd	nd
PCB70	nd	nd	**4.54**	nd	nd	nd	nd	nd	nd	nd
PCB66	nd	nd	**6.41**	nd	nd	nd	nd	nd	nd	nd
PCB101	nd	nd	**4.33**	**1.37**	nd	nd	nd	nd	nd	nd
PCB99	nd	nd	**2.93**	nd	nd	nd	nd	nd	nd	nd
PCB119	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB87	nd	nd	**1.09**	nd	nd	nd	nd	nd	nd	nd
PCB110	nd	nd	**5.13**	**2.67**	nd	nd	nd	nd	nd	nd
PCB81	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB77	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB149	nd	nd	**2.09**	nd	nd	nd	nd	nd	nd	nd
PCB123	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB118	nd	nd	**5.35**	**1.75**	nd	nd	nd	nd	nd	nd
PCB114	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB153/68	nd	nd	**3.50**	nd	nd	nd	nd	nd	nd	nd
PCB105	nd	nd	**1.63**	nd	nd	nd	nd	nd	nd	nd
PCB138	nd	nd	**2.39**	nd	nd	nd	nd	nd	nd	nd
PCB158	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB187	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB126	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB167	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB156	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB157	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB180	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB170	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB169	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB189	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB194	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCB	0	0	60.80	5.80	0	0	0	0	0	0

Table A3. Newport Bay sediment PAH concentrations from May 2001 sampling.
Concentrations are in µg/dry kg. Method detection limit for all constituents is 20 µg/dry kg.

Compound	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
Naphthalene	nd	nd	**31**	**31**	nd	nd	nd	**18**	**26**	**18**
Naphthalene-2-methyl-	nd	nd	nd	**58**	nd	nd	nd	nd	**21**	nd
Naphthalene-1-methyl-	nd	nd	nd	**42**	nd	nd	nd	nd	nd	nd
Biphenyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Naphthalene-2,6-dimethyl	nd	nd	nd	nd	nd	nd	nd	nd	**37**	nd
Acenaphthylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acenaphthene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Naphthalene-2,3,6-trimet	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fluorene	nd	nd	nd	nd	nd	nd	nd	nd	**18**	nd
Phenanthrene	**34**	nd	**42**	**46**	nd	nd	nd	**96**	**108**	**39**
Anthracene	nd	nd	nd	nd	nd	nd	nd	**30**	**23**	nd
Phenanthrene-2-methyl-	nd	nd	nd	nd	nd	nd	nd	**18**	**23**	nd
Phenanthrene-1-methyl-	nd	nd	nd	nd	nd	nd	nd	**18**	**17**	nd
Phenanthrene-3,6-dimethyl-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fluoranthene	**63**	**34**	**103**	**100**	**24**	**34**	**17**	**177**	**224**	**61**
Pyrene	**53**	**45**	**110**	**112**	**30**	**38**	**19**	**193**	**228**	**61**
11H-Benzo[b]fluorene	nd	nd	**28**	nd	nd	nd	nd	**24**	**28**	nd
Benz[a]anthracene	**24**	nd	**44**	**44**	nd	nd	nd	**80**	**86**	**30**
Chrysene	**29**	**26**	**64**	**64**	nd	**29**	nd	**117**	**92**	**38**
Benzo[b]fluoranthene	**29**	**31**	**171**	**96**	**24**	**41**	nd	**107**	**123**	**47**
Benzo[k]fluoranthene	nd	nd	**62**	**37**	nd	nd	nd	**41**	**34**	nd
Benzo[e]pyrene	**12**	nd	**80**	**57**	nd	**20**	nd	**67**	**74**	**29**
Benzo[a]pyrene	**15**	nd	**89**	**55**	nd	**20**	nd	**63**	**98**	**26**
Perylene	**13**	nd	**38**	nd	nd	nd	nd	**40**	**41**	nd
Anthracene-9,10-diphenyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Indeno[1,2,3-cd]pyrene	nd	nd	nd	nd	nd	nd	nd	**26**	**36**	nd
Dibenz[a,h]anthracene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Benzo[ghi]perylene	nd	nd	**46**	**32**	nd	nd	nd	**41**	**38**	nd
Total PAH	272	137	940	774	78	182	36	1156	1375	349

Table A4. Newport Bay sediment PAH concentrations from September 2000 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 20 µg/dry kg.

Compound	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
Naphthalene	nd	nd	**35**	**43**	**29**	**23**	nd	**30**	**17**	**25**
Naphthalene-2-methyl-	nd	nd	nd	**49**	nd	**21**	nd	**25**	**18**	**22**
Naphthalene-1-methyl-	nd	nd	nd	**32**	nd	nd	nd	nd	nd	nd
Biphenyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Naphthalene-2,6-dimethyl	nd	nd	nd	**32**	nd	nd	nd	nd	nd	nd
Acenaphthylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acenaphthene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Naphthalene-2,3,6-trimet	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fluorene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Phenanthrene	nd	nd	**61**	**65**	nd	**23**	nd	**56**	**18**	**29**
Anthracene	nd	nd	nd	nd	nd	**23**	nd	nd	**18**	nd
Phenanthrene-2-methyl-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Phenanthrene-1-methyl-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Phenanthrene-3,6-dimethyl-	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fluoranthene	nd	nd	**120**	nd	nd	nd	nd	**139**	nd	nd
Pyrene	nd	nd	**94**	**66**	nd	nd	nd	**83**	nd	nd
11H-Benzo[b]fluorene	nd	nd	**26**	nd	nd	nd	nd	nd	nd	nd
Benz[a]anthracene	nd	nd	**35**	**32**	nd	nd	nd	**38**	nd	nd
Chrysene	nd	nd	**80**	**75**	**40**	**27**	nd	**101**	**31**	**37**
Benzo[b]fluoranthene	nd	nd	**98**	nd	nd	nd	nd	**86**	nd	nd
Benzo[k]fluoranthene	nd	nd	**102**	nd	nd	nd	nd	**66**	nd	nd
Benzo[e]pyrene	nd	nd	**72**	**62**	nd	nd	nd	**66**	**18**	nd
Benzo[a]pyrene	nd	nd	**93**	nd	nd	nd	nd	**84**	nd	nd
Perylene	nd	nd	**28**	nd	nd	nd	nd	**25**	**17**	nd
Anthracene-9,10-diphenyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Indeno[1,2,3-cd]pyrene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dibenz[a,h]anthracene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Benzo[ghi]perylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PAH	0.00	0.00	844	456	69	115	0.00	798	137	113

Table A5. Newport Bay sediment DDT concentrations from September 2000 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 1 µg/dry kg.

Compound	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
o,p'-DDE	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-DDE	**2.43**	**18.68**	**7.17**	**16.20**	**17.80**	**7.73**	**2.81**	**15.60**	**2.10**	**10.00**
o,p'-DDD	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-DDT	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-DDD	**1.40**	**6.97**	**7.93**	**9.89**	**6.11**	**3.66**	nd	**9.82**	**1.57**	**6.96**
p,p'-DDT	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
total DDT	3.83	25.66	15.11	26.09	23.91	11.38	2.81	25.42	3.66	16.96

Table A6. Newport Bay sediment metals concentrations and grain size parameters from May 2001 sampling. Concentrations of grain size parameters are expressed as percentages while metals concentrations are in mg/dry kg.

Constituent	MRL[1]	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
Solids		68.7	48.3	32.9	33.8	37.2	50	56.5	53.1	47.9	51.9
Gravel, Medium		0	0	15.3	0.28	0	0	0.27	0.19	1.9	0
Gravel, Fine		0.05	0.23	9.14	0.16	0.24	0.25	0.53	2.6	1.3	0.19
Sand, Very Coarse		0.18	0.28	5.99	0.22	0.15	0.44	0.93	10.2	1.89	0.58
Sand, Coarse		0.27	0.31	4.79	0.19	0.12	0.44	1.62	22.3	2.05	0.55
Sand, Medium		1.36	0.9	7.09	0.24	0.24	0.98	11.4	19.9	3.02	1.45
Sand, Fine		70.7	5.9	14.8	0.74	0.26	14	32.3	13.8	28.4	24.4
Sand, Very Fine		14.7	8.03	1.57	0.69	0.08	8.96	4.85	2.25	10.4	11
Silt		7.19	47.9	22.9	45.8	53.3	41.5	34.9	17.8	41.2	38.5
Clay		4.72	33.3	19.5	52.2	49.6	31.8	13	5.75	9.13	19.4
Aluminum	10.4	5160	23400	27300	41600	43600	25200	13600	8970	13600	15800
Antimony	10.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	2.6	3	6	12	10	8	6	5	3	4	5
Barium	1.0	29	119	92	134	145	111	72	50	93	119
Cadmium	1.0	nd	2	2	2	2	1	1	nd	1	2
Chromium	1.0	12	32	44	57	54	34	20	14	20	20
Copper	2.1	10	44	607	120	75	54	28	23	38	21
Iron	4.2	8130	27500	33700	43900	41900	28000	16400	12100	18600	18800
Lead	2.2	6	19	87	78	26	21	14	22	37	13
Manganese	1.0	101	235	216	313	325	232	147	114	208	219
Mercury	0.03	0.03	0.06	5.8	0.73	0.1	0.08	0.04	0.04	0.06	0.03
Nickel	4.2	7	21	23	33	28	20	12	10	17	12
Selenium	1.0	nd	nd	nd	nd	nd	nd	nd	nd	1	nd
Silver	2.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tin	21	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	2.1	36	135	366	248	189	156	97	112	169	103

[1] Method reporting limits varied for each sample. The value listed is the mean for the ten samples measured.

Table A7. Newport Bay sediment PCB congener concentrations from May 2001 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 1 µg/dry kg.

Compound	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
PCB18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB28	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB52	nd	nd	**7.16**	nd	nd	nd	nd	nd	nd	nd
PCB49	nd	nd	**4.47**	nd	nd	nd	nd	nd	nd	nd
PCB44	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB37	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB70	nd	nd	**6.23**	nd	nd	nd	nd	nd	nd	nd
PCB66	nd	nd	**8.35**	nd	nd	nd	nd	nd	nd	nd
PCB101	nd	nd	**8.21**	nd	nd	nd	nd	nd	nd	nd
PCB99	nd	nd	**6.71**	nd	nd	nd	nd	nd	nd	nd
PCB119	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB87	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB110	nd	nd	**8.39**	nd	nd	nd	nd	nd	nd	nd
PCB81	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB77	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB149	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB123	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB118	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB114	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB153/68	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB105	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB138	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB158	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB187	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB183	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB126	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB167	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB177	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB156	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB157	nd	nd	nd	**8.76**	nd	nd	nd	nd	nd	nd
PCB180	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB170	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB169	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB189	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB194	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PCB206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCB	0	0	53.7	8.76	0	0	0	0	0	0

Table A8. Newport Bay sediment pesticide concentrations from May 2001 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 1 µg/dry kg.

Compound	NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8	NB9	NB10
o,p'-DDE	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-DDE	**2.52**	**17.23**	**9.28**	**30.43**	**16.12**	**12.73**	**8.78**	**12.93**	**20.77**	**19.67**
o,p'-DDD	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o,p'-DDT	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
p,p'-DDD	nd	**9.07**	nd	**25.58**	nd	nd	nd	nd	nd	nd
p,p'-DDT	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total DDT	**2.52**	**26.30**	**9.28**	**56.01**	**16.12**	**12.73**	**8.78**	**12.93**	**20.77**	**19.67**
gamma Chlordane*	nd	nd	nd	nd	nd	nd	nd	**3.38**	**3.70**	**1.87**
alpha-Chlordane*	nd	nd	nd	nd	nd	nd	nd	**2.58**	**3.67**	**1.56**
trans-Nonachlor*	nd	nd	nd	nd	nd	nd	nd	**2.79**	**4.54**	**2.16**
cis-Nonachlor*	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diazinon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlordene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Aldrin	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloropyrifos	nd	nd	nd	nd	nd	nd	nd	nd	nd	**24.41**
Oxichlordane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Dieldrin	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Endrin	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

*Reported concentrations are an estimate (± 50%) because a calibration standard was not included in the analysis for these constituents.

Table A9. Newport Bay sediment PCB congener concentrations from November 2001 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 1 µg/dry kg.

Compound	NB10	NB3
PCB018	ND	1.11
PCB028	ND	3.36
PCB031	ND	5.55
PCB033	ND	5.66
PCB037	ND	ND
PCB044	ND	8.53
PCB049	ND	12.6
PCB052	ND	8.99
PCB066	ND	10.8
PCB070	ND	8.68
PCB074	ND	5.1
PCB077	ND	ND
PCB081	ND	ND
PCB087	ND	4.04
PCB095	ND	5.53
PCB097	ND	2.33
PCB099	ND	7.07
PCB101	ND	9.98
PCB105	ND	11.2
PCB110	ND	11.8
PCB114	ND	ND
PCB118	ND	12.3
PCB119	ND	ND
PCB123	ND	1.73
PCB126	ND	ND
PCB128	ND	ND
PCB138	ND	3.58
PCB141	ND	ND
PCB149	ND	4.45
PCB151	ND	ND
PCB153	ND	8.29
PCB156	ND	ND
PCB157	ND	ND
PCB158	ND	3.51
PCB167	ND	ND
PCB168/132	ND	ND
PCB169	ND	ND
PCB170	ND	ND
PCB177	ND	ND
PCB180	ND	1.12
PCB183	ND	ND
PCB187	ND	1.24
PCB189	ND	ND
PCB194	ND	ND
PCB200	ND	ND
PCB201	ND	ND
PCB206	ND	ND
Total PCB	0	158

Table A10. Newport Bay sediment PAH concentrations from November 2001 sampling. Concentrations are in µg/dry kg. Method detection limit for all constituents is 1 µg/dry kg.

Compound	NB10	NB3
Naphthalene	8.6	9.2
2-Methylnaphthalene	5.6	7.0
1-Methylnaphthalene	2.8	4.2
Biphenyl	2.0	3.2
2,6-Dimethylnaphthalene	6.8	4.8
Acenaphthene	1.8	7.4
Acenaphthylene	4.7	12.3
2,3,5-Trimethylnaphthalene	1.8	1.0
Fluorene	6.0	8.4
Phenanthrene	42.5	120
Anthracene	9.0	42.1
1-Methylphenanthrene	10.6	12.5
Fluoranthene	124	322
Pyrene	152	330
Benz[a]anthracene	45.4	125
Chrysene	93.6	211
Benzo[b]fluoranthene	60.0	183
Benzo[k]fluoranthene	13.8	34.7
Benzo[e]pyrene	61.6	132
Benzo[a]pyrene	48.3	153
Perylene	32.6	34
Indeno[1,2,3-c,d]pyrene	37.4	91.1
Dibenz[a,h]anthracene	11.6	30
Benzo[g,h,i]perylene	65.0	90.9
Total Detectable PAHs	847	1970

ND=Not detected.

Table A11. Newport Bay sediment pesticides from November 2001 sampling. Concentrations are in ug/dry kg. Method detection limits for all constituents are 1 µg/dry kg, except toxaphene which is 10 µg/dry kg.

Compound	NB10	NB3
Toxaphene	ND	ND
Aldrin	ND	ND
BHC-alpha	ND	ND
BHC-beta	ND	ND
BHC-delta	ND	ND
BHC-gamma	ND	ND
Chlordane-alpha	ND	ND
Chlordane-gamma	ND	ND
Dieldrin	ND	ND
Endosulfan Sulfate	ND	ND
Endosulfan-I	ND	ND
Endosulfan-II	ND	ND
Endrin	ND	ND
Endrin Aldehyde	ND	ND
Heptachlor	ND	ND
Heptachlor Epoxide	ND	ND
Methoxychlor	ND	ND
Mirex	ND	ND
trans-Nonachlor	ND	ND
2,4'-DDD	6.25	4.4
2,4'-DDE	ND	ND
2,4'-DDT	ND	ND
4,4'-DDD	8.6	ND
4,4'-DDE	61.45	31.7
4,4'-DDT	ND	ND
Total Detectable DDTs	76.3	36.1

ND=Not detected.

Table A12. Newport Bay sediment PCB congener concentrations from March 2002 sampling. Concentrations are in µg/dry kg. Reporting limit for all constituents is 1 µg/dry kg.

	San Diego Creek			Rhine Channel		
Compound	NB10	NB10B	NB10C	NB3	NB11	NB12
PCB018	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB028	<1.0	<1.0	<1.0	3.63	3.94	0.93
PCB031	<1.0	<1.0	<1.0	5.72	6.07	1.56
PCB033	<1.0	<1.0	<1.0	5.3	3.58	<1.0
PCB037	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB044	<1.0	3.38	1.61	6.07	9.83	2.77
PCB049	<1.0	1.74	0.93	14.6	12.3	5.2
PCB052	<1.0	1.08	<1.0	8.55	8.81	3.39
PCB066	<1.0	<1.0	<1.0	12.2	14.8	9.83
PCB070	<1.0	<1.0	<1.0	8.44	8.6	7.08
PCB074	<1.0	<1.0	<1.0	4.92	8.81	7.34
PCB077	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB081	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB087	<1.0	<1.0	<1.0	3.4	3.05	4.19
PCB095	<1.0	<1.0	<1.0	4.16	5.07	3.8
PCB097	<1.0	<1.0	<1.0	1.03	3.84	4.51
PCB099	<1.0	<1.0	<1.0	8.11	8.68	5.85
PCB101	<1.0	<1.0	<1.0	10.4	11.1	9.08
PCB105	<1.0	<1.0	<1.0	7.37	4.11	4.02
PCB110	<1.0	1.2	1.75	9.6	10.2	9.7
PCB114	<1.0	<1.0	<1.0	4.54	3.64	<1.0
PCB118	<1.0	<1.0	<1.0	12.5	13.9	8.98
PCB119	<1.0	<1.0	<1.0	<1.0	0.7	0.75
PCB123	<1.0	<1.0	<1.0	2.84	2.09	6.8
PCB126	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB128	<1.0	<1.0	<1.0	1.08	1.93	<1.0
PCB138	<1.0	<1.0	<1.0	3.77	14.6	7.99
PCB141	<1.0	<1.0	<1.0	<1.0	<1.0	0.93
PCB149	<1.0	<1.0	<1.0	4.87	7.48	4.79
PCB151	<1.0	<1.0	<1.0	<1.0	1.5	0.48
PCB153	<1.0	<1.0	<1.0	8.41	9.65	8.38
PCB156	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB157	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB158	<1.0	<1.0	1.52	2.22	<1.0	1.83
PCB167	<1.0	<1.0	<1.0	<1.0	1.68	<1.0
PCB168/132	<1.0	<1.0	<1.0	<1.0	1.23	1.25
PCB169	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB170	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB177	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB180	<1.0	<1.0	<1.0	1.9	1.41	1.96
PCB183	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB187	<1.0	<1.0	<1.0	1.26	<1.0	2.44
PCB189	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB194	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB200	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB201	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCB206	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total PCBs	0	7.4	5.81	156.89	186.6	125.83

Table A13. Newport Bay sediment PAH concentrations from March 2002 sampling. Concentrations are in µg/dry kg. Reporting limit for all constituents is 1 µg/dry kg.

	San Diego Creek			Rhine Channel		
Compound	NB10	NB10B	NB10C	NB3	NB11	NB12
Naphthalene	13.5	7.6	4.9	8.1	7.9	3.4
2-Methylnaphthalene	10.2	4.6	2.1	5.5	7.3	2.2
1-Methylnaphthalene	4.2	1.9	1.6	2.2	5.7	1.3
Biphenyl	2.9	2.1	1.3	1.7	2.7	0.85
2,6-Dimethylnaphthalene	8.1	4	6.9	5	6.4	2.2
Acenaphthene	3.1	2.1	1.6	9.6	4.5	4.5
Acenaphthylene	6.2	4.9	3.5	5.1	71.6	4.3
2,3,5-Trimethylnaphthalene	2.7	1.9	2.5	1.7	5.7	2.3
Fluorene	8	5	3.1	6.6	51	3.9
Phenanthrene	79.3	44.8	25.8	67.3	572	71.8
Anthracene	14.3	9.3	6.8	32.1	137	18.5
1-Methylphenanthrene	16.6	7.3	5.3	14.2	87.7	11.7
Fluoranthene	197	130	87.2	167	810	210
Pyrene	228	141	102	202	763	197
Benz[a]anthracene	58.1	48.2	35.6	111	408	102
Chrysene	144	85.9	60.4	216	398	124
Benzo[b]fluoranthene	79.8	61.3	41.8	209	285	128
Benzo[k]fluoranthene	14	25	17	39.1	114	56.2
Benzo[e]pyrene	92.1	46.3	31.5	153	172	78.0
Benzo[a]pyrene	64.4	39.4	27	177	238	90.3
Perylene	31.9	21	15.3	56.3	48.3	23.3
Indeno[1,2,3-c,d]pyrene	47.9	39.7	33.1	145	147	112
Dibenz[a,h]anthracene	12.6	17.7	8.4	37.8	35.7	17.0
Benzo[g,h,i]perylene	83.8	39.7	33.7	138	86.4	95.7
Total PAHs	1223	791	558	1810	4465	1360

Table A14. Newport Bay sediment pesticide concentrations from March 2002 sampling. Concentrations are in µg/dry kg. Reporting limit for all constituents is 1 µg/dry kg.

	San Diego Creek			Rhine Channel		
Compound	NB10	NB10B	NB10C	NB3	NB11	NB12
Toxaphene	<10	<10	<10	<10	<10	<10
2,4'-DDD	8.3	5.97	6	<1.0	4.34	<1.0
2,4'-DDE	<1.0	8.23	10.3	<1.0	22.2	14.1
2,4'-DDT	<1.0	5.23	4.67	<1.0	3.22	2.21
4,4'-DDD	<1.0	10	9.98	<1.0	4.38	4.58
4,4'-DDE	64.9	76.6	80.6	41.1	54.2	25.1
4,4'-DDT	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total DDTs	73.2	106	112	41.1	88.3	46.0
Aldrin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BHC-alpha	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BHC-beta	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BHC-delta	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BHC-gamma	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chlordane-alpha	<1.0	1.84	3.39	<1.0	<1.0	<1.0
Chlordane-gamma	<1.0	1.88	2.59	<1.0	<1.0	<1.0
Dieldrin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Endosulfan Sulfate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Endosulfan-I	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Endosulfan-II	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Endrin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Endrin Aldehyde	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Heptachlor	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Heptachlor Epoxide	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methoxychlor	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mirex	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
trans-Nonachlor	<1.0	0.92	2.23	<1.0	<1.0	<1.0

B. Toxicity Data

Toxicity Data Summary

Project: Newport Bay Sediment Toxicity
Sample Description: Newport Bay Surface Water Samples

Sample Collected: 09/19/00 Experiment Number: S465
Test Initiated: 09/20/00 Test Ended: 09/20/00

Test Method: Purple Sea Urchin Fertilization Test (EPA/600/R-95/136)
Species: *Strongylocentrotus purpuratus* Laboratory: SCCWRP
Supervising Technician: Darrin Greenstein

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW0920001	Seawater Control	99	0.8	5	
NBBK09190001	Pump Blank	98	2.1	5	
NBRO09190001	Sta. NB1 Surface Water	100	0.4	5	
NBRO09190003	Sta. NB3 Surface Water	90	3.8	5	*
NBRO09190004	Sta. NB4 Surface Water	71	25.7	5	*
NBRO09190005	Sta. NB5 Surface Water	96	4.2	5	
NBRO09190006	Sta. NB6 Surface Water	41	25.5	5	*
NBRO09190007	Sta. NB7 Surface Water	51	33.4	5	*
NBRO09190008	Sta. NB8 Surface Water	43	27.2	5	*
NBRO09190009	Sta. NB9 Surface Water	67	30.6	5	
NBRO09190010	Sta. NB10 Surface Water	78	23.3	5	

Due to lack of homogeneity of variance, samples were compared to control using Steele's test.

The test met acceptability criteria for control fertilization (70% or greater) and reference toxicant
EC50 was within control chart limits.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.99		28.8		
Test Max.	8.31		33.2		

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Surface water from Newport Bay

Sample Collected: 09/20/00 Experiment Number: S467
Test intitiated:09/20/00 Test Ended: 09/23/00

Test Method: Purple Sea Urchin Embryo development Test(EPA/600/R-95/136)
Species:*Strongylocentrotus purpuratus*
Supervising Technician: Darrin Greenstein Laboratory: SCCWRP

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced From Control
NBSW0920001	Seawater Control	91	2.9	4	
NBBK09190001	Pump Blank	94	1.3	4	
NBRO09190001	Sta. NB1 Surface Water	95	2.4	4	
NBRO09190003	Sta. NB3 Surface Water	90	3.6	4	
NBRO09190004	Sta. NB4 Surface Water	94	1.7	4	
NBRO09190005	Sta. NB5 Surface Water	82	11.1	4	*
NBRO09190006	Sta. NB6 Surface Water	95	2.1	4	
NBRO09190007	Sta. NB7 Surface Water	95	1.0	4	
NBRO09190008	Sta. NB8 Surface Water	94	4.2	4	
NBRO09190009	Sta. NB9 Surface Water	93	2.6	4	
NBRO09190010	Sta. NB10 Surface Water	92	3.0	4	

Note : Sample Pump Blank has not been included in the calculations because of the constraints of Toxstat software. The test would accept only ten samples.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.89	6.9	28.8		0.01
Test Max.	8.27	7.5	34.9		0.07

Toxicity Data Summary

Project: Newport Bay Sediment Toxicity
Sample Description: Surface Water from Newport Bay

Sample Collected: 9/19/00 Experiment Number: MB22
Test Initiated: 9/20/00 Test Ended: 9/27/00

Test Method: Mysid survival and growth test
Species: *Americamysis bahia*
Supervising Technician: Darrin Greenstein Laboratory: SCCWRP

% Survival

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW0920001	Seawater Control (30 ppt)	93	14.9	8	
NBBK09190002	Salinity Control (33 ppt)	98	7.1	8	
NBRO09190001	Sta. NB1 Surface Water	95	9.3	8	
NBRO09190003	Sta. NB3 Surface Water	100	0.0	8	
NBRO09190005	Sta. NB5 Surface Water	98	7.1	8	
NBRO09190009	Sta. NB9 Surface Water	98	7.1	8	
NBRO09190010	Sta. NB10 Surface Water	100	0.0	8	

.

Weight Data

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW0920001	Seawater Control (30 ppt)	0.327	0.070	8	
NBBK09190002	Salinity Control (33 ppt)	0.330	0.027	8	
NBRO09190001	Sta. NB1 Surface Water	0.376	0.032	8	
NBRO09190003	Sta. NB3 Surface Water	0.384	0.043	8	
NBRO09190005	Sta. NB5 Surface Water	0.375	0.035	8	
NBRO09190009	Sta. NB9 Surface Water	0.396	0.059	8	
NBRO09190010	Sta. NB10 Surface Water	0.371	0.040	8	

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp. (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.73	5.2	17.3	21.1	0.39
Test Max.	8.23	8.0	34.2	26.3	0.67

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Overlying water from Newport Bay

Sample Collected: 09/19/00 Experiment Number: S471
Test intitiated:09/26/00 Test Ended: 09/26/00

Test Method: Purple Sea Urchin Fertilization Test(EPA/600/R-95/136)
Species: *Strongylocentrotus purpuratus*
Supervising Technician: Jeff Brown Laboratory: SCCWRP

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW09260001	Seawater Control	89	6.5	5	
NBBK09260001	Dana Point Core Tube Overlying 100%	80	18.2	3	
NBBK09260002	Core Tube Water Blank 100%	84	8.0	4	
NBOW09190001	NB1 Core Tubes Overlying 50%	86	9.1	4	
NBOW09190001	NB1 Core Tubes Overlying 100%	80	8.9	4	
NBOW09190002	NB3 Core Tubes Overlying 50%	91	7.0	4	
NBOW09190002	NB3 Core Tubes Overlying 100%	87	14.5	4	
NBOW09190003	NB5 Core Tubes Overlying 50%	67	23.7	4	
NBOW09190003	NB5 Core Tubes Overlying 100%	70	9.6	4	
NBOW09190004	NB9 Core Tubes Overlying 50%	74	22.9	4	
NBOW09190004	NB9 Core Tubes Overlying 100%	66	19.3	4	
NBOW09190005	NB10 Core Tubes Overlying 50%	81	8.5	4	
NBOW09190005	NB10 Core Tubes Overlying 100%	88	5.9	4	

Note: The samples NB3(50%),NB3(100%),NB10(100%) were not included in the calculation because of the constraints of Toxstat software. The above samples were chosen because the sample means are similar to the control.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.71	6.2	33.0	14.7	0.0
Test Max.	8.05	7.0	33.9	14.7	7.9

Toxicity Data Summary

Project: Newport Bay Sediment Toxicity
Sample Description: Core Sample Overlying Water For Newport Bay Sediment Toxicity

Sample Collected: 09/26/00 Experiment Number: S474
Test Initiated: 09/26/00 Test Ended: 09/29/00

Test Method: Purple Sea Urchin Development Test (EPA/600/R-95/136)
Species: *Strongylocentrotus purpuratus* Laboratory: SCCWRP
Supervising Technician: Darrin Greenstein

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW09260004	Seawater Control	96	3.3	5	
NBBK09260001	Dana Point Core Tube Overlying 100%	96	0.6	3	
NBBK09260002	Core Tube Water Blank 100%	98	0.6	4	
NBOW09190001	NB1 Core Tubes Overlying 50%	-	-	0	
NBOW09190001	NB1 Core Tubes Overlying 100%	98	1.0	4	
NBOW09190002	NB3 Core Tubes Overlying 50%	75	41.3	4	
NBOW09190002	NB3 Core Tubes Overlying 100%	28	31.7	4	*
NBOW09190003	NB5 Core Tubes Overlying 50%	-	-	0	
NBOW09190003	NB5 Core Tubes Overlying 100%	96	1.7	4	
NBOW09190004	NB9 Core Tubes Overlying 50%	97	1.3	4	
NBOW09190004	NB9 Core Tubes Overlying 100%	79	25.1	4	
NBOW09190005	NB10 Core Tubes Overlying 50%	62	44.1	4	
NBOW09190005	NB10 Core Tubes Overlying 100%	7	7.4	4	*

Test met acceptability criteria for control normal development (>80%) and the copper reference toxicant EC50 was within control chart limits.

Note that each replicate within a station is a sample taken from a separate core tube.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB T0 100%					
Test Min.	7.71	6.2	33.0		0.0
Test Max.	8.05	7.0	33.9		7.9

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Whole Sediment From Newport Bay

Sample Collected: 09/20/00 Experiment Number: EE19
Test Initiated: 10/03/00 Test Ended: 10/04/00

Test Method: 10 Day Survival
Species: *Eohaustorius estuarius* Laboratory: SCCWRP
Supervising Technician: Darrin Greenstein

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBHS09280001	Home Sediment	98	2.7	5	
NBWS09200001	NB 1 Whole Sediment	96	6.5	5	
NBWS09200002	NB 2 Whole Sediment	77	10.4	5	*
NBWS09200003	NB 3 Whole Sediment	21	31.3	5	*
NBWS09200004	NB 4 Whole Sediment	67	14.4	5	*
NBWS09200005	NB 5 Whole Sediment	43	11.5	5	*
NBWS09200006	NB 6 Whole Sediment	44	20.4	5	*
NBWS09200007	NB 7 Whole Sediment	96	4.2	5	
NBWS09200008	NB 8 Whole Sediment	57	39.6	5	*
NBWS09200009	NB 9 Whole Sediment	97	2.7	5	
NBWS09200010	NB 10 Whole Sediment	1	2.2	5	*

Note: Sample NB10 was not included in the calculation due to constraints of Toxtstat software. Since sample NB10 survival is very low, it is assumed significantly different from control.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity	Temp (C°)	Total Ammonia (mg/L)
NB					
Interstitial Test Min.	7.21		21.8	18.9	1.0
Interstitial Test Max.	7.93		29.6	23.9	> 50
Overlying Test Min	7.80	5.3	20.5	18.9	0.3
Overlying Test Max	8.79	8.7	22.5	23.9	34.9

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Surface Water Samples following Storm Event

Sample Collected: 1/11/01 Experiment Number: MB27
Test Initiated: 1/17/01 Test Ended: 1/24/01

Test Method: Mysid survival and growth test
Species: Americamysis bahia
Supervising Technician: Darrin Greenstein Laboratory: SCCWRP

%Survival

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW01170101	Seawater Control (30 ppt)	98	7.1	8	
NBBK01170101	Salt Blank	88	21.2	8	
NBRW01110101	Surface Water (UNBJAM)	52	30.3	5	*
NBRW01110102	Surface Water (HIR)	98	7.1	8	
NBRW01110103	Surface Water (UNBSDC)	68	18.3	8	*

The test met acceptability criteria for control survival (80% or greater) and the reference toxicant EC50 was within control chart limits.

Weight Data

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW01170101	Seawater Control (30 ppt)	0.259	0.039	8	
NBBK01170101	Salt Blank	0.293	0.040	8	
NBRW01110101	Surface Water (UNBJAM)	0.200	0.032	5	*
NBRW01110102	Surface Water (HIR)	0.270	0.019	8	
NBRW01110103	Surface Water (UNBSDC)	0.248	0.036	8	*

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.67	4.8	29.4	22.7	0.06
Test Max.	8.70	7.5	31.1	26.4	1.51

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Surface Water Samples following Storm Event

Sample Collected: 1/11/01 Experiment Number: S497
Test Initiated: 1/17/01 Test Ended: 1/17/01

Test Method: Purple Sea Urchin Fertilization
Species: Strongylocentrotus purpuratus
Supervising Technician: Darrin Greenstein Laboratory: SCCWRP

Sample Code	Sample	Mean	Standard Deviation	Number Counted
NBSW01170101	Seawater Control	98	1.5	5
NBBK01170102	Brine Control	95	2.1	5
NBRW01110101	Surface Water (UNBJAM)	98	1.0	5
NBRW01110102	Surface Water (HIR)	98	0.9	5
NBRW01110103	Surface Water (UNBSDC)	99	0.5	5

Test met acceptability criteria for control fertilization (>70%) and the reference toxicant EC50 was within control chart limits.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.84		32.7	13.0	
Test Max.	8.05		33.7	13.0	

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Surface Water Samples following Storm Event

Sample Collected: 1/11/01 Experiment Number: S499
Test Initiated: 1/17/01 Test Ended: 1/20/01

Test Method: Purple Sea Urchin Development
Species: Strongylocentrotus purpuratus
Supervising Technician: Darrin Greenstein Laboratory: SCCWRP

Sample Code	Sample	Mean	Standard Deviation	Number Counted
NBSW0920001	Seawater Control	96	1.7	4
NBBK01170103	Brine Control	93	7.9	4
NBRW01110101	Surface Water (UNBJAM)	99	1.3	4
NBRW01110102	Surface Water (HIR)	98	2.1	4
NBRW01110103	Surface Water (UNBSDC)	98	1.0	4

Test met acceptability criteria for control normal development (>80%) and the reference toxicant EC50 was within control chart limits.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB 100%					
Test Min.	7.94		32.7		
Test Max.	8.05		33.7		

Toxicity Data Summary

Project: Newport Bay Sediment Toxicity
Sample Description: Newport Bay Surface Water Samples

Sample Collected: 05/7/01 Experiment Number: S534
Test Initiated: 05/8/01 Test Ended: 05/8/01

Test Method: Purple Sea Urchin Fertilization Test (EPA/600/R-95/136)
Species: *Strongylocentrotus purpuratus* Laboratory: SCCWRP
Supervising Technician: Ehren Doris

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW05080101	Seawater Control	99	1.1	5	
NBRO05070101	Sta. NB1 Surface Water	-	-	0	
NBRO05070102	Sta. NB2 Surface Water	95	2.1	5	
NBRO05070103	Sta. NB3 Surface Water	93	2.3	5	
NBRO05070104	Sta. NB4 Surface Water	49	18.9	5	*
NBRO05070105	Sta. NB5 Surface Water	95	3.0	5	
NBRO05070106	Sta. NB6 Surface Water	77	2.9	5	*
NBRO05070107	Sta. NB7 Surface Water	90	2.4	5	*
NBRO05070108	Sta. NB8 Surface Water	79	6.1	5	*
NBRO05070109	Sta. NB9 Surface Water	50	8.5	5	*
NBRO05070110	Sta. NB10 Surface Water	62	7.1	5	*

Sample from station NB1 not collected.

Data was neither normally distributed nor were the variances homogenous, therefore Steel's test was used for significance testing.

The test met acceptability criteria for control survival (>70%) and the reference toxicant EC50 was within control chart limits.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.94	5.4	22.6	15.0	0.01
Test Max.	8.16	6.5	33.3	15.0	0.46

Toxicity Data Summary
Project: Newport Bay Sediment Toxicity
Sample Description: Newport Bay Core Tube Overlying Water
Sample Collected: 05/4/01 & 5/7/01 Experiment Number: S535
Test Initiated: 05/8/01 Test Ended: 05/8/01
Test Method: Purple Sea Urchin Fertilization Test (EPA/600/R-95/136)
Species: *Strongylocentrotus purpuratus* Laboratory: SCCWRP
Supervising Technician: Ehren Doris

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW05080102	Seawater Control	97	1.1	5	
NBBK05080102	Core Tube Water Blank 100%	96	2.8	4	
NBOW05070101	NB1A Core Tube Overlying 50%	-	-	0	
NBOW05070101	NB1A Core Tube Overlying 100%	98	1.5	3	
NBOW05070101	NB1B Core Tube Overlying 50%	-	-	0	
NBOW05070101	NB1B Core Tube Overlying 100%	96	3.5	3	
NBOW05070102	NB3A Core Tube Overlying 50%	79	4.0	3	*
NBOW05070102	NB3A Core Tube Overlying 100%	67	10.2	3	*
NBOW05070102	NB3B Core Tube Overlying 50%	70	4.6	3	*
NBOW05070102	NB3B Core Tube Overlying 100%	74	3.8	3	*
NBOW05070103	NB5A Core Tube Overlying 50%	-	-	0	
NBOW05070103	NB5A Core Tube Overlying 100%	94	2.1	3	*
NBOW05070103	NB5B Core Tube Overlying 50%	94	2.0	3	*
NBOW05070103	NB5B Core Tube Overlying 100%	78	3.1	3	*
NBOW05040101	NB8A Core Tube Overlying 50%	94	2.1	3	
NBOW05040101	NB8A Core Tube Overlying 100%	85	3.6	3	*
NBOW05040101	NB8B Core Tube Overlying 50%	96	2.1	3	
NBOW05040101	NB8B Core Tube Overlying 100%	87	3.2	3	*
NBOW05040102	NB10A Core Tube Overlying 50%	-	-	0	
NBOW05040102	NB10A Core Tube Overlying 100%	99	0.6	3	
NBOW05040102	NB10B Core Tube Overlying 50%	94	0.6	3	
NBOW05040102	NB10B Core Tube Overlying 100%	54	13.9	3	*

The test met acceptability criteria for control survival (>70%) and the reference toxicant EC50 was within control chart limits.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
Overlying Test Min.	7.58	5.6	32.7	15.0	0.1
Overlying Test Max.	7.91	5.9	33.4	15.0	1.0

Toxicity Data Summary.
Project: Newport Bay Sediment Toxicity
Sample Description: Newport Bay Surface Water
Sample Collected: 5/7/01 Experiment Number: MB48
Test Initiated: 5/9/01 Test Ended: 5/16/01

Test Method: Mysid survival and growth
Species: *Americamysis bahia* Laboratory: SCCWRP
Supervising Technician: Darrin Greenstein

Survival Data

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW05080102	Salinity Control (33 ppt)	98	7.1	8	
NBRW05080102	Sta. NB3 Surface Water	98	7.1	8	
NBRW05080104	Sta. NB5 Surface Water	98	7.1	8	
NBRW05080107	Sta. NB8 Surface Water	98	7.1	8	
NBRW05080109	Sta. NB10 Surface Water	95	9.3	8	

Weight Data (dry mg/mysid)

Sample Code	Sample	Mean	Standard Deviation	Number Counted	Significantly Reduced from Control
NBSW05080102	Salinity Control (33 ppt)	0.302	0.037	8	
NBRW05080102	Sta. NB3 Surface Water	0.313	0.024	8	
NBRW05080104	Sta. NB5 Surface Water	0.339	0.034	8	
NBRW05080107	Sta. NB8 Surface Water	0.337	0.022	8	
NBRW05080109	Sta. NB10 Surface Water	0.331	0.035	8	

Since all samples had both survival and weights that were greater than or equal to the controls, no statistical analysis was performed.

The test met acceptability criteria for control survival (>80%) and average weight of controls (0.20mg/mysid) and reference toxicant EC50 was within control chart limits.

Sample	pH	Dissolved Oxygen (mg/L)	Salinity (g/kg)	Temp (C°)	Total Ammonia (mg/L)
NB					
Test Min.	7.78	5.1	28.2	23.2	
Test Max.	8.00	6.8	33.6	25.7	

Table B1. Adjustment of sea urchin embryo toxicity test results for ammonia influence in the sediment-water interface test. Ammonia levels >0.067 mg/L NH_3 were sufficient to have caused all of the toxicity in a given sample, and no usable data regarding toxicity from other constituents could be obtained; these samples were removed as outliers. Samples with ammonia concentrations 0.033 – 0.067 mg/L NH_3 that had sea urchin embryo development <80% of the control were likely to be influenced by ammonia. Normal development for these samples was increased by the amount predicted to compensate for the ammonia toxicity effect.

Sample	Core Tube Replicate	Initial NH_3 (mg/L)	Normal Development (%Control)	Ammonia Influenced	Adjusted Normal Development (%Control)	Mean Adjusted Development (%Control)	Standard Deviation	N
NB1	1	0.044	101.0	No	101.0			
NB1	2	0.046	101.0	No	101.0			
NB1	3	0.026	103.1	No	103.1			
NB1	4	0.055	102.1	No	102.1	101.8	1.0	4
NB3	1	0.085	3.1	Outlier	Outlier			
NB3	2	0.043	68.8	Ammonia Influenced	100.3			
NB3	3	0.087	42.7	Outlier	Outlier			
NB3	4	0.172	0.0	Outlier	Outlier	96.8	–	1
NB5	1	0.035	99.0	No	99.0			
NB5	2	0.034	102.1	No	102.1			
NB5	3	0.030	97.9	No	97.9			
NB5	4	0.023	99.0	No	99.0	99.5	1.8	4
NB9	1	0.055	101.0	No	101.0			
NB9	2	0.064	103.1	No	103.1			
NB9	3	0.080	78.1	Outlier	Outlier			
NB9	4	0.093	46.9	Outlier	Outlier	102.1	1.5	2
NB10	1	0.278	0.0	Outlier	Outlier			
NB10	2	0.219	2.1	Outlier	Outlier			
NB10	3	0.147	10.4	Outlier	Outlier			
NB10	4	0.118	16.7	Outlier	Outlier	All Outliers	–	0

C. Sediment Quality Guideline Data

Table C1. Sediment quality guidelines used to evaluate contaminant concentrations in Newport Bay sediments.

	TEL	PEL	Amphipod AET
Metals/Metalloids (mg/kg)			
As	7.24	41.6	450
Cd	0.68	4.21	14
Cr	52.3	160	>1,100
Cu	18.7	108	1,300
Hg	0.13	0.7	2.3
Pb	30.2	112	1,200
Ni	15.9	42.8	>370
Ag	0.73	1.77	6.1
Zn	124	271	3,800
Organics (ng/g)			
Low molecular weight PAHs	312	1442	29,000
acenaphthene	6.71	88.9	2,000
acenaphthylene	5.87	128	1,300
anthracene	46.9	245	13,000
fluorene	21.2	144	3,600
2-methyl naphthalene	20.2	201	1,900
naphthalene	34.6	391	2,400
phenanthrene	86.7	544	21,000
High molecular weight PAHs	655	6,676	69,000
benzo(a)anthracene	74.8	693	5,100
benzo(a)pyrene	88.8	763	3,500
chrysene	108	846	21,000
dibenz(a,h)anthracene	6.22	135	1,900
fluoranthene	113	1,494	30,000
pyrene	153	1,398	16,000
Total PAHs	1684	16,770	–
Total DDTs	3.89	51.7	
Total PCBs	21.6	189	–

TEL = Threshold Effect Level, PEL = Probable Effects Level from MacDonald 1994; AET = Apparent Effects Threshold, from Puget Sound Estuary Program 1988.

Table C2. Newport Bay stations exceeding sediment quality guidelines. Non-detects were treated as equal to 0 for calculating the ERM quotient (ERMq).

Station	Sampling event	Mean ERMq	Contaminants exceeding TEL	Contaminants exceeding PEL	Contaminants exceeding amphipod AET
NB1	September 2000	0.012	None	None	None
NB1	May 2001	0.017	None	None	None
NB2	September 2000	0.051	Cd, Cu, Ni, Zn, total DDTs	None	None
NB2	May 2001	0.062	Cd, Cu, Ni, Zn, total DDTs	None	None
NB3	September 2000	0.617	As, Cu, Hg, Pb, Zn, total DDTs, total PCBs, benzo(a)pyrene, fluoranthene, naphthalene	Cu, Hg, Zn	Hg
NB3	May 2001	0.562	As, Cd, Cu, Hg, Ni, Pb, Zn, benzo(a)pyrene, total PCBs, total DDTs	Cu, Hg, Zn	Hg
NB4	September 2000	0.179	As, Cd, Cu, Hg, Ni, Pb, Zn, 2-methyl naphthalene, naphthalene, total DDTs	Cu, Hg	None
NB4	May 2001	0.156	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, 2-methyl naphthalene, total DDTs	Cu, Hg, total DDTs	None
NB5	September 2000	0.069	As, Cd, Cu, Ni, Zn, total DDTs	None	None
NB5	May 2001	0.085	As, Cd, Cr, Cu, Ni, Zn, total DDTs	None	None
NB6	September 2000	0.054	Cd, Cu, Zn, 2-methyl naphthalene, total DDTs	None	None
NB6	May 2001	0.066	Cd, Cu, Ni, Zn, total DDTs	None	None
NB7	September 2000	0.019	Cu	None	None
NB7	May 2001	0.041	Cd, Cu, total DDTs	None	None

Table C2 Continued.

Station	Sampling event	Mean ERMq	Contaminants exceeding TEL	Contaminants exceeding PEL	Contaminants exceeding amphipod AET
NB8	September 2000	0.042	Cu, 2-methyl naphthalene, total DDTs, fluoranthene	None	None
NB8	May 2001	0.036	Cu, phenanthrene, fluoranthene, pyrene, benz(a)anthracene, chrysene, total DDTs	None	None
NB9	September 2000	0.013	None	None	None
NB9	May 2001	0.061	Cd, Cu, Ni, Pb, Zn, phenanthrene, fluoranthene, benzo(a)pyrene, benz(a)anthracene, 2-methyl naphthalene, total DDTs	None	None
NB10	September 2000	0.063	Cd, Cu, Ni, Zn, 2-methyl naphthalene, total DDTs	None	None
NB10	May 2001	0.042	Cd, Cu, total DDTs	None	None