

Technical Memorandum for Phase III Investigations

McAllister Point Landfill Marine Ecological Risk Assessment

Naval Education and Training Center
Newport, Rhode Island



Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0197

April 1997



Brown & Root Environmental

A Division of Halliburton NUS Corporation

**TECHNICAL MEMORANDUM FOR
PHASE III INVESTIGATIONS**

**MCALLISTER POINT LANDFILL
MARINE ECOLOGICAL RISK ASSESSMENT**

**NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND**

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT**

**Submitted to:
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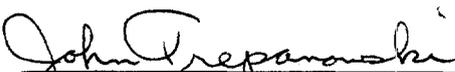

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E.0 EXECUTIVE SUMMARY

This technical memorandum describes the most recent chemical and physical conditions present at the shoreline of the McAllister Point Landfill and outlines the Navy's plan to address those conditions.

Ecological risk to the off-shore marine environment from the McAllister Point Landfill (the site) was evaluated in 1994 and 1995, and is described in the Marine Ecological Risk Assessment for McAllister Point Landfill (Draft Final, SAIC and URI GSO, June 1996). The sample collection and data analysis for the ecological risk assessment were performed in the fall of 1994 and 1995, concurrent with the first phase of the site's capping (construction of a protective stone revetment and the lower sections of the landfill cap). These activities were completed in November 1995.

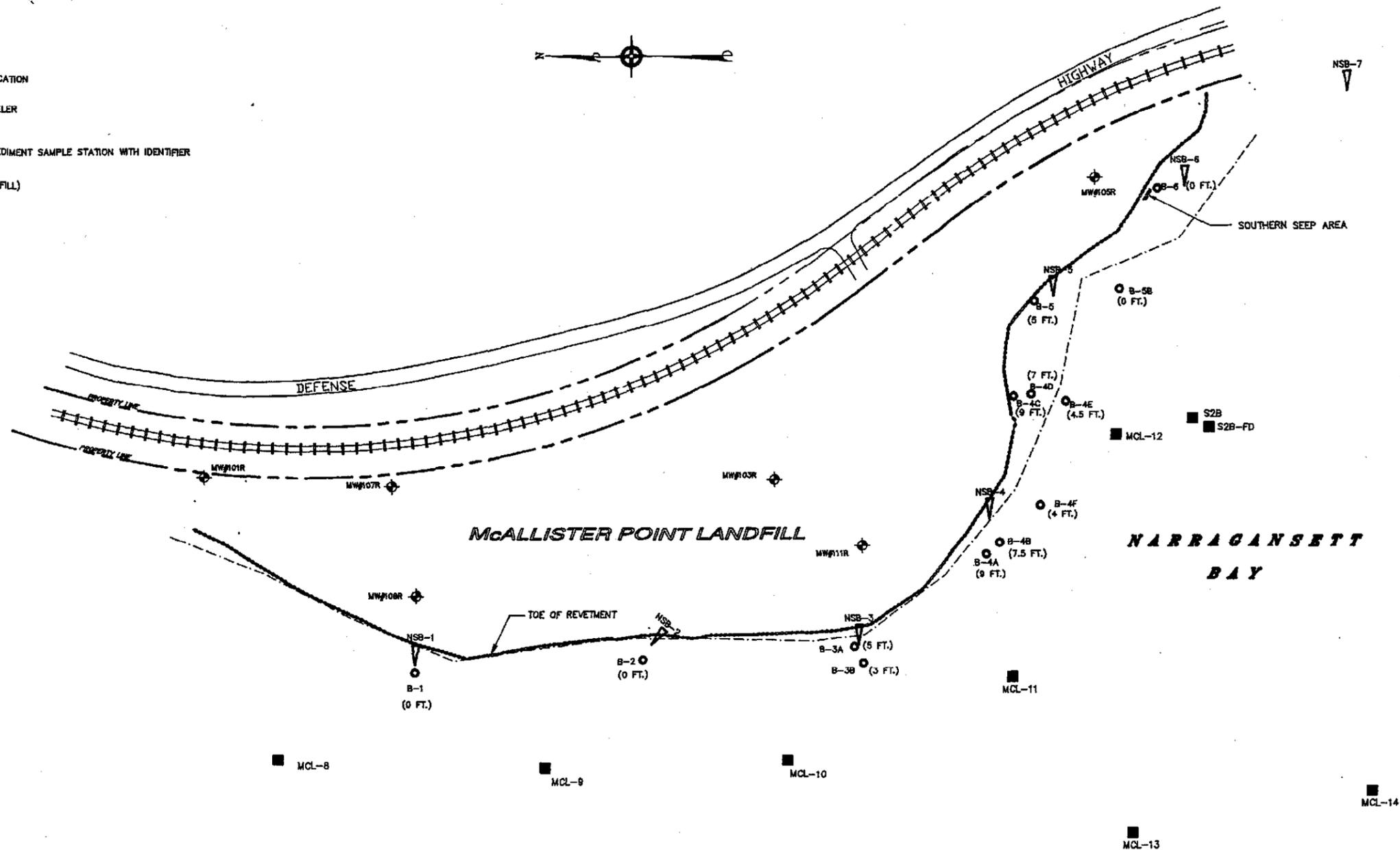
When construction resumed in April 1996, oversight engineers from B&R Environmental observed that the shoreline seaward of the new stone revetment near stations NSB-2, NSB-3, and NSB-4 (Figure E-1) had undergone a noticeable change in the five-month interim. In November 1995, a small beach had been present in the intertidal zone, consisting of sand and gravel. In April 1996, sand was absent from this area, and landfill debris, consisting of wire, metal, concrete, asphalt, glass, and other material was visible at low tide. Further inspections indicated that some form of erosion had occurred over the winter, uncovering landfill material that had previously been covered.

In June of 1996, the Navy initiated an investigation to determine if the newly exposed materials posed a greater risk to ecological receptors than the sediments that had eroded. A new baseline topography survey was performed between August and October 1996, seaward of the new stone revetment, using sonar and standard survey methods. The results of the topography survey were compared to the baseline topography survey performed by TRC Environmental Consultants in 1994. This comparison confirmed that up to 1.72 vertical feet of surficial material had eroded from the intertidal zone of the landfill between 1994 and 1996.

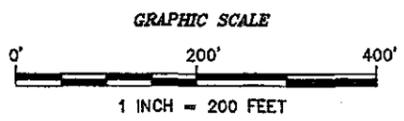
Thirteen borings were performed seaward of the new stone revetment to determine thickness of the fill material and to evaluate other subsurface conditions. Landfill material was found up to nine feet thick immediately seaward of the bottom of the stone revetment at the central portions of the landfill. Fill was not found seaward of the revetment at the southern and northern limits of the stone revetment. Fill was found as far as 50-80 feet from the toe of the stone revetment near NSB-4 (Figure E-1). Geologists performing the borings noted that some of the fill material seaward of the revetment,

LEGEND

- MWP01R  BEDROCK MONITORING WELL WITH IDENTIFIER
- NSB-1  PHASE III NEARSHORE SEDIMENT SAMPLE LOCATION
- MLW DATUM 0.00 LOCATED BY FOSTER WHEELER IN APRIL, 1996
- MCL-12  APPROX. LOCATION PHASE III OFF-SHORE SEDIMENT SAMPLE STATION WITH IDENTIFIER
- B-2  (3 FT.) SUBTIDAL BORING LOCATION (THICKNESS OF FILL)
- TOE OF REVETMENT



NOTES:
 1. PLAN NOT TO BE USED FOR DESIGN.
 2. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.



SUMMARY OF PHASE III INVESTIGATIONS		FIGURE E-1
McALLISTER POINT LANDFILL		 Brown & Root Environmental A Division of Halliburton NUS Corporation 55 Jonspin Road Wilmington, MA 01887 (508)658-7899
NEWPORT, RHODE ISLAND		
DRAWN BY: R.G. DEWSNAP CHECKED BY: S. PARKER SCALE: 1" = 200'	REV.: 0 DATE: 23 DEC 96 FILE NO.: D:\DWG\NAVY\MC_PT\PHI_INV.DWG	

including ash, glass, metal and other fragmented solid debris is subject to erosion during heavy seas, and is not protected by the revetment. Figure E-1 depicts boring locations and thickness of fill.

During the drilling program, a small oily seep was noted in the southern intertidal zone of the landfill (Figure E-1). An investigation indicated that the sheen was produced by a mass of oily soil and rock fragments encompassing an area approximately 21 feet by 6 feet. Samples were collected and analyzed for petroleum hydrocarbons and a petroleum characterization, known as a "fingerprint". Results indicate that these soils contain high concentrations of a material that is most likely a waste oil.

The study team that performed the 1994/1995 risk assessment returned to the 16 sample stations (seven near shore and nine off shore) affected by the winter erosion to collect additional samples for chemistry and toxicity analysis. Figure E-1 depicts sample collection locations. Sediment samples were analyzed for organic compounds and metals. Results from analysis of these samples were compared with results from samples collected at these locations in 1994 and 1995. Results indicate that concentrations of some organics (PCBs at stations NSB-4 and NSB-5; and PAHs at NSB-4, NSB-6, and MCL-12) and metals (NSB-2, -3, -4, -5, -7, and MCL-10) are higher in the 1996 samples than were reported in the 1994/1995 samples. Because the latest concentrations were higher, additional samples were collected from deeper sediments at some of these locations. Analytical results of some deeper samples also indicated higher concentrations of PCBs (NSB-2) and PAHs (NSB-2, -3, and -4) than those measured in the surface samples. Results from metals analysis of these deeper samples indicated a large increase in aluminum, arsenic, cadmium, and chromium at NSB-2. In addition, a large increase in mercury concentrations was found in these deeper samples at NSB-3 and NSB-4.

Sediment samples from these locations were also evaluated for toxicity. This evaluation measured the number of amphipods (tiny crustaceans that live on sediment) that were killed when exposed to sediments collected from each sample location. Results were compared to similar tests conducted in 1995. Toxicity increased markedly at one sample location (NSB-2), but decreased slightly at three stations (S2B, NSB-1, and NSB-6). Additional samples were collected from deeper locations at these stations, and used in another type of toxicity test. In the second test, sediments were suspended in water and introduced to reproductive cells and embryos of sea urchins. This test measures frequency of fertilization of the exposed cells and embryo development. Test results indicated high toxicities at S2B and MCL-12.

The purpose of an Ecological Risk Assessment is to provide a baseline of data to measure risk to environmental receptors from the contaminants present in the sediments. Because the draft final risk assessment published in June 1996 was prepared from 1994/1995 data, it no longer reflects current conditions. Due to the increased concentrations of contaminants and the increased toxicity measured in sediments found in the most recent investigation, the Navy, the EPA, and the State of Rhode Island have determined that the Marine Ecological Risk Assessment should be revised to include the latest findings.

This technical memorandum describes a plan for revising the June 1996 Draft Final Marine Ecological Risk Assessment to incorporate these recent findings. The new data will be included in the appropriate sections to revise the risk-based characterization of the marine environment near the landfill.

1.0 INTRODUCTION

Ecological risk to the off-shore marine environment from this site was evaluated in the Marine Ecological Risk Assessment (Marine ERA) for McAllister Point Landfill (SAIC and URI GSO, June 1996). The sample collection and data analysis for this study was performed at the same time as the construction of the stone revetment and lower sections of the landfill cap, between June and November 1995.

During the construction of the stone revetment, the visible debris was removed from the shoreline of the landfill, and placed on top of the landfill to be covered later. This debris included concrete, asphalt, scrap metal, bricks, and other landfill-type debris. Large items were moved using excavation equipment and trucks, and smaller items were hand-picked and carried to the top of the landfill in trucks. After completion of the revetment, the shoreline consisted of sand, gravel, and cobbles.

Construction of the landfill cap was discontinued between November 1995 and April 1996. When construction resumed in April 1996, oversight engineers from B&R Environmental observed that the shoreline had undergone a noticeable change in the four-month interim. Sand was absent from the northern section of the landfill shoreline, and had been replaced by a "shingle" beach. At the central section of the shoreline, the sand and gravel was absent, and landfill debris, consisting of wire, metal, concrete, asphalt, glass, and other material was visible at low tide. Further inspections indicated that erosion had occurred over the winter.

As a result of these observations, the Navy initiated "Phase III Investigations" in the marine environment near the site. These investigations were designed to focus on changes to the baseline conditions since the revetment construction was completed. The concentrations of chemical contaminants were to be measured and compared with those in near-shore and off-shore sediments before the erosion occurred. Toxicity of sediments to organisms was also to be compared to that measured for sediments before erosion. Samples for Phase III were to be collected at the same locations as those for the risk assessment so that results could be compared.

In addition, topography was measured to compare elevations of specific points of the shoreline under current conditions to the elevations of those points prior to the erosion event. The topography could then be measured periodically to monitor any continuing erosion. The presence of fill, which was visible off shore of the stone revetment, indicated the presence of fill under water. The fill thickness of this fill was to be measured by performing borings seaward of the revetment. These borings were

to be performed to determine the nature of native materials under the fill and depth to bedrock. Finally, a small seep area was also noted in the southern sub-tidal slope. This seep was characterized by the presence of an oily sheen visible on the sediment surface during low tide. Samples were collected to attempt to identify the seep source.

At the eighth meeting of the Ecological Risk Advisory Board (July 18, 1996), the regulatory oversight parties requested that the Marine ERA be revised to reflect current conditions. It was agreed that this revision would be required if the new samples collected under the Phase III investigation revealed a condition that was significantly different than that presented in the Draft Final Risk Assessment. A change in results of 30 percent was identified as a reasonable level of difference that would require a revision to the risk assessment. The plan for the revision would be included in this technical memorandum.

2.0 TOPOGRAPHY

A shoreline topography survey was performed by SAI Surveying Company of Jamestown, Rhode Island, in October 1996. This survey was performed with the intention that it could be repeated on a periodic basis to measure continued erosion or other (seasonal) elevation changes below the revetment.

Prior to the initiation of this survey, elevations were measured at seven known points located at the landfill shoreline. These points are also sample stations used for the Marine ERA. Old land survey data were used to interpret the approximate elevations of these points as of 1994. The elevations of these points were then measured in May 1996. The two elevations were corrected for variations in the elevation datum used, and it was found that elevations had changed between 1994 and 1996. Changes were identified between 0.24 feet (NSB-5) and 1.72 feet (NSB-3). However, this change could be a combination of effects from erosion, construction of the revetment, and removal of debris from the shoreline during the construction operation.

After this initial survey effort, it was realized that the topography of the shoreline should be monitored, possibly on a periodic basis. Permanent benchmarks were constructed beyond the north and south limits of the landfill.

The topography of the shoreline was measured to produce a 1-foot contour interval map of a 30-foot strip of land from the toe of the revetment seaward, bounded on the north and south by the limits of the revetment. Data points were collected at a 50-foot interval, and recorded with northings, eastings, and elevations. Horizontal datum was taken from the design and construction datum (TRC) for the McAllister Point Landfill Cap Construction. The vertical datum is the project datum that is unique to the site. Project 0.0 datum is 1.08 feet above Mean Low Water (MLW-Navy), and 0.52 feet below Mean Sea Level (MSL NGVD 1929) (source: SAI Surveying Co., October 1996).

Precision or repeatability of the horizontal location at each 50-foot data point will vary due to conditions at the site. However, the surveyor stated that it is reasonable to expect to see variation of +/-0.10 feet horizontally and vertically at fixed points.

Because the surveyor was able only to perform a land based survey, and much of the area of interest is below the low tide line, the land based survey was augmented by a sonar survey of the subtidal slope. This sonar survey was performed using a chart-recording depth sounder, driven along 200 foot

lines laid out directly south and west of the shoreline at six specific points, where elevation control had been measured. The readings were normalized for tide and the project datum described above. Two-foot contour intervals were extrapolated from this information, and were plotted on the contour map described above. Subtidal topography is shown on Figure 2-1.

Raw data from the survey effort is presented in Appendix A. This information shows an even slope seaward the northern shore of the landfill, dropping to approximately 12 feet deep 200 feet from shore. There are some irregular features off shore of the site's central section that indicate the presence of boulders approximately 50 to 150 feet from the toe of the revetment. In addition, the slope in this section is less even, dropping steeply within the first 100 feet from shore, then leveling out somewhat further seaward. The slope off shore of the southern section of the site is more shallow, dropping to only 7 feet 200 feet from shore. Another notable finding was south of NSB-5, where the maximum depth reached was only 4 feet, 230 feet south of the revetment.

Precision or repeatability of the sonar portions of the survey is limited by several factors. The lines are driven in a small boat for the full 200-foot distance, and there is a potential for slight drift from side to side along this line, because the line is followed visually using way-points. Wave action can affect the depth reading depending on vessel size and weather. This survey was performed with a 13-foot runabout, and wave action was less than 0.5 feet during the performance of the work, so there was no affect to the sonar readings. Finally, the precision of the instrument itself is good, measured at +/-0.5 feet, as indicated on the graphic strip charts presented in Appendix A.

3.0 GEOLOGICAL CONDITIONS

In October 1996, the geological conditions of the study area were evaluated via borings advanced near the areas that eroded between 1994 and 1996. The objective of the borings was to determine the thickness of fill in these areas, and depth to bedrock, to determine the possibility for future erosion.

A first set of borings was advanced at or near the sample stations known previously as the "NSB" stations, sampled by SAIC and URI for the Marine ERA. Following the evaluation of information from these borings, it would be determined if additional borings were necessary further off shore to help define limits of fill.

Borings were performed using drive and wash drilling methods. Samples were collected using three-inch outside diameter split barrel sampling devices driven with a 300-pound slide hammer. Samples were collected continuously through the fill and overburden materials. Split barrel samplers were driven ahead of the drilling casing at 24-inch intervals, then extracted and evaluated carefully for the presence of fill. Lithology of the material was described on boring logs that are presented in Appendix B.

When encountered, bedrock was cored using NX double walled core barrels, which can allow a 10-foot core to be recovered in a single section. Rock cores were evaluated after recovery from each boring. Rock evaluations are expressed in percent of recovered rock and "% rock quality designation" (RQD). The RQD is an index of rock quality that indicates weathered, soft, fractured, sheared, and/or jointed rock. Rock cores with a low RQD are graded as such because they are recovered in small pieces, indicating numerous fractures or softness of the rock. High RQDs indicate more competent, less fractured rock. Evaluations of the rock cores are presented on the boring logs.

The drilling apparatus was set on a floating platform to reach locations under water. An all-terrain vehicle was used to install borings above the tide influence. Borings generally took at least 12 hours to complete, so borings could not effectively be placed directly in the intertidal zone; access to this zone would damage a floating apparatus when the tide retreated, and water would damage a land-access vehicle during high water periods.

Six borings were placed at or near the NSB sample stations, as described above. Four additional borings were placed off-shore of these locations because fill was found in corresponding near-shore borings. An additional three borings were placed in a north to south line equidistant between NSB-4

and NSB-5 in order to fill a data gap in this area. Table 3-1 describes each boring and the general findings. Figure 3-1 depicts boring locations.

This boring program indicates that a significant amount of landfill material is present off shore of the existing landfill cap. As indicated on the boring logs presented in Appendix B, the fill material consists of glass, metal pieces, ash, incinerator slag, asphalt, concrete, brick, and wood. This material is mixed into gravel, sand, and silt, but the largest pieces of debris are visible closest to the toe of the revetment at NSB-4 and NSB-3. The distribution of the material found indicates that the smaller size debris, particularly the ash, is transportable through wave action and current. The recently constructed new revetment does not prevent the material already in the marine environment to be transported further from the site.

Chemical composition and toxicity of the "sediments", including the debris described above, has been evaluated in the Marine ERA, as augmented with data presented in Sections 5 and 6 of this technical memorandum.

During the boring program, it was observed that this shoreline is a very dynamic location. On a regular basis, it is subject to seas up to 3 feet. Strong currents have been observed sweeping north to south. Such shorelines can be subject to seasonal sediment displacement and long-term erosion. It is plausible that the landfill material found in the off-shore borings (B-4E, B-4F) could have been deposited at these locations during past erosional events. Furthermore, this material could easily continue to migrate, when subjected to typical winter conditions in this part of Narragansett Bay.

The boring data was used to prepare cross-sections of the revetment slope and the landfill subtidal slope at three locations: one at the northern section of the site (cross-section A-A'), and two at the central section of the site where fill was present off shore of the landfill (cross-sections B-B' and C-C'). These cross-sections display bedrock elevations, ground surface elevations, and use 0.0 project datum as a reference point. Cross-sections are presented as a part of Figure 3-1.

**TABLE 3-1
SUMMARY OF SUBTIDAL BORINGS
PHASE III INVESTIGATIONS, McALLISTER POINT LANDFILL
NETC NEWPORT, RHODE ISLAND**

BORING NO.	TARGETED LOCATION	PURPOSE	FINDINGS
B-1	10 feet west of NSB-1	Determine presence of fill.	No fill: Bedrock at 3.5' BGS ⁽¹⁾ .
B-2	10 feet west of NSB-2	Determine presence of fill.	Debris on surface, no fill: Bedrock at 3.5' BGS
B-3A	At NSB-3	Determine thickness of fill.	Fill material to 5.0' BGS Bedrock at 13' BGS
B-3B	20 feet west of NSB-3	Determine presence of fill.	Fill material to 3.0' BGS Bedrock at 10.5' BGS
B-4A	Proximal to NSB-4	Determine thickness of fill.	Fill material to 9.0' BGS Bedrock at 20.5' BGS
B-4B	Off shore (west) of NSB-4	Determine presence of fill.	Fill material to 7.5' BGS Bedrock not determined
B-4C	At toe of revetment, between NSB-4 and NSB-5	Determine thickness of fill.	Fill material to 9.0' BGS Bedrock at 9.0' BGS
B-4D	Off shore (south) of B-4C	Determine presence of fill.	Fill material to 7.0' BGS Bedrock at 9.0' BGS
B-4E	Off shore (south) of B-4D	Determine presence of fill.	Fill material to 4.5' BGS Bedrock not determined
B-4F	Off shore (south) of NSB-4	Determine presence of fill.	Fill material to 4.0' BGS Bedrock not determined
B-5	20 feet upgradient of NSB-5	Determine presence of fill.	Fill material to 5.0' BGS Bedrock at 6.0' BGS
B-5B	Off shore of NSB-5	Determine presence of fill.	No fill present Bedrock at 2.0' BGS
B-6	Proximal to NSB-6	Determine presence of fill.	No fill present Bedrock at 9.0' BGS

Note:

(1) BGS - below ground surface

4.0 SEEP AREA INVESTIGATION

During the geological investigation of the landfill shoreline, a small zone in the southern intertidal zone exhibited an oily sheen during low tide. A mass of oily debris appeared just below the surface of the sand. This area was targeted for a more thorough investigation to determine the source of the sheen and to delineate the extent of the source.

In November 1996, B&R Environmental collected samples of the sediments in and around the seep area for chemical analysis. The seep area was first delineated by visual observation, and the limits of the affected area were marked with stakes and flagging. A grid was laid out over the seep area, with points on 5-foot intervals. This grid extended from the toe of the existing stone revetment seaward to the lower limit of the tide. The seep area and sample grid are presented on Figure 4-1.

Sediment samples were first collected from the grid points that fell within the seep area itself. Samples were collected using hand augers, turned into the sediments at 0.5-foot intervals. Samples were evaluated visually, and were screened for total volatile organic compounds using a jar headspace screening procedure; sediments were placed into an 8-ounce jar, covered with aluminum foil, and capped for headspace screening using a photo-ionization detector (PID).

Visual inspection and headspace screening of the sediment samples indicated the presence of a layer of oily sediments approximately 1-foot thick in the area previously marked and staked. This material did not extend more than 1.5 feet in depth at any of the sample locations. The sediments exhibited a maximum of 11.5 parts per million (ppm) by headspace screening, using a PID equipped with a 10.2 ev lamp.

After the apparent limits of contamination were determined by visual inspection and headspace screening, 12 sample locations were selected for additional sample collection and confirmatory laboratory analysis. The samples collected for laboratory analysis were targeted as follows: two samples were collected from the material that was expected to be most contaminated and ten samples were collected from the outer edge of the impacted sediments, both vertically and horizontally.

Samples collected for laboratory analysis were also collected by turning hand augers into the sediment to the target depth interval. Each sediment sample was placed into a decontaminated steel bowl. After the material was mixed thoroughly, aliquots of the material were removed and containerized for chemical analysis. Samples were analyzed for total petroleum hydrocarbons by Method 418.1 and for

gasoline and diesel range organic compounds, and "fingerprint" of the makeup of the contaminant set detected (Method 8015B). The samples collected from the center of the seep area were also analyzed for PCBs (Method 8080).

Quality control samples were collected in accordance with B&R Environmental Standard Operating Procedures. A summary of field samples and Quality Control samples collected during this sampling program is presented in Table 4-1.

All samples were stabilized against contaminant degradation using chemical preservatives and by storing samples on ice at 4 degrees C. Chemical preservatives were supplied and used for aqueous samples only, in accordance with the instructions provided by the analytical laboratory.

Validation of this data was not part of the scope of this task. Unvalidated results from analysis of sediment samples are presented in Appendix C-3. These results, summarized on Table 4-2, indicate the presence of total petroleum hydrocarbons (TPH) measured using Method 418.1 at high concentrations (up to 24,000 milligrams per kilograms (mg/kg)) in the sediments at the center of the seep area (EZ-0006). While concentrations decrease in the perimeter of the investigated area, they do not drop below detection limits.

In addition, there were also detections of gasoline range organic compounds (up to 1,100 ug/kg), diesel range organic compounds (up to 11,800 mg/kg) and polychlorinated biphenyls (PCBs) (up to 170 ug/kg). Each of these component groups is a subset of the TPH measured by Method 418.1. The presence of these components indicates that the sediments may be contaminated with some type of waste oil.

After much consideration, it was determined that this data will not be used in the ecological risk assessment. The seep data was collected in order to quickly delineate an affected area, the parameters measured and the data quality does not match other data collected for the risk assessment. Therefore there is no comparability between this and other stations evaluated in the risk assessment.

**TABLE 4-1
SUMMARY OF SAMPLE ANALYSES
SOUTHERN SEEP AREA INVESTIGATION, MCALLISTER POINT LANDFILL
NETC NEWPORT, RHODE ISLAND**

Analysis	Field Samples (Solid)	Duplicates (Solid)	Field Blanks (Aqueous)	Trip Blanks (Aqueous)	Rinsate Blanks (Aqueous)	Total
GRO/DRO, 8015B	10	1	0	0	1	12
TPH, 418.1	10	1	0	0	1	12
TCL PCBs, 8080	2	1	0	0	0	3

PCB method to exclude pesticides

TABLE 4-2
SUMMARY OF ANALYTICAL RESULTS
SOUTHERN SEEP AREA
McALLISTER POINT LANDFILL PHASE III
NETC NEWPORT RHODE ISLAND

ANALYTE	MP-SS DEPTH:	SAMPLE LOCATION/TYPE					
		C1-0006	C1-1218	E2-0006 FIELD DUP 1	E2-0006 FIELD DUP 1	E2-1218	A1-0006
		0.0' - 0.5'	1.0' - 1.5'	0.0' - 0.5'	0.0' - 0.5'	1.0' - 1.5'	0.0' - 0.5'
Headspace Screening Analysis							
Total VOCs (ppm in air)		8.2	1.2	11.5	11.5	1.3	1.2
TPH, Infrared, 418.1							
Total Petroleum Hydrocarbons (mg/kg, soil)		18000	120	20000	24000	420	780
GRO/DRO 8015A							
Gasoline Range Organics (ug/kg, soil)		260	600	720	1100	740	130 U
Diesel Range Organics (mg/kg, soil)		11800	31 J	7800	11000	180	280 J
PCBs, 8080 (ug/kg, soil)							
Arochlor - 1016		39 U	NA	36 U	36 U	NA	NA
Arochlor - 1221		78 U	NA	72 U	72 U	NA	NA
Arochlor - 1232		39 U	NA	36 U	36 U	NA	NA
Arochlor - 1242		39 U	NA	36 U	36 U	NA	NA
Arochlor - 1248		39 U	NA	36 U	36 U	NA	NA
Arochlor - 1254		60	NA	170	130	NA	NA
Arochlor - 1260		39 U	NA	36 U	36 U	NA	NA

NOTES:

NA - Not Analyzed
U - Below detection limit specified
J - Estimated quantitation

W5296129F

4-4

CTO 197

TABLE 4-2
 SUMMARY OF ANALYTICAL RESULTS
 SOUTHERN SEEP AREA
 McALLISTER POINT LANDFILL PHASE III
 NETC NEWPORT RHODE ISLAND
 PAGE 2 OF 2

ANALYTE	MP-SS DEPTH:	SAMPLE LOCATION/TYPE				
		G1-0006	F3-0006	B3-0006	D0-0006	D3-0006
		0.0' - 0.5'	0.0' - 0.5'	0.0' - 0.5'	0.0' - 0.5'	0.0' - 0.5'
Headspace Screening Analysis						
Total VOCs (ppm in air)		1	1	0.7	0.2	0.3
TPH, Infrared, 418.1						
Total Petroleum Hydrocarbons (mg/kg, soil)		510	2500	190	500	1700
GRO/DRO 8015A						
Gasoline Range Organics (ug/kg, soil)		110 U	180	270	230	150
Diesel Range Organics (mg/kg, soil)		86 J	1100	140	280	1200
PCBs, 8080 (ug/kg, soil)						
Arochlor - 1016		NA	NA	NA	NA	NA
Arochlor - 1221		NA	NA	NA	NA	NA
Arochlor - 1232		NA	NA	NA	NA	NA
Arochlor - 1242		NA	NA	NA	NA	NA
Arochlor - 1248		NA	NA	NA	NA	NA
Arochlor - 1254		NA	NA	NA	NA	NA
Arochlor - 1260		NA	NA	NA	NA	NA

NOTES:

- NA - Not Analyzed
- U - Below detection limit specified
- J - Estimated quantitation

W/5296129F

4-5

CTO 197

5.0 SEDIMENT CHEMISTRY ANALYSIS

This section presents the data obtained in the analysis of organic and inorganic contaminants in marine sediments near McAllister Point Landfill. The surface samples were collected in September 1996, and the core samples were collected in October and November 1996. All procedures used in this investigation have been described in detail in the Final Work/Quality Assurance Project Plan - Narragansett Bay Ecorisk and Monitoring for Navy Sites (URI and SAIC, 1995). The results of the Phase I and II investigations of the McAllister Point Landfill have been previously reported (Brown & Root Environmental, 1996).

All station locations are shown in Figure 5-1. Eighteen surface sediments and 7 core sections were analyzed for 27 PCB congeners and 24 polycyclic aromatic hydrocarbons (PAHs), 12 metals, grain size, and total organic carbon. Station S2BFD is a separate grab sample taken at site S2B.

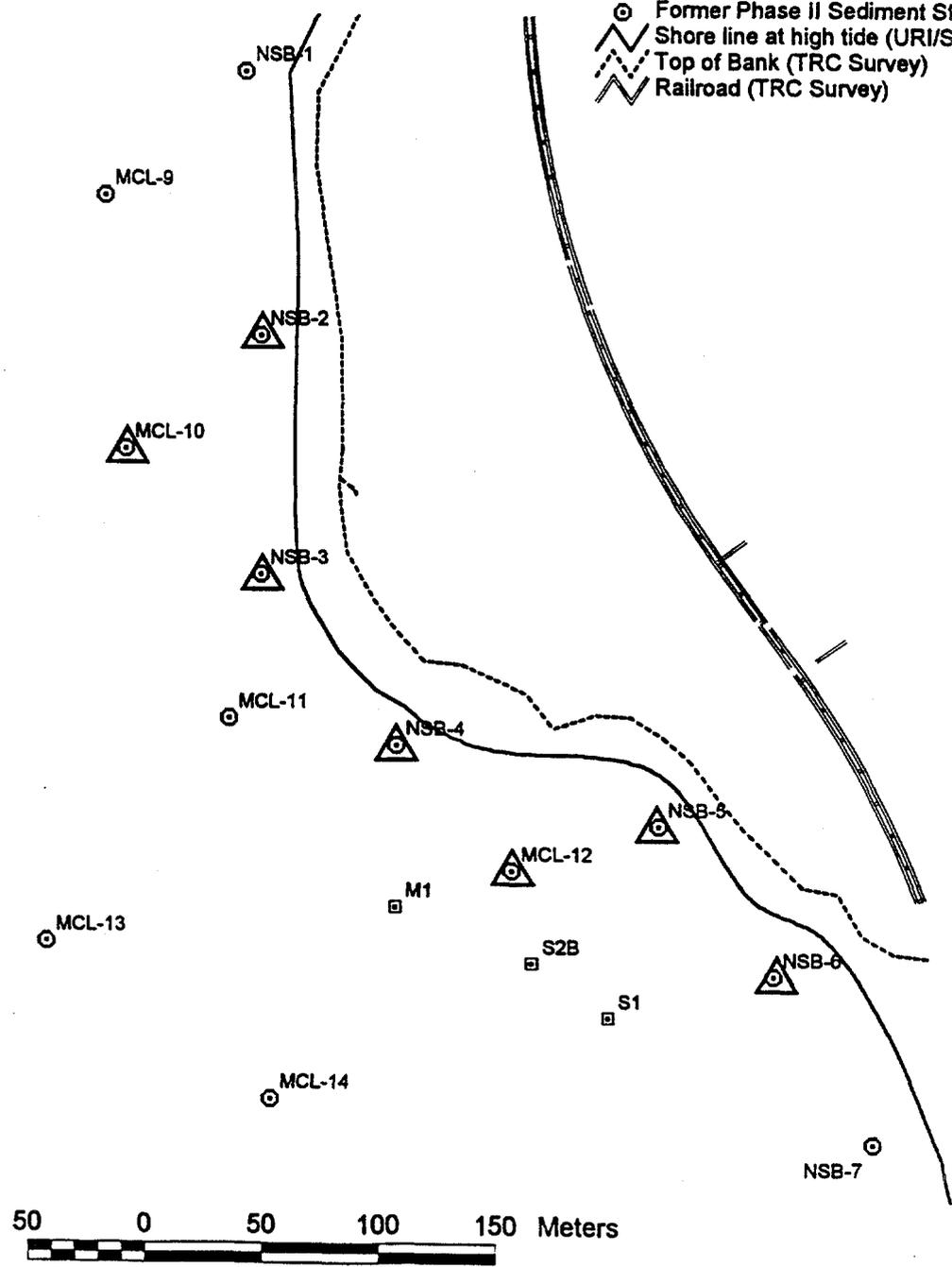
This study was performed by scientists from the University of Rhode Island Graduate School of Oceanography. Analytical packages were validated by B&R Environmental in accordance with EPA Validation (Tier II) guidelines. The complete reports and validation memoranda are presented in Appendix C. The conclusions of the report are restated below.

5.1 CONCLUSIONS FROM THE FATE AND TRANSPORT ANALYSIS OF ORGANIC CONTAMINANTS IN SEDIMENTS (From Quinn et.al., December 1996)

There was fair agreement in PCB concentrations between most surface stations collected in 1995 and 1996; however, the comparisons between near-shore stations NSB-4 and NSB-5 were poor, and the 1996 samples were considerably higher in PCB levels than those collected in 1995. Organic carbon normalization did not substantially change the trends obtained using sediment-based values. In addition, evaluation of the distribution of individual PCB congeners in the yearly samples showed that the congener CB206 at station NSB-5 was higher in 1996 than in 1995. Thus, based on the analyses of the surface samples, concentrations of PCBs at stations NSB-4 and NSB-5 in 1996 are higher than in 1995. The differences between the 1995 and 1996 samples suggest different sources and/or environmental modification of the PCBs at these locations. Environmental modification could include any type of degradation or change in the physical nature of the sediments transported or blended with other contaminants or sediments.



- △ Sediment Core Station
- Former Phase I Sediment Station
- ⊙ Former Phase II Sediment Station
- Shore line at high tide (URI/SAIC, 1994)
- - - Top of Bank (TRC Survey)
- ≡≡≡ Railroad (TRC Survey)



SOURCE: SAIC, NARRAGANSETT, RI; POSITIONING BY GPS

PHASE III SEDIMENT SAMPLE LOCATION		FIGURE 5-1	
McALLISTER POINT LANDFILL		 Brown & Root Environmental A Division of Halliburton NUS Corporation 55 Jonspln Road Wilmington, MA 01887 (508)658-7899	
PORTSMOUTH, RI			
DRAWN BY: SAIC CORP.	REV.: 0		
CHECKED BY: G. TRACEY	DATE: 09 APR 97		
SCALE: AS SHOWN	PROJECT NO: 4725 CTO# 197		

The greatest increases for PAH levels detected in surface samples from 1995 and 1996 were at stations NSB-6 and MCL-12. Normalization to organic carbon showed about the same trends obtained with the sediment-based values. The distribution of individual PAH components was relatively similar, both within and between most stations. However, higher levels of low-molecular-weight PAHs were detected at station NSB-4 in the 1996 samples. Therefore, there is evidence for substantial changes in PAH concentrations and/or qualitative distributions at stations NSB-4, NSB-6, and MCL-12. Again, these differences in the yearly PAH data suggest different source materials and/or environmental modification at these locations.

Only station NSB-2 showed a significant increase in concentration of PCBs for the core samples (0 to 18 cm) compared to the surface sediments (0 to 2 or 0 to 6 cm). Stations NSB-2 through NSB-4 had higher concentrations of PAHs in the core samples relative to the surface. Furthermore, station NSB-4 showed the presence of low-molecular-weight PAHs in both the surface and core samples. Thus, there is additional evidence for PAH changes in the sediments at stations NSB-3 through NSB-4.

5.2 CONCLUSIONS FROM THE FATE AND TRANSPORT ANALYSIS OF INORGANIC CONTAMINANTS IN SEDIMENTS (From King et.al., December 1996)

Major macroscopic changes observed in the study area during 1996 sampling include: (1) removal of 1 to 2 feet of sediment from the base of the revetment, (2) exposure of new metal debris at and immediately north of station NSB-2 and (3) rapid deposition of silty clay at station S2B.

Metal concentrations analyzed from 1996 were higher for several metals at stations NSB-2, NSB-3, NSB-4, NSB-5, NSB-7, and MCL-10 than metal concentrations from earlier sampling.

Aluminum normalization for lithologic variation of the samples does not change the general spatial pattern of trace metal contamination observed in previous studies, although normalization does indicate that increases at station NSB-5 are less dramatic than is indicated by the concentration data. A full description of normalization for aluminum and grain size is provided in the Marine ERA report.

Erosion has exposed more contaminated sediments with respect to trace metals at stations NSB-2, NSB-3, NSB-4, and NSB-7. In addition, station MCL-10 may represent an area of off-shore deposition for contaminated sediments eroded from the shoreline.

5.3

SUMMARY

During the review of the draft version of this technical memorandum, the NETC Restoration Advisory Board (RAB) requested clarification on which stations experienced increases of contaminant concentrations between 1996 sample analysis and previous sample analysis. In response to this request, Figures 5-2 and 5-3 are presented.

Figure 5-2 presents concentrations of organic contaminants detected during investigation performed on 1994 (Phase I), 1995 (Phase II), and 1996 (Phase III). Figure 5-3 presents concentrations of metals detected during the investigations. On these figures, Phase I and II analyses are identified with the appropriate sample station identifier (i.e. NSB-3), and Phase III analyses are identified with the sample station identifier and an "R" for resampling (i.e. NSB-3R).

6.0 SEDIMENT TOXICITY RESULTS

In October and November 1996, sediment samples were obtained from splits of chemistry stations identified in Section 5, and analyzed for toxicity to invertebrate animals. These tests were conducted by SAIC at their Environmental Testing Center in Narragansett, Rhode Island. The results of these tests are summarized in this section. Laboratory reports are presented in Appendix D.

6.1 SEDIMENT TOXICITY TO AMPHIPOD SURVIVAL

The acute toxicity of sediments from the vicinity of McAllister Point Landfill was assessed to measure the biological effects of sediment contaminants and to evaluate the bioavailability of contaminants in bulk sediments. Sixteen sediment samples were evaluated for toxicity using the 10-day *Ampelisca abdita* amphipod test. Complete details of sample handling, storage, and testing are contained in Appendix D1. Sample locations are presented in Figure 5-1. Sample testing at NSB-3 was not possible due to insufficient sample volume.

The test endpoint was adult survival. Stations with a mean survival less than that of the LIS performance control were compared statistically to the control using a two-sample student's t-test (assuming unequal variances). Significant toxicity for *A. abdita* has been defined as survival statistically less than the performance control and ≤ 80 percent of the mean control survival (U.S.EPA 1994). Sites meeting both requirements (statistically different than the performance control and survival ≤ 80 percent of the control) were flagged ("* +"). The data were further flagged ("* + +") where survival was less than 60 percent of the performance control.

Raw survival data are presented in Appendix D1. Summary survival data are presented in Table 6-1. Mean sample survival, normalized to performance controls, ranged from 15 to 98 percent. Mean survival at Stations NSB-2, NSB-4, NSB-5, (i.e. 15, 24, and 37 percent, respectively), was both statistically different than the performance control and < 60 percent of the mean control survival, while survival for Station NSB-7 (63 percent) was both statistically different than the performance control and < 80 percent of the mean control survival. Water quality parameters for temperature, salinity, and dissolved oxygen measured in the overlying water of chambers during the test were within acceptable limits.

TABLE 6-1
SEDIMENT TOXICITY RESULTS FOR AMPHIPOD (*Amplesca abdita*)
PRE AND POST EROSION SEDIMENTS
McALLISTER POINT LANDFILL PHASE III TECHNICAL MEMORANDUM
NETC NEWPORT RHODE ISLAND

Station	Amphipod Survival (% of control)	
	Pre-erosion	Post-erosion
S2B	71.3 *	97.8
S2B-FD	NA	92.3
SDA-M1	100.6	93.4
NSB-1	52.6 **	90.5
NSB-2	80.4	14.7 ***
NSB-3	79.4 *	NA
NSB-4	49.0 **	24.2 ***
NSB-5	0.0 **	36.8 ***
NSB-6	75.3 *	90.5
NSB-7	78.4 *	63.2 **
MCL-8	102.6	97.8
MCL-9	99.2	93.4
MCL-10	92.6	92.3
MCL-11	101.3	97.8
MCL-12	96.1	94.8
MCL-13	91.6	93.4
MCL-14	95.8	90.1

- * - Significantly lower than control
- + - Survival between 60 and 80%.
- ++ - Survival less than 60%.

A comparison of amphipod sediment toxicity results between pre- and post-erosion conditions is also presented in Table 6-1. No toxicity was observed in subtidal sediment Stations MCL-8 to MCL-14 for either sampling event. Post-erosion toxicity was significantly higher than pre-erosion conditions at Station NSB-2 (15 vs. 80 percent survival, respectively; $P_f = .003$). In contrast, post-erosion toxicity was significantly lower than pre-erosion conditions at Stations NSB-1 (91 percent vs. 53 survival, respectively; $P_f = .033$) NSB6 (90.5 percent vs. 75.3 percent, respectively) and S2B (98 percent vs. 71 survival, respectively; $P_f = 0.034$). Other stations (NSB-4, NSB-5, and NSB-7) were unchanged between sampling events.

6.2 ELUTRIATE TOXICITY TO SEA URCHIN FERTILIZATION AND LARVAL DEVELOPMENT

The chronic toxicity of elutriates prepared from core sediments collected in the vicinity of the McAllister Point Landfill was assessed to evaluate the biological effects of resuspended sediment contaminants on water column organisms. Test sediments originated as sample splits with chemistry samples, as identified in Section 5. Complete details of sample handling, storage, and testing are contained in Appendix D2. Sample locations are presented in Figure 5-1.

The life cycle of the purple sea urchin, *Arbacia punctulata*, includes external fertilization of the egg, followed by a period of planktonic embryo-larval development, and subsequent settlement and metamorphosis into the adult life stage. Fertilization and larval development success were used as test endpoints. Responses were measured in each of three concentrations per station/sample, from which a point estimate of the concentration that would cause a given percent inhibition in fertilization/development is calculated (called the inhibition concentration (IC)).

Sediments from seven sites were collected between October 8 and November 5, 1996. Elutriates were prepared by adding homogenized sediment to filtered ($0.45 \mu\text{m}$) natural seawater collected from Narragansett Bay, on an incoming tide, in a 1 to 4 volumetric ratio. The mixture was stirred for 30 minutes by hand and then allowed to settle for one hour. The supernatant was siphoned off and was used to prepare dilutions. Dilutions were prepared by mixing the supernatant with filtered ($0.45 \mu\text{m}$) natural seawater (NSW) collected from lower Narragansett Bay on an incoming tide. Elutriate dilutions (10 percent, 50 percent, and 100 percent) as well as a NSW performance control (0 percent) were tested.

Stations with mean fertilization less than that of the NSW performance control were compared statistically to the control. Samples were flagged with an alpha or p value less than or equal to 0.05, indicating statistical significance, and with fertilization ≤ 70 percent. The linear interpolation method

available on ToxCalc (version 4.0.8) from TidePool Scientific Software was used to calculate the IC_{60} s of samples where statistically significant responses were noted in one or more of the elutriate dilutions. The IC_{10} was calculated, which is a point estimate of the elutriate concentration that would cause a 10 percent reduction in the test endpoint.

For the present investigation, significant toxicity ("*") for *A. punctulata* has been defined as reduced fertilization/development that is statistically less than the performance control. The data were further flagged where the prior condition was met and the IC_{10} was less than 50 percent ("* +") and less than 10 percent ("* + +").

Raw fertilization and larval development data are presented Appendix D2. The IC values for sea urchin fertilization and development are presented in Table 6-2. IC_{10} s for fertilization varied over a relatively narrow range from most toxic (13.3 percent) at Station MCL-12 to least toxic at Station NSB-6 (36.2 percent), while IC_{10} s for larval development reflected a broader range, but comparable rank order sensitivity from 6.3 percent at Station NSB-2 to >100 percent at Station NSB-6.

Total ammonia and unionized ammonia was measured in elutriates of sediments used for the sea urchin fertilization test and did not exceed the IC_{60} thresholds of 20.0 milligrams per liter (mg/L) and >0.60 mg/L, respectively (NOAA 1994; Carr, et al., in press).

The sea urchin data presented above and that collected during 1995 are not directly comparable since the depth intervals used in the different studies were not the same. However, the data is comparable in that the same tests were performed, and the toxicity posed by deeper sediments measured in 1996 is higher or lower than that posed by surface sediments measured in 1995, as discussed above. A complete discussion of this comparability of data will be presented in the Final Marine ERA Report for McAllister Point Landfill.

TABLE 6-2
ELUTRIATE TOXICITY RESULTS FOR SEA URCHIN FERTILIZATION (*Arbacia punctulata*)
SEDIMENT CORE SAMPLES
McALLISTER POINT LANDFILL PHASE III TECHNICAL MEMORANDUM
NETC NEWPORT RHODE ISLAND

Station	10% Inhibition Concentration (%) ¹			
	Fertilization		Development	
NSB-2	13.6	**	6.3	***
NSB-3	16.1	**	94.5	*
NSB-4	21.4	**	21.3	**
NSB-5	16.1	**	11.0	**
NSB-6	36.2	**	>100	
MCL-10	17.5	**	51.3	*
MCL-12	13.3	**	12.2	**

1- IC₁₀ = Elutriate concentration causing 10% toxicity.

Flags:

- * = one or more dilutions statistically < control;
- ** = <50% Elutriate concentration is toxic.
- *** = <10% Elutriate concentration is toxic.

7.0 FINAL PLAN FOR REVISION OF ECOLOGICAL RISK ASSESSMENT REPORT

7.1 INTRODUCTION

Previous data identified in Sections 5 and 6 identify some substantial changes in chemical exposure and effects related to sediment erosion observed during the winter of 1995-96. This new station data must be reflected in the baseline risk assessment for the site. The purpose of this section is to specifically identify areas of the existing ERA Report that must be modified to build weight of evidence with respect to location-based probability of baseline risks.

7.2 SUMMARY OF NEW INFORMATION

The Phase III resampling program revisited the intertidal (Stations NSB-1 to NSB-7) and near-shore subtidal (MCL-8 to MCL-12, S2B and SDA-M1) stations to determine surficial chemical contaminants (PCBs, PAHs, metals) and associated toxicological effects (amphipod survival). Upon identification of several stations noting increased chemical concentrations, core samples were identified to address whether erosion of sampled surface materials would result in exposure of new materials of potentially greater concern. Data collected on these cores again included chemical concentrations (PCBs, PAHs, metals) and associated toxicological effects (sea urchin fertilization and development impairment).

The results of organics analyses identified substantial changes in surficial chemical concentrations from 1995 (pre-erosion) to 1996 (post-erosion) for intertidal middle landfill Stations NSB-4 (PCBs), NSB-5 (PCBs), and intertidal south landfill Stations NSB-6 (PAHs) and NSB-7 (PCBs), and subtidal Stations MCL-12 (PCBs, PAHs) and Station S2B-FD (PCBs, PAHs). For metals, increased concentrations of copper, lead, silver, and chromium were noted primarily for the northern intertidal Station NSB-2 and intertidal Stations NSB-3, NSB-4, and NSB-5.

The amphipod test data revealed that for intertidal stations, post-erosion toxicity was significantly higher than pre-erosion conditions at Station NSB-2 only, NSB-1 was lower, and other intertidal stations remained similarly toxic and subtidal stations remained non-toxic. Toxicity results of intertidal core samples confirm these results; sea urchin fertilization and development was impacted at Stations NSB-2 through NSB-6, indicating that adverse effects in this region would continue to persist despite erosion.

Toxicity results for subtidal stations also appear temporally consistent. Amphipod toxicity was not observed for subtidal stations in either the pre- or post-erosion period. In contrast, sea urchin toxicity occurred at Station S2B (12 percent fertilization success) and Station SDA-M1 (40 percent fertilization success) in Phase I; these two locations are in the general vicinity of Station MCL-12 where similar core toxicity was found during the Phase III investigation. Although surface sediment samples from MCL-12 were not toxic in Phase II, it can be assumed that contaminants in deeper sediments at this station are still important risk drivers. Increased toxicity was also measured in core samples from Station S2B-FD during Phase III; this station is near Station MCL-12 and Station S2B.

In summary, a preliminary assessment of the data suggests that sediment erosional processes in the intertidal area, resulting mostly from the landfill revetment construction, have enlarged the area of greatest marine ecological risk probability (namely Zone 2) to the north, to now encompass Station NSB-2. A marked change in contaminant of concern (CoC) exposure and effects between Stations NSB-5 and NSB-6 is still present, and the new data do not suggest substantial changes from the risk characterization presented for Zone 3 in the Draft Final Marine ERA Report. Off shore, stations in the vicinity of Zone 3A still show greatest impacts. However, the new core and toxicity data suggest that Station MCL-12 should be included in this zone rather than Zone 4. The new data from Station S2B and S2B-FD will also be included in Zone 3A. The revised Zone 4 stations, including MCL-8 to MCL-11, did not show substantial change between pre- and post-erosion conditions.

7.3 SUMMARY OF REPORT MODIFICATIONS

The following modifications are proposed to adequately incorporate new information with the objective of providing an accurate baseline risk characterization for the site:

- New text in Section 3.1.1. Discuss the construction of the landfill revetment and the Phase III investigations conducted to address the concern for possible modification of chemical exposure conditions at the site due to erosion.
- New Section 3.6.1. Discuss pre- and post-erosion sampling objectives and activities; previous Section 3.6.1 will be expanded and identified as Section 3.6.2.

- New text in Section 4.2.2.1 (Organics) and Section 4.2.3.2 (Inorganics) entitled “Comparison of Pre- and Post-Erosion Conditions” to be added at the end, with accompanying text, figures, and tables as presented in Section 5 of this memorandum.
- To eliminate possible confusion in the Marine ERA Report, sample location S2B-FD, as identified in this memorandum, will be relabeled as “S2C” throughout to acknowledge that the sampling procedure did not constitute a “Field Duplicate”, in that the sample was not co-located with the S2B sample.
- Section 4.2.4 (Fecal Pollution Indicators) will be revised to move the information on indicators in mussels into Section 5.3 (Biological Field Investigations) as consistent with the format for the Derecktor Shipyard Report.
- Section 4.2.5 (Avian Exposure Pathways) will be moved to new Section 6.3.3 as consistent with the format for the Derecktor Shipyard Report.
- New Section 5.2.3 entitled “Post-Erosion Toxicity Assessment” to be added at the end of Section 5.2, with accompanying text, figures, and tables as presented in Section 6 of this data memorandum.
- New text in Section 6.1.1 “Comparison of Pre- and Post-Erosion Sediment Hazard Quotients”, to include new figures for PCBs, PAHs, and metals, with text describing changes in exposure-based risks as a result of the erosion associated with the landfill revetment construction.
- New text and accompanying figures will be added in Section 6.4.1 to address amphipod survival vs. post-erosion surficial sediment CoCs concentrations, in order to identify/clarify CoC site risk drivers for the site.
- Revised zonation map and accompanying data reduction (e.g. Tables 6.6-1 and 6.6-2) and text will be added; a new Table 6.6-3 will be added to present an overall summary of the risk characterization by zones.

- Table 6.6.1, which will include new station data by sampling event, will be revised. An additional risk ranking for HQ-ERM > 2 = “+++” will be added for Sediment HQs.
- Sections 1 and 7 will be revised, as necessary, to reflect the modifications identified above. The conclusions of the revised ERA report will take into consideration the data generated during Phase III of the investigation.

7.4 CONCLUSIONS

The above plan to revise the Draft Final Marine ERA Report has been designed from the perspective that the post-erosion condition is a quantifiable perturbation of the original baseline assessment presented in such report.

REFERENCES

REFERENCES

Carr, R. Scott, D.C. Chapman, C.L. Howard, D.N. Biedenbach. In press. Sediment Quality Triad Assessment Survey on Galveston Bay, Texas System. Ecotoxicology.

NOAA. 1994. Magnitude and Extent of Sediment Toxicity in Tampa Bay, Florida. NOAA Technical Memorandum NOS ORCA 78.

U.S. EPA. 1994. Methods for Assessing the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods. EPA 600/R-94/025.

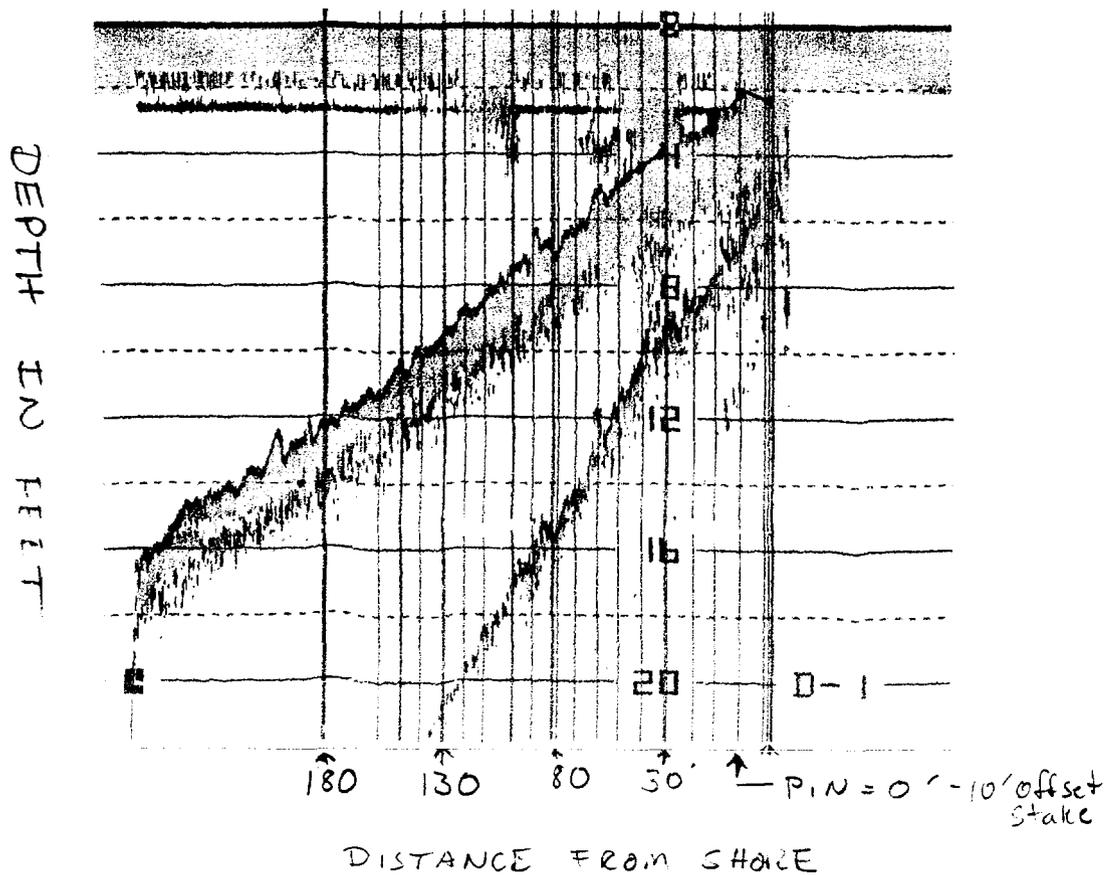
APPENDIX A
TOPOGRAPHY SURVEY DATA

APPENDIX A
TOPOGRAPHY SURVEY DATA

CLIENT <i>CLEAN CTO 197</i>		JOB NUMBER <i>4725-0430</i>	
SUBJECT <i>McAllister Point Landfill Subtidal Slope</i>			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE <i>8-22-96</i>

LINE 1 W
 RUN #4
 WEST → EAST

TIME: 1250



Add 1.5' to correct for depth of transducer below water surface.

SAMPLE LOG SHEET

Site: McALLISTER POINT LF
 Line Name: NSB-1W
 Sample Number: Run #4
 Instrument: LOWRANCE X15B
 Date: 8.22-96
 CAL: 14.2 (Read) 15.7 DIRECT MEASURE

Tide Gauge Start 2.3 Stop: 2.3
 Corrected For: Project Datum = 0.00'
 By: Transducer @ 1.5' BWS
Tide @ 2.3' MLW

Time Start: 1248
 Time Stop: 1250
D.f = 0.8

Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
	-10*	-2.5	+0.8	-1.7
	0	-2.0		-2.2
	10	-3.5		-2.7
	20	-3.5		-2.7
	30	-4.0		-3.2
	40	-5.0		-4.2
	50	-5.0		-4.2
	60	-6.0		-5.2
	70	-7.0		-6.2
	80	-6.5		-5.7
	90	-7.5		-6.7
	100	-8.0		-7.2
	110	-8.8		-8.0
	120	-9.5		-8.7
	130	-9.8		-9.0
	140	-10.2		-9.4
	150	-11.3		-10.5
	160	-11.8		-11.0
	170	-12.0		-11.2
	180	-12.5	v	-11.7

Prepared By: _____

* - Stake w/ flag is NSB-1 10' off set (East)

CLIENT <i>CLEAN CTO 197</i>		JOB NUMBER <i>4725-0430</i>	
SUBJECT <i>McAllister Point Landfill Subtidal Slope</i>			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE <i>8-22-96</i>

LINE 2W

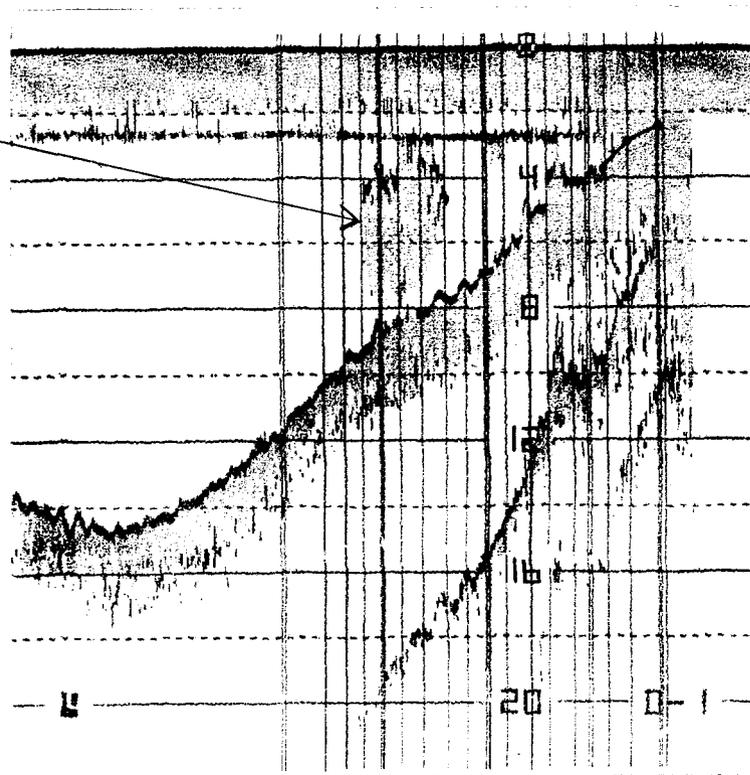
Run #2

TIME 1310

WEST → EAST

BAITFISH

DEPTH IN FEET



180 130 90 30 0' = NSB2

DISTANCE FROM SHORE

Add 1.4' to correct for depth of transducer

SAMPLE LOG SHEET

Site: McALLISTER POINT LF
 Line Name: NSB-2W
 Sample Number: Run # 2
 Instrument: LOWRANCE X15B
 Date: 8.22-96
 CAL: 12.3 (Read) 13.8 DIRECT MEASURE

Tide Gauge Start 4.5 Stop: 4.5
 Corrected For: Project Datum = 0.00'
 By: Tide @ 2.70 ~~EST~~ MLW
Transducer @ 1.50 BWS

Time Start: 1308
 Time Stop: 1310

1.20

Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
NSB-2 Stake → 0	0	-2.6 *	1.2	1.4
	10	-3.1 *	1.2	1.9
	20	-3.9 *		2.7
	30	-4.0		2.8
	40	-4.0		2.8
	50	-4.0		2.8
	60	-5.0		3.8
	70	-6.0		4.8
	80	-7.0		5.8
	90	-7.5		6.3
	100	-7.8		6.6
	110	-8.0		6.8
	120	-8.5		7.3
	130	-8.5		7.3
	140	-9.3		8.1
	150	-9.8		8.6
	160	-10.2		9.0
	170	-11.0		9.8
	180	-12.0		10.8

* - Direct measure, survey rod

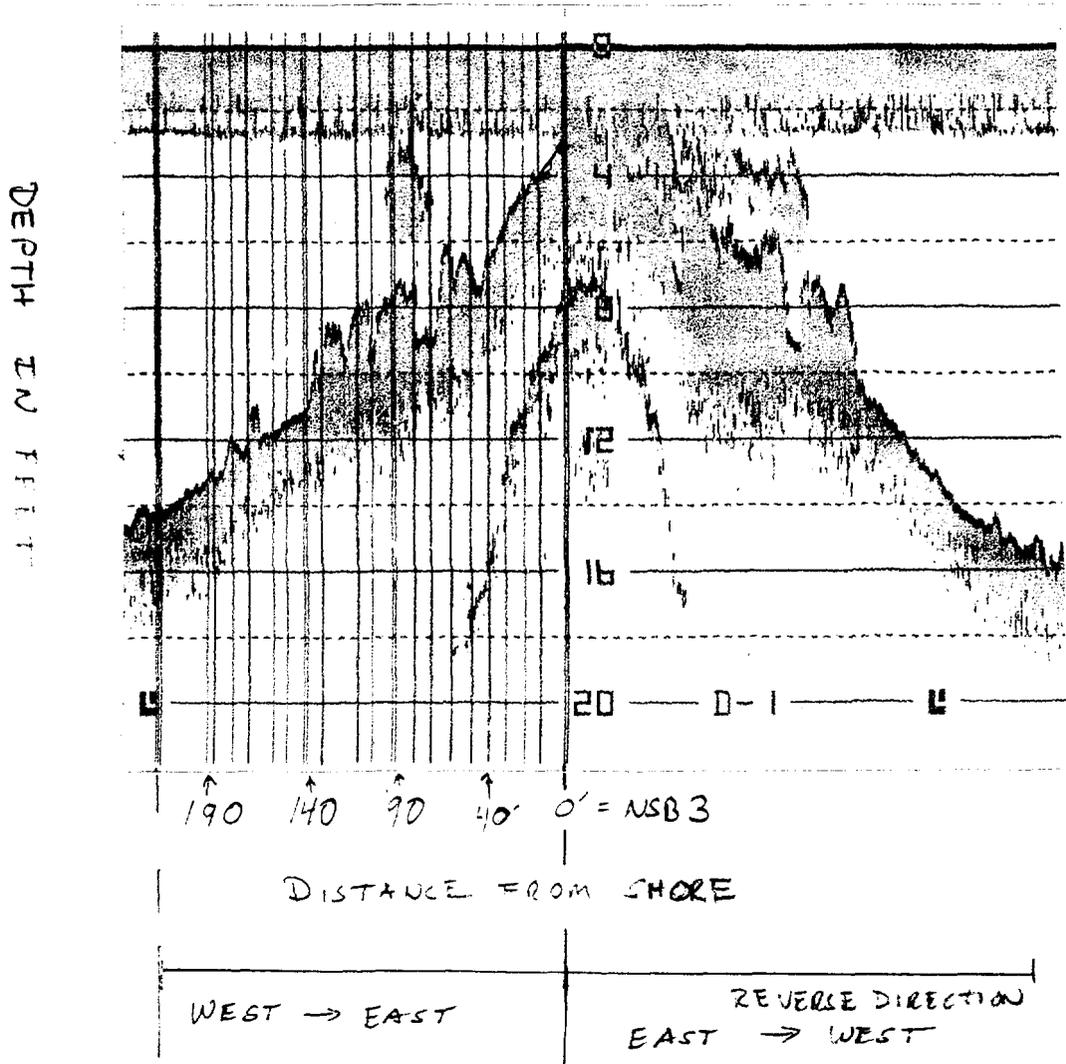
Prepared By: _____

CLIENT <i>CLEAN CTO 197</i>		JOB NUMBER <i>4725-0430</i>	
SUBJECT <i>McAllister Point Landfill Subtidal Slope</i>			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE <i>8-22-96</i>

LINE 3W

TIME = 1322

RUN #1



Add 1.4' to correct for depth of transducer

SAMPLE LOG SHEET

Site: McALLISTER POINT LF
 Line Name: NSB-3W
 Sample Number: Run # 1
 Instrument: LOWRANCE X15B
 Date: 8-22-96
 CAL: 13.0 (Read) 14.5 DIRECT MEASURE

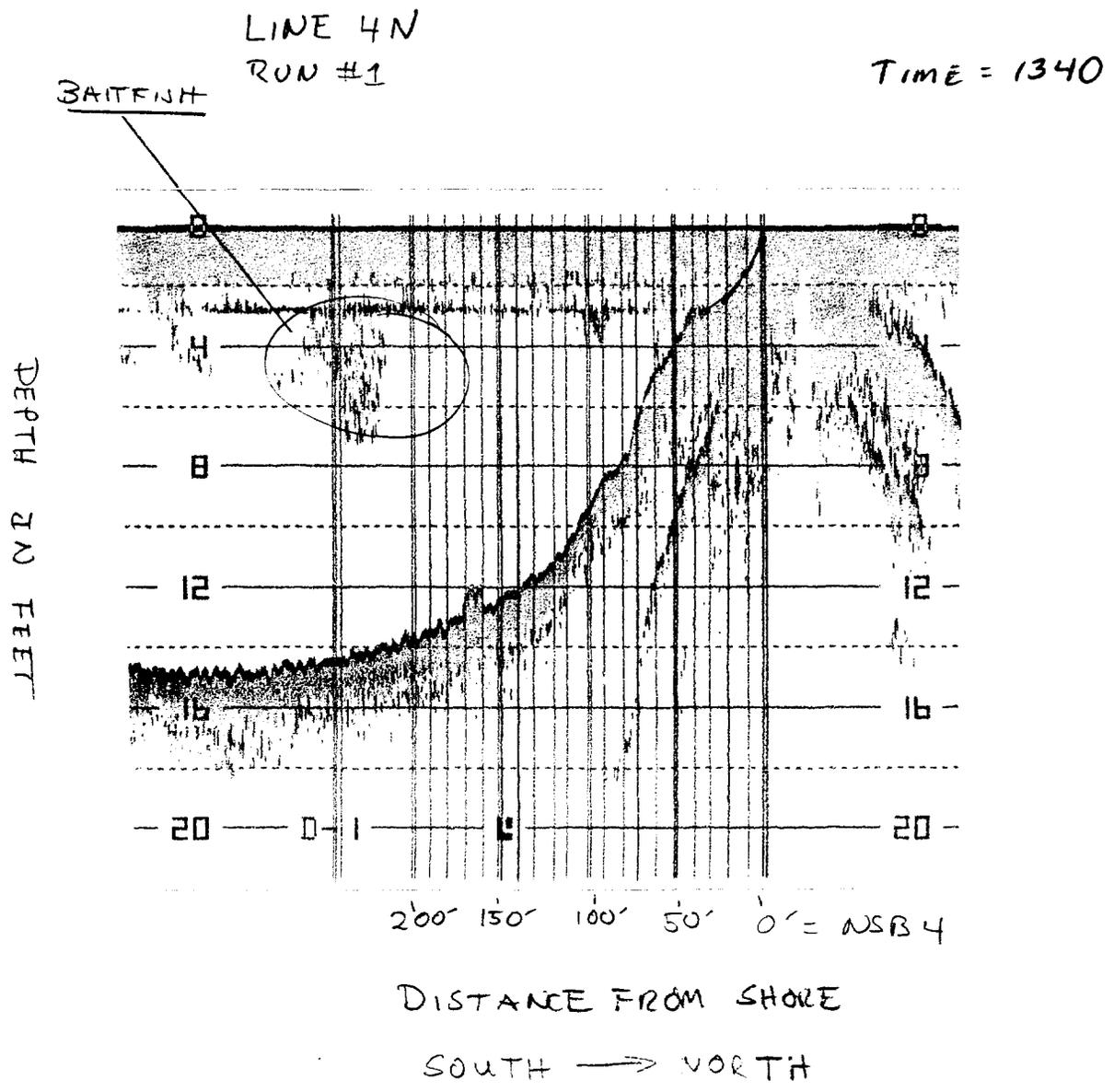
Tide Gauge Start 4.8 Stop: 4.8
 Corrected For: Project Datum = 0.00'
 By: Tide @ 2.9' MLW
Transducer @ 1.5' BWS
+ 1.4
 Time Start: 1320
 Time Stop: 1322

Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
NSB-3 Pin → 0		- 3.4 *	1.4	- 2.0
	10	- 4.1 *		2.7
	20	- 5.4 *		4.0
	30	- 6.3		4.9
	40	- 6.5		5.1
	50	- 6.0		4.6
	60	- 9.0		7.6
	70	- 7.5		6.1
	80	- 7.5		6.1
	90	- 9.5		8.1
	100	- 8.0		6.6
	110	- 10.0		8.6
	120	- 9.0		7.6
	130	- 11.0		9.6
	140	- 11.5		10.1
	150	- 12.0		10.6
	160	- 12.0		10.6
	170	- 13.0		11.6
	180	- 13.0		11.6
	190	- 13.5		12.1

* Direct measure

Prepared By: _____

CLIENT CLEAN CTO 197	JOB NUMBER 4725-0430		
SUBJECT McAllister Point Landfill Subtidal Slope			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE 8-22-96



Add 1.4' to correct for depth of transducer

SAMPLE LOG SHEET

Site: McALLISTER POINT LF
 Line Name: NSB-4N
 Sample Number: Run #1
 Instrument: LOWRANCE X15B
 Date: 8.22-96
 CAL: 14.0 (Read) 16.5 DIRECT MEASURE

Tide Gauge Start 5.0 3.2 Stop: 3.2
 Corrected For: Project Datum = 0.00'
 By: Tide @ 3.2' (MLW)
transducer @ 1.5' BWS
1.7'
 Time Start: 1338
 Time Stop: 1340

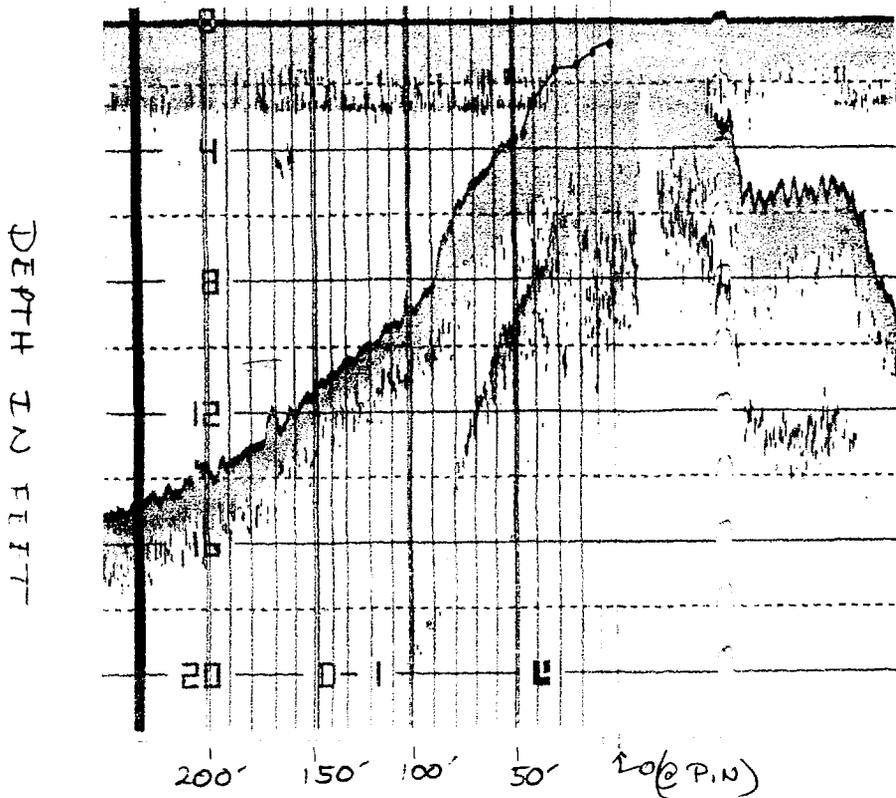
Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
NSB-4 Pin →	0	2.0 * 0.5 *	1.7	0.5 + 1.2
	10	-1.5 *	↓	+0.2
	20	-2.6 *		-0.9
	30	-3.1 *		-1.4
	40	-3.0		-1.3
	50	-3.8		-2.1
	60	-4.7		-3.0
	70	-6.0		-4.3
	80	-7.8		-6.1
	90	-8.2		-6.5
	100	-7.5		-7.8
	110	-10.5		-8.8
	120	-11.0		-9.3
	130	-11.8		-10.1
	140	-12.0		-10.3
	150	-12.2		-10.5
	160	-12.5		-10.8
	170	-12.0		-10.3
	180	-13.0		-11.3
	190	-13.5		-11.8
	200	-13.8		-12.1

Prepared By: _____ * - Direct Measurements

CLIENT CLEAN CTO 197		JOB NUMBER 4725-0430	
SUBJECT McAllister Point Landfill, Subtidal Slope			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE 8-22-96

LINE 4 W
RUN # 1

TIME = 1345 LHP
1402



WEST → EAST

DISTANCE FROM SHORE

Add 1.4' to correct for depth of transducer

SAMPLE LOG SHEET

Site: McALLISTER POINT LF
 Line Name: NSB-4W
 Sample Number: Run # 1
 Instrument: LOWRANCE X15B
 Date: 8.22-96
 CAL: 13.5 (Read) 15.0 DIRECT MEASURE

Tide Gauge Start 3.3' Stop: 3.3'
 Corrected For: Project Datum = 0.00'
 By: Tide @ 3.3' MLW
Transducer @ 1.5' MLW

Time Start: 1400
 Time Stop: 1402

1.8

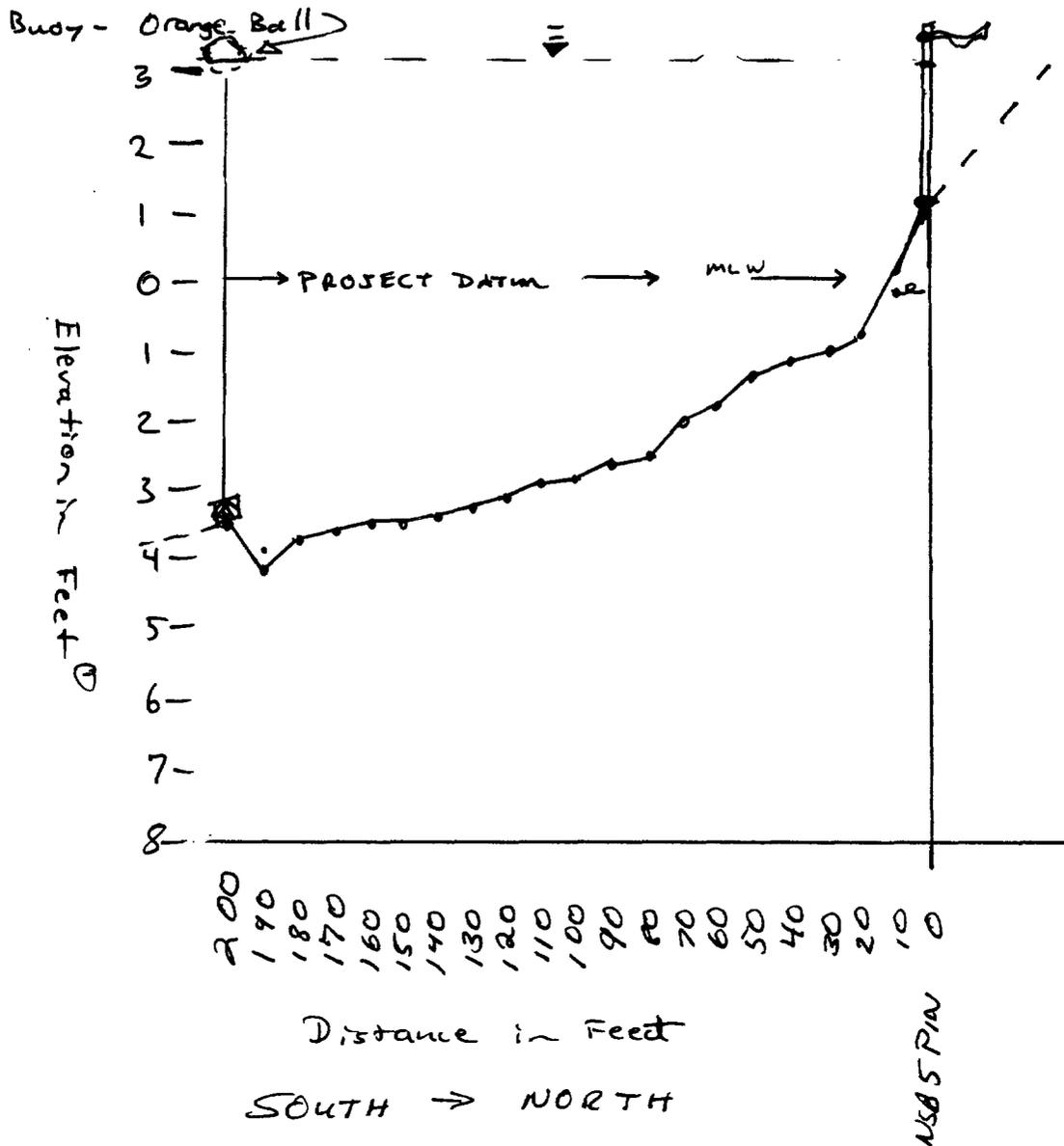
Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
NSB-4 Pm →	0	-0.8*	+1.8	+1.0
	10	-1.1*		+0.7
	20	1.5*		+0.3
	30	1.6*		+0.2
	40	2.8*		1.0
	50	3.5		1.7
	60	4.0		2.2
	70	5.0		3.2
	80	6.0		4.2
	90	8.0		6.2
	100	9.0		7.2
	110	9.5		7.7
	120	10.0		8.2
	130	10.5		8.7
	140	11.0		9.2
	150	11.2		9.4
	160	12.0		10.2
	170	12.0		10.2
	180	13.0		11.2
	190	13.5		11.7
	200	14.0	↓	12.2

Prepared By:

* Direct Measure

CLIENT Navy "CLEAN" CTO197		JOB NUMBER 4725-0430	
SUBJECT McAllister Point Landfill, Subtidal Slope			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE

LINE NSB5 N
Run #1 Direct Measurements, corrected^①



① Depths measured w/ survey rod, corrected for tide and 0.00 project datum

SAMPLE LOG SHEET

Site: MCALLISTER POINT LF
 Line Name: NSB-5N
 Sample Number: Run #1
 Instrument: ~~LOWRANCE XT5B~~ Survey Rod
 Date: 8-22-96
 CAL: N/A (Read) N/A DIRECT MEASURE
 Tide Gauge Start ~~5.0~~ 3.201 Stop: ~~5.0~~ 3.2
 Corrected For: Project Datum = 0.00'
 By: 3.2
- 0
3.2
 Time Start: _____
 Time Stop: 1420

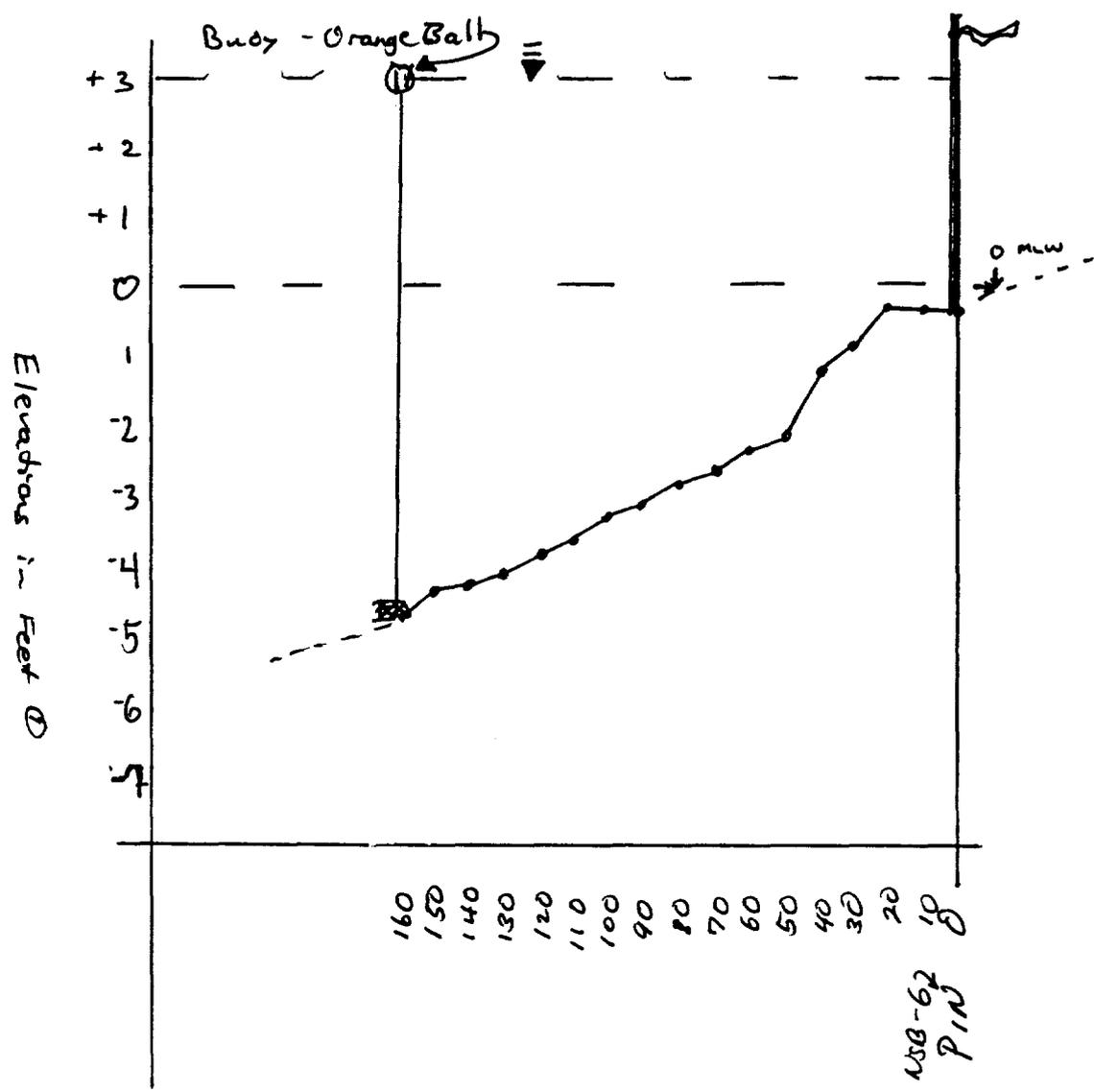
Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
	0	- 2.0	+ 3.2	1.2
	10	- 3.0		0.2
	20	- 3.9		-0.7
	30	- 4.2		-1.0
	40	- 4.4		-1.2
	50	- 4.6		-1.4
	60	- 4.9		-1.7
	70	- 5.2		-2.0
	80	- 5.7		-2.5
	90	- 5.8		-2.6
	100	- 6.0		-2.8
	110	- 6.1		-2.9
	120	- 6.3		-3.1
	130	- 6.5		-3.3
	140	- 6.6		-3.4
	150	- 6.7		-3.5
	160	- 6.7		-3.5
	170	- 6.8		-3.6
	180	- 6.9		-3.7
	190	- 7.3		-4.1
	200	- 6.7	V	-3.5

Prepared By: _____

CLIENT <i>NAVY "CLEAN" CTD 197</i>		JOB NUMBER <i>4725-0430</i>	
SUBJECT <i>McAllister Point Landfill, Subtidal Slope</i>			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE <i>8-22-96</i>

LINE NSB-6N

Run #1, Direct Measurements, Corrected ①



① Depths measured w/ survey rod @ high tide, corrected for tide and 0.00 project datum.

SAMPLE LOG SHEET

Site: McALLISTER POINT LF
 Line Name: NSB-6 N
 Sample Number: RUN #1
 Instrument: ~~LOWRANGE XT5B~~ Survey Rod
 Date: 8-22-86
 CAL: N/A (Read) N/A DIRECT MEASURE

Tide Gauge Start 3.0 el. Stop: 3.0 el.
 Corrected For: Project Datum = 0.00'
 By: 3.0 Tide

- 0 TDR
3.0

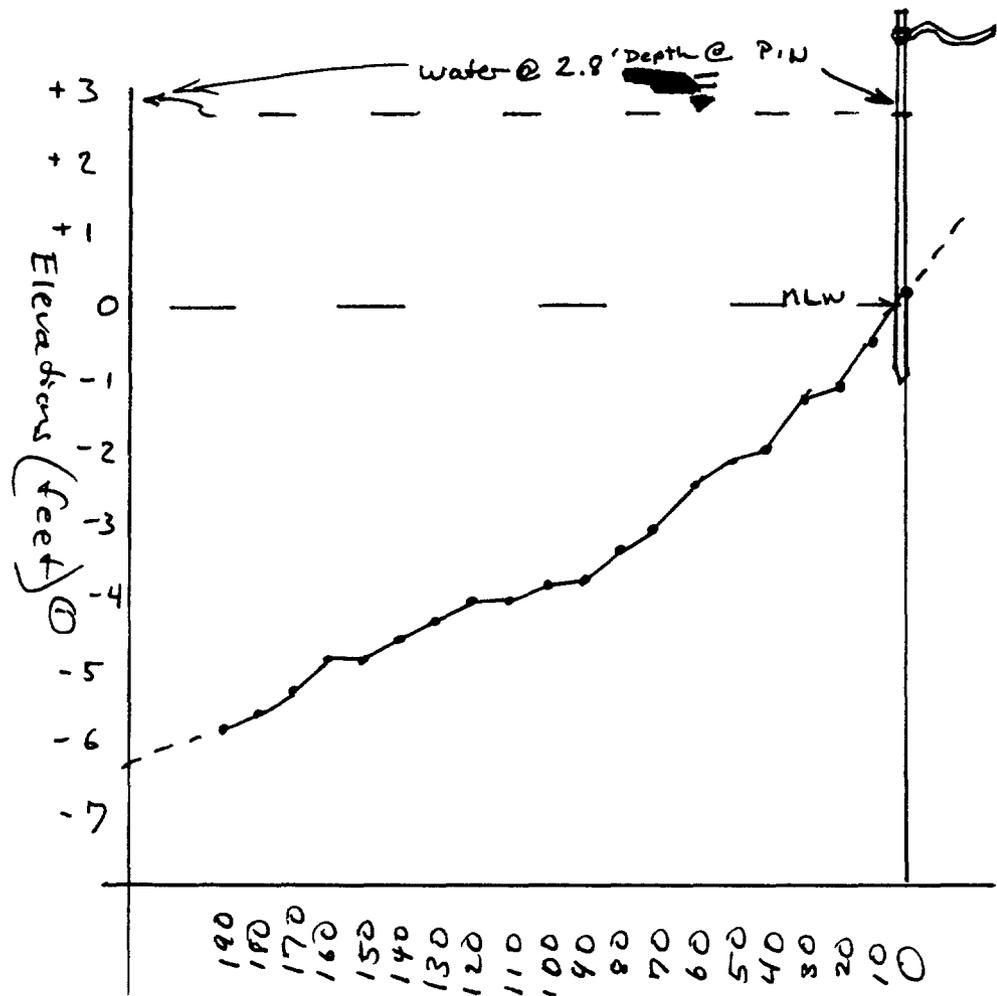
Time Start: _____
 Time Stop: 1450

Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
	0	- 3.4	3.0	- 0.4
	10	- 3.3		- 0.3
	20	- 3.3		- 0.3
	30	- 3.9		- 0.9
	40	- 4.3		1.3
	50	- 5.1		2.1
	60	- 5.4		2.4
	70	- 5.6		2.6
	80	- 5.8		2.8
	90	- 6.1		3.1
	100	- 6.3		3.3
	110	- 6.6		3.6
	120	- 6.9		3.9
	130	- 7.1		4.1
	140	- 7.3		4.3
	150	- 7.4		4.4
	160	- 7.7		4.7

Prepared By: _____

CLIENT Navy "CLEAN" ETO 197		JOB NUMBER 4725-0430	
SUBJECT McAllister Point Landfill, Subtidal Slope		DRAWING NUMBER	
BASED ON		DATE 8-22-96	
BY	CHECKED BY	APPROVED BY	

LINE NSB-7W
 RUN #1 Direct Measurements, corrected ①



① Depths corrected measured w/ survey rod, corrected for tide and 0.00 Project Datum.

SAMPLE LOG SHEET

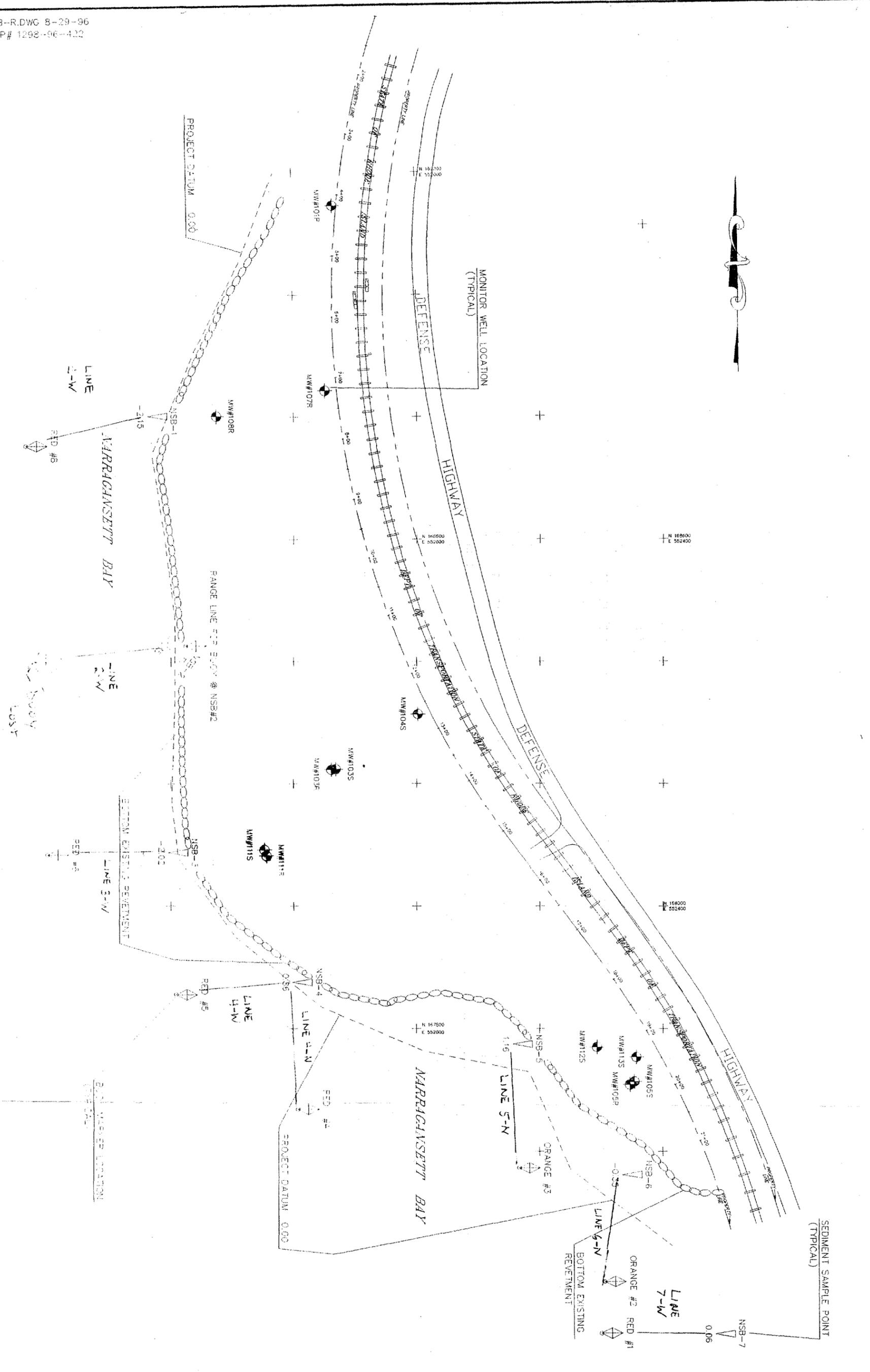
Site: McALLISTER POINT LF
 Line Name: NSB-7W
 Sample Number: Run #1
 Instrument: ~~LOWRANCE XT05~~ Survey Reel
 Date: 8-22-96
 CAL: N/A (Reed) N/A DIRECT MEASURE

Tide Gauge Start 2.8 Stop: 2.8
 Corrected For: Project Datum = 0.00'
 By: 2.8 Tide
- 0 Tide
2.8'

Time Start: _____
 Time Stop: 1510

Time Interval	Distance	Depth Read	Tide Corr	Bottom Elev.
	0 = NSB7	-2.6	+2.8	0.2
	10	-3.3	2.8	-0.5
	20	-3.9	2.8	-1.1
	30	-4.0	↓	-1.2
	40	-4.8		-2.0
	50	-5.0		-2.2
	60	-5.3		-2.5
	70	-6.0		-3.2
	80	-6.2		-3.4
	90	-6.6		-3.8
	100	-6.7		-3.9
	110	-6.9		-4.1
	120	-6.9		-4.1
	130	-7.2	-4.4	
	140	-7.4	-4.6	
	150	-7.9	-5.1	
	160	-7.9	-5.1	
	170	-8.2	-5.4	
	180	-8.4	-5.6	
	190	-8.7	-5.9	

Prepared By: _____



00091R022

BROWN & ROOT ENVIRONMENTAL
 SAMPLING CONTROL POINTS
 McALLISTER POINT LANDFILL
 NAVAL EDUCATION AND TRAINING CENTER
 MIDDLETOWN, RI
 AS-BUILT SITE PLAN

SAI SURVEYING CO.
 Land & Construction Surveyors
 23 Narragansett Avenue
 Jamestown, RI 02835
 401-423-0430

Proj. No. 9608-29	Date 08-29-96
Drawn: TMC	Checked: MST
Horiz. 1"=150' SCALES Vert. 1"=15'	
Vert. 0 5 10 15 30	
Horz. 0 50 100 150 225 300	

DATE	REVISION
Sheet: 1	of 1

APPENDIX B
BORING LOGS

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-1 DRILLED BY: Paul Brescia BORING NO: B-1
 DATE START: 10/2/96 DEPTH TO WATER: NM LOGGED BY: J Holder GROUND EL.: NM
 TE COMPLETED: 10/2/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 14.0'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			26 53 47 51	24	17	0800 Oppm 0805 prepare 4" casing	S-1 sandy silty GRAVEL, mostly f-crs angular gravel (phyllite/slate), some silt, 1lb to few f-crs sand. poorly graded. gray w/some oxidized material	GM	Natural
1		S-1							
2			50 85 110	18	14	0833 Oppm	S-2a (12) sandy silty GRAVEL, similar to S-1 S-2b (2) weathered bedrock	GM	Natural
3		S-2							
4						Drive + wash in 4'	Prepare to core		Weathered bedrock
5			4:54 12"			11:11 RAD = 8.9% recovery = 93%	C-3 Black-grey slate/phyllite from 4-6 feet very broken and fractured 1st 2" pink granite from 6-9 feet lots of fractures w/ weathered surfaces. fractures are shallow ~15° no aze or calcite veins		Bedrock
6		C-3	7:34 12"	60	56				
7			6:31 12"						
8			8:17 12"						
9			7:52 12"						
10		C-4	7:20 12"			12:00	C-4 Similar to C-3, much more competent. Fractures at 45° and 10°		Bedrock

LEGEND:

TYPE-NO. - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 ∞ - Natural groundwater table

NOTES:

12' west of 10' offset pin for NSB-1 (2' west of station NSB-1)
 Split barrel is 3" using 300 lb Hammer
 Core barrel is NX
 4" Drive + WASH Casing

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-1 DRILLED BY: P. Brescia BORING NO: B-1
 DATE START: 10/2/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 TEST COMPLETED: 10/2/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 14.0

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
	10								
	10.5	Z-4	539	12		ROD = 54%			
	11								
	11.5		514	12	60"	57			
	12							Bedrock	
	12.5		455	12		Recovery = 95%			
	13								
	13.5		612	12					
	14								
						End of Boring 14.0'			
						backfill w/ Bentonite + cement Grout			

LEGEND:
 TYPE-NO - Type of Sample
 RC - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: see page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-2 DRILLED BY: P. Brescia BORING NO: B-2
 DATE START: 10/7/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 TIME COMPLETED: 10/7/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 14.0'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	S U C C I	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			4			1030	S-1 gravelly silty SAND. poorly graded, mostly f-med. sand. some silt. some cns avg gravel, dense. gray	SM/6M	Natural
			11			Oppm			
		S-1	13	24	14				
1			23						
2			11			1100	S-2a (14") gravelly silty SAND. poorly graded. mostly f-cns sand. some silt. few-little f avg gravel. gray. dense. S-2b (6") weathered phyllite/slate. gray. dense	SM	Natural
			16			Oppm			
		S-2	33	24	20				
3			125			1126 prep to core			
4			244	12		1210	C-3 black/gray phyllite/schist grains visible in 1st foot angle of fractures 15°-20°, some are 45° last 1' very fractured		Bedrock
			332	12		RGD = 0% Recovery = 93%			
		C-3	328	12	60	56			
5			552	12					
6			619	12					
7									
8						1337	C-4 gray phyllite/schist highly fractured Fractures at 30° lots of rust/ weathering on fractured surface		Bedrock
9		C-4	539	12					
10									

LEGEND:
 TYPE-NO - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: Approx 30' from Retreatment/shore
 Split Barrel is 3" using 30 lb Hammer
 NX Core barrel
 4" Drive + wash casing
 Sand bags + metal on surface of bottom
 water 2' 7" deep @ 10:25

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: <u>4725</u>	LOCATION: <u>NSB-2</u>	DRILLED BY: <u>P. Brescia</u>	BORING NO: <u>B-2</u>
DATE START: <u>10/7/96</u>	DEPTH TO WATER: <u>NM</u>	LOGGED BY: <u>J. Itolden</u>	GROUND EL.: <u>NM</u>
DATE COMPLETED: <u>10/7/96</u>	DATE & TIME: <u> / / </u>	CHECKED BY: <u> </u>	TOTAL DEPTH: <u>14.0'</u>

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
	10						not many machine breaks, possibly graphitic		
	11	C-4	514				quartz vein at 11'		
	12		458	60	53	ROD = 7.5% Recovery = 88%			Bedrock
	13		500						
	14		504				Last 6" highly weathered / ground up		
							End of Boring @ 14' Backfill w/Bentonite + cement Grout		

LEGEND:

TYPE-NO. - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler;
 coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 W - Natural groundwater table

NOTES: See Page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-3 DRILLED BY: P. Brescia BORING NO: B-3A
 DATE START: 10/8/96 DEPTH TO WATER: NM LOGGED BY: J Holden GROUND EL.: NM
 DATE COMPLETED: 10/8/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 23.0'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0	0		13			0810	S-1a(5") sandy GRAVEL. mostly CRS gravel. some F-med sand. to clay. black (ASH?)	GP	
1	1	S-1	18 42 45	24	16		S-1b (16") gravelly silty SAND. mostly F sand. some silt. few F SAND gravel. glass, metal gray ash @ 4". Black	SM	LANDFILL
2	2					0820	S-2a (11) gravelly silty SAND. mostly F-CRS sand. some silt. few F gravel. Black. 1 screw	GP	
3	3	S-2	21 20	24	21		S-2b (16) Similar to S-1b. glass + handle to kitchen utensil	SM	LANDFILL
4	4					Roller bit to 5'	wash water and glass/metal fragments		LANDFILL
5	5		8			0900	S-3 silty sandy GRAVEL. mostly F-CRS any gravel (gravel composed of phyllite/Schist) some F-CRS sand. LTL SILT. GRAY	GP	Natural (Till?)
6	6	S-3	10 11 14	24	18				
7	7		13			0925 ABH 0910 ^{10/11/96}	S-4 gravelly silty SAND. mostly F-CRS sand. some silt. LTL F any gravel. poorly graded. dense + compact. gray	GP	Natural
8	8	S-4	12 13 15	24	19				
9	9		10			0935	S-5a(9) similar to S-4 S-5b(2) weathered rock/phyllite	GP —	Natural
10	10	S-5	20	24	11				

LEGEND:
 TYPE-NO - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: 28' west of reetment, 24.3' from offset stake.
 3" Split barrel using 300lb Hammer
 NX Core barrel
 4" Drive + wash Casing

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-3 DRILLED BY: P. Brescia BORING NO: B-3A
 DATE START: 10/8/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 DATE COMPLETED: 10/8/96 DATE & TIME: — / — CHECKED BY: — / — TOTAL DEPTH: 23.0'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
-10			40 55				See page 1 for S-5		
-11						Roller bit to 12'	1044 Drive casing to 12', will attempt Spear 12-14'		NATURAL
-12		S-6	30 75	12	11	1106	1050 Washing out casing S-6, similar to S-5a	GP	Natural
-13						1215	C-7 Black schist/shale 13-17' very broken Fractures @ 10° and 80° Weathered along fracture surfaces 17'-18' Coarser grained		Bedrock
-14			241 12						
-15		C-7	253 12						
-16			409 12	60	56				
-17			258 12						
-18			240 12						
-19						1240	C-8 Black schist/phyllite. graphitic		Bedrock
-20		C-8	237 12						
			257 12	60	60				
							Coarser grained from 19'9" to 20'8"		

LEGEND:
 YPE-NO - Type of Sample
 SC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 40 lb hammer falling 30" to drive a split barrel sampler;
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: See page 1
 1110 clean out wash tub

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-3 DRILLED BY: P. Brascia BORING NO: B-3A
 DATE START: 10/8/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 DATE COMPLETED: 10/8/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 23.0'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
	20		2:56:12				highly weathered @ 20.5'		
	21	C-5	2:18:12						Bedrock
	22		5:50:12						
	23						End of Boring @ 23.0' Backfill w/bentonite + cement Grout		

LEGEND:

TYPE-NO - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler;
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 W - Natural groundwater table

NOTES: See page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-3 DRILLED BY: P. Brescia BORING NO: B-3B
 DATE START: 10/10/96 DEPTH TO WATER: NM LOGGED BY: J. Holder GROUND EL.: NM
 TEST COMPLETED: 10/10/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 20.5'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0	0		29			0902	S-1 silty SAND. mostly f-crs sand, some silt. black. pet. odor/shear. 1 piece slag 3x2" ash?	SM	Landfill
1	1	S-1	14 10 9 ¹⁰ 11	24	7	0.5 ppm			
2	2		12			0910	S-2a (10") similar to S-1, metal & glass debris. pet odor. to f-s-rnd gravel. 1" layer of f sand @ bottom. black	SM	LANDFILL
3	3	S-2	11 9 15	24	14	0.4 ppm	S-2b (4") silty sandy GRAVEL. mostly f-crs avg gravel (composed of sand/phyllite) LTL f-crs sand. Few silt. gray	SM GM	
4	4		8			0945	S-3a (15") silty gravelly SAND. mostly f-crs sand. some f-crs s-sand to s-avg gravel. LTL silt. gray	SM GM	Natural
5	5	S-3	11 18	24	17	0 ppm	S-3b (2") silty SAND. mostly f-crs sand. Some silt. gray	SM	
6	6		26			1030	S-4 silty gravelly SAND. mostly f-crs sand some f-crs avg to s-rnd gravel. some silt gray to brown. dense	SM GM	Natural (+11?)
7	7	S-4	23 55 80	24	17	0 ppm			
8	8		21			1127	S-5 similar to S-4, 1 piece CRS gravel (3")	SM GM	Natural (+11?)
9	9	S-5	41 90 130	24	17	0 ppm			
	10								

LEGEND:
 TYPE-NO - Type of Sample
 RC - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb hammer falling 30" to drive a split barrel sampler.
 PEN - Penetration length of rock coring time per foot of rock
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: 53' west of offset marker, surveyed horizontal location
 0855 water level deep
 3" Split barrel w/140 lb hammer
 NX Core barrel
 4" Airline + Wash Casings

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-3 DRILLED BY: P. Brescia BORING NO: B-3B
 DATE START: 10/10/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 TIME COMPLETED: 10/10/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 20.5'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
-10						1150	S-6a (4") similar to S-5	sm-gm	(E.11?)
-10.5		S-6	112	6	5		S-6b (1") weathered rock, gray, fissile		weathered bedrock
-11			262	12		1300	1st foot had silt wad, probably not competent rock		
-11.5						RAD = 0%	Black phyllite/schist, graphitic		
-12			120	12		Recovery = 53%	most fractures @ 15°, one @ 45°		
-12.5		C-7					machine surfaces weathered		
-13			144	12	60	32			Bedrock
-13.5									
-14			3:22	12					
-14.5									
-15			3:37	12					
-15.5									
-16		1010 288 272	2:22	12		1333	graphitic schist/phyllite, similar to above		
-16.5									
-17		1010 288 255	3:31	12					
-17.5									
-18		C-8							
-18.5			4:15	12	50	42			Bedrock
-19									
-19.5			2:47	12					
-20			4:15	12			End of boring 20.5'		
							Backfill w/ bentonite + cement grout		

LEGEND:
 TYPE-NO - Type of Sample
 S - Rock core sample
 SB - Split barrel sample
 SLOWS PER 6" - 40 lb hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: See Page 1
 1157 Quince broken, had to pull back 4" casing to get off
 1230 prepare to core

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: 50' from MSB4 DRILLED BY: P. Brescia BORING NO: B-4A
 DATE START: 10/22/96 DEPTH TO WATER: NM LOGGED BY: J. Halden GROUND EL.: NM
 TEST COMPLETED: 10/23/96 DATE & TIME: / / CHECKED BY: TOTAL DEPTH: 25.5'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			5			1244 0ppm	S-1 silty gravelly SAND mostly f-las sand. poorly graded. some f-las gravel. LTL silt. Black.	SM	
1		S-1	5 5	24	11		1st 2" asphalt last 3" asphalt		Landfill
2			3			1250 0ppm	S-2 Similar to S-1. also has glass (melted + non-melted). Black fine grained material may be ash	SM	Landfill
3		S-2	1 1 1	24	10				
4						No sample Casing went from 3'-6' with 1 blow			Landfill
5									
6			3			1315 0ppm	S-3 Silty SAND. mostly f sand. Some silt. Black (Ash?)	SM	Landfill
7		S-3	2 7 9	24	6				
8									
9		S-4	10 7 8 10	24	22	1320 0ppm	S-4a (10) Similar to S-3 S-4b (12) silty gravelly SAND mostly f-las sand. Some f. ang gravel. Some silt. (Till?)	SM SM/gm 9.0	Landfill Natural
10									

LEGEND:
 TYPE-NO - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 ∅ - Natural groundwater table

NOTES: 3" Split Barrel w/ 300 lb Hammer
 NX Core barrel
 4" Drive + wash boring
 1240 water 3.0' deep

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: 56' from N 5134 DRILLED BY: P. Brescia BORING NO: B-4A
 DATE START: 10/22/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 TIME COMPLETED: 10/23/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 25.5

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
	10		12			1355	S-5 similar to S-4b. also C-SAND gravel. gravel composed of phyllite & qtz. Dense	SM/GM	Natural
	11	S-5	15 17 40	24	11	Oppm			
	12		9			1416	S-6 similar to S-4b. dense	SM/GM	Natural
	13	S-6	12 15 19	24	8	Oppm			
	14		17			1422	S-7 similar to S-6	SM/GM	Natural
	15	S-7	21 29 32	24	16	Oppm			
End 10/22	16		16			0800	S-8 gravelly silty SAND mostly f-CRS sand. some silt. LTL of arg gravel. grey-brown. dense	SM/GM	Natural
Start 10/23	17	S-8	15 20 25	24	16	Oppm			
	18		12			0807	S-9 similar to S-8 Last 4" may be weathered bedrock. very dense	SM/GM	Natural
	19	S-9	25 55	18	14	Oppm			
	20								

LEGEND:
 TYPE-NO. - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 W - Natural groundwater table

NOTES: See Page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4925 LOCATION: 56' from MSB-4 DRILLED BY: P. Brescia BORING NO: B-4A
 DATE START: 10/22/96 DEPTH TO WATER: NM LOGGED BY: J. Holder GROUND EL.: NM
 DATE COMPLETED: 10/23/96 DATE & TIME: / / CHECKED BY: TOTAL DEPTH: 25.5

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
20		S-10	80	6	4	weathered gray phyllite in mass	5-10 silty sandy gravel, mostly F and gray. some t-cas sand, some silt. dense	SM	Natural
21			320	12		0920	C-11 from 20.5 to 21.5 very broken.		
22			210	12		Recovery =	Black/gray phyllite/schist		
23		C-11	220	12	60	ROD =	Fractures @ 80° and 45°		
24			400	12			Quartz vein from 22 to 22.5		
25			420	12			Coarse grained (grains visible) @ 22.5 to 25.5		Bedrock
25.5							EOB 25.5'		
							Backfill w/Bentonite + cement grout.		

LEGEND:

- TYPE-NO. - Type of Sample
- 10 - Rock core sample
- 3 - Split barrel sample
- BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; casing time per foot of rock
- PEN - Penetration length of sampler
- REC - Length of sample recovered
- 2 - Natural groundwater table

NOTES: See page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: 40' west of MS04 DRILLED BY: P. Brescia BORING NO: B-4B
 DATE START: 10/28/96 DEPTH TO WATER: NM LOGGED BY: J. Hildner GROUND EL: NM
 TE COMPLETED: 10/28/96 DATE & TIME: — / — / — CHECKED BY: _____ TOTAL DEPTH: 10.0

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
	0		13			0843	S-1 gravelly silty SAND, mostly f-crs sand, some silt. few - CTL f. any to crs gravel & gravel composed of concrete. Ash + glass. black	SM/GM	LANDFILL
	1	S-1	24 21 20	24	10				
	2		7			0850	S-2 silty SAND, mostly f-crs sand, some silt. glass + metal. black	SM	LANDFILL
	3	S-2	4 2 1	24	11				
	4		3			0917	S-3 stuff? silty SAND, mostly red-crs sand. CTL silt. glass + metal	SM	LANDFILL
	5	S-3	4 7	24	3				
	6					No sample	Drive casing to 8' change at 7.5' soil loose from 4'-7.5'		Landfill
	7							7.5'	Natural
	8					0940	S-4a(B) silty sandy GRAVEL, mostly f-crs gravel (phyllite) some f-crs sand, some f-crs - pen water silt. gray.		
	9	S-4	19 13 15 19	24	11	shale/phyllite in near of spoon	S-4b (3) weathered bedrock.		Natural
	10								

LEGEND:
 TYPE-NO - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler;
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES: 0835 - water 7' deep
 4" driver wash
 3" spoon w/300 lb hammer
 E.O.B = 10.0' backfill w bentonite + cement grout

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-4 DRILLED BY: P. Brescia BORING NO: B-4C
 DATE START: 10/16/96 DEPTH TO WATER: NM LOGGED BY: J. Helden GROUND EL.: NM
 TIME COMPLETED: 10/17/96 DATE & TIME: — / — / — CHECKED BY: — / — / — TOTAL DEPTH: 21.0'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	USCS	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0	0		2			1330	S-1 gravelly SAND. mostly f. cgs sand. Some f s-rnd to avg gravel. glass fragments. 3 piece cgs gravel (5"x3") Brown/dark on end	GP	LANDFILL
	1	S-1	3			Oppm			
	2		7	24	12				
	3		8						
	2		11			1340	S-2 similar to S-1, but cgs gravel is 3"x3"	GP	LANDFILL
	3	S-2	11			Oppm			
	4		13	24	14				
	5		8						
	4		3			1400	S-3 gravelly silty SAND. mostly f-cgs sand. LPL f gravel. glass. rubber. white material (ASH?) some silt. Black	GM/SM	Landfill
	5	S-3	5			Oppm			
	6		6	24	6	poor recovery			
	7		4						
	6		2			1404	S-4 similar to S-3. also has metal debris. oil sheen.	GM/SM	Landfill
	7	S-4	2			Oppm			
	8		12	24	4	poor recovery			
	9		9						
	8		7	6		1421	S-5a(5) similar to S-4, no sheen S-5b(6) weathered bedrock. black/gray schist	GM/SM	Landfill
	9	S-5	24	6	18	11			
	10		120	6					
	11								

weathered rock in nose of spout

No sample from 9' to 11'

LEGEND:
 TYPE-NO. - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler.
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 □ - Natural groundwater table

NOTES:
 3" Split Barrell w/300 lb hammer
 NX Core barrel
 4" Drive + wash boring
 Land boring 6' from base of Reventmnd. 200' south of NSB4

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-4 DRILLED BY: P. Brescia BORING NO: B-4C
 DATE START: 10/16/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 DATE COMPLETED: 10/17/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 21.0'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 5"	PEN. in.	REC. in.				
10							No Sample		
11			351 12			111C	C-6 Black graphitic Schist / Phyllite. lots of fractures @ 15°. few at 45° [6' 8" + 14' 10"] weathering along fracture surfaces. Rock breaks easily along bedding planes. Can't see mineral grains.		Bedrock
12			305 12			Recovery = 92.5% RGR = 0.07%			
13		C-6	240 12	60	55.5				
14			230 12						
15			240 12						
16			250 12			114C	C-7 Similar to C-6. from 16-17 very broken Calcite Qtz vein from 16' 10" to 17' 2"		
17			510 12			Recovery = 96.6% RGR = 0%	90° fracture from 18' 5" to 19' 4" Oxidation on fracture surfaces 45° fracture at 16' 6" and 20' 2"		
18		C-7	450 12	60	58				
19			510 12						
20			730 12						

LEGEND:

- TYPE-NO - Type of Sample
- RC - Rock core sample
- SB - Split barrel sample
- BLOWS PER 5" - 140 lb. hammer falling 30" to drive a split barrel sampler.
- PEN - Penetration length of sampler
- REC - Length of sample recovered
- Σ - Natural groundwater table

NOTES: See page 1

Backfill with Bentonite + cement Grout
 Σ O.B. = 21.0'

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-4 DRILLED BY: P. Breslin BORING NO: B-4D
 DATE START: 10/21/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 TIME COMPLETED: 10/22/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 14.0'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			2			1135	S-1 silty gravelly SAND, mostly F-crs	SM/Gr	
			7			Oppm	Swk. some F gravel. LTL silt. brick fragment in last 4". glass + metal. Brown.		Landfill
-1		S-1	7	24	16				
			7						
-2			13			1140	S-2a (8) Similar to S-1	SM/Gr	
			10			Oppm	S-2b (9) silty SAND, mostly F-med sand. Some silt. glass Black (Ash?)	SM	Landfill
-3		S-2	10	24	17				
			10						
-4			4			1255	S-3 Similar to S-2b. also trace f	SM	
			3			Oppm	S-med gravel		
-5		S-3	2	24	8				Landfill
			17						
-6			10				S-4a (8) Similar to S-3	SM	
			19				S-4b (13) weathered bedrock. gray, dense. mostly crs gravel. phyllite		Landfill
-7		S-4	37	24	21				
			42				slough on top		Natural
-8									
							NO sample		Natural
-9									
							graphite in cuttings and silt wads.		Natural
-10									
		C-5	350	60	46	Recovery = 77% RQD = 11%	L-5 from 9' to 10' 2" chips/broken phyllite. Black		bedrock

LEGEND:

TYPE-NO. - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES:

3" Split Barrel w/200 lb Hammer
 NX Core barrel
 4" Drive + wash boring
 Land boring. South of B-4C

Paul would not take sample from CS-10

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSR 4 DRILLED BY: P. Brescia BORING NO: B-4D
 DATE START: 10/21/96 DEPTH TO WATER: NM LOGGED BY: J. Hilden GROUND EL.: NM
 TE COMPLETED: 10/22/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 14.0

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
	10								
			350	12			C-5 (cont) 11' contact cover grained schist		
	11						12' to 12'6" 90° fracture other fractures are @ 10-20° or 45°		
		C-5	340	12					
	12								
			230	12					
	13								
			330	12					
	14						E.O.B. 14'		

End
10/21/96

LEGEND:
 TYPE-NO. - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of rock
 REC - Length of sample recovered
 X - Natural groundwater table

NOTES: see page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: SE of 2504 DRILLED BY: P. Bressia BORING NO: B-4E
 DATE START: 10/30/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL.: NM
 TEST COMPLETED: 10/30/96 DATE & TIME: — / — CHECKED BY: — TOTAL DEPTH: 7'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			9			0817	S-1 gravelly silty SAND. mostly f-cas sand. Some silt. LTL f sand gravel. 1 piece cas gravel. black.		
1		S-1	15 10	24	12	Oppm	brick, glass and metal	SM/GM	Landfill
2			5			0820	S-2 silty SAND. mostly f sand. some cas-med sand. LTL silt. trace f-cas s-and gravel. gray/black		
3		S-2	4 1 1	24	10	Oppm	glass metal.	SM	Landfill
4						No Sample.	when trying to wash to 4', casing moving down drove casing to 5'. Paul reports strata change at 4'6"		Landfill
5						Wash has gte + phyllite fragments			till?
6		S-3	13 15 16 21	24	15	0905 Oppm	S-3 silty sandy GRAVEL. mostly f-cas arg gravel. some f-cas sand. LTL silt.	GM/SM	till
7							weathered rock in nose backfill w/ bentonite + cement grout.		
8									

LEGEND:
 TYPE-NO - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb hammer falling 30" to drive a split barrel sampler.
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 W - Natural groundwater table

NOTES: 0811 water 4' deep
 4" DAW casing
 3" split spoon w/300 lb hammer
 Approx 84' from base of Reinment. (south)

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: ~80' south of NSB4 DRILLED BY: P. Brescia BORING NO: B-41F
 DATE START: 10/28/96 DEPTH TO WATER: _____ LOGGED BY: A. Holden GROUND EL: Nm
 TEST COMPLETED: 10/28/96 DATE & TIME: _____ / _____ CHECKED BY: _____ TOTAL DEPTH: P.O.

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0	0		6			1132	S-1 silty gravelly SAND. mostly f-cas sand. some f s-rms gravel. ctk silt. Black ash?, brick, metal	Sm/GM	Landfill
1	1	S-1	9 5	24	11				
2	2		2			1137	S-2 similar to S-1, some silt. glass	Sm/GM	Landfill
3	3	S-2	1 2 4	24	12				
4	4		6			1154	S-3 silty SAND. mostly f sand. some silt. trace cnc. med sand. gray	Sm	Natural
5	5	S-3	2 6 10	24	10				
6	6		15			1213	S-4 silty sandy GRAVEL mostly f org gravel (phyllite/schist) some f-cas sand. few silt. dense. gray/brown	Gm/Sm	Natural
7	7	S-4	12 20 19	24	11				
8	8								
9	9								
10	10								

LEGEND:

- PE-NO - Type of Sample
- NO - Rock core sample
- SB - Split barrel sample
- BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler
- PEN - Penetration length of sampler
- REC - Length of sample recovered
- Z - Natural groundwater table

NOTES: 11:25 water 6.0'

- 4" brace + wash
- 3" Spoon w/ 300 lb Hammer

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-5 DRILLED BY: P. Brescia BORING NO: B-5
 DATE START: 10/16/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL: NM
 TE COMPLETED: 10/16/96 DATE & TIME: / / CHECKED BY: TOTAL DEPTH: 17.0

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0									
	1				1020	S-1 gravelly ^{1 1/2} silty SAND. mostly f-cas sand - some f s-ano gravel. brown. dry glass	SM	Landfill	
	2				Oppm				
1	3	S-1		24	13				
	4								
2					1033	S-2a (P) sand. mostly f sand, some med-cas sand. orange glass fragments	SP	Landfill	
	7				Oppm				
3	10	S-2		24	16	S-2b (E) gravelly SAND. Similar to S-1 No glass or metal	SM		
	8				Pet odor				
4					1040	S-3a (E) silty gravelly sand. mostly f-cas sand. Some f gravel. Ltc silt. metal/wood black	SM	Landfill	
	10								
5	25	S-3		24	16	S-3b (7) silty gravelly sand mostly f-cas sand some f ang gravel. few silt. gray decomposed bedrock?	SM	Natural	
	30				weathered bedrock in nose	S-3c (1) weathered phyllite			
6						S-4 weathered bedrock phyllite/saprolite? green crumbles			
	95	S-4	6	9	5	Refused @ 6' 9" Roller bit to 7.0'			
	100		3						
7									
8						first 3' very broken. green schist		Bedrock	
	247		12			Some fractures @ 90° and 10°			
	2103		12			oxidation/weathering on fracture planes			
9		C-5							
	154		12			40° fractures			
10									

LEGEND:
 TYPE-NO. - Type of Sample
 RC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 * - Natural groundwater table

NOTES: start @ 10.12
 3" Split barrel w/300 lb hammer
 N x core barrel
 4" Drive + wash boring
 sand boring @ toe of revetment - 6' away

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: MSB-5 DRILLED BY: P. Brescia BORING NO: B-5
 DATE START: 10/16/96 DEPTH TO WATER: NM LOGGED BY: J. Holder GROUND EL.: NM
 TE COMPLETED: 10/16/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 17.0

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE- NO.	BLOWS PER 6"	PEN. in.	REC. in.				
10									
11		C-5	210/12			15° fractures		Bedrock	
			220/12						
12			254/12			1200 finish coring Recovery = 100% RQD = 9%	C-6 similar to C-5 has quartz vein @ 12.5 and calcite @ 15-17 fractures @ 20° and 30° fracture surfaces weathered Rock is coarser grained @ 14'-17'	Bedrock	
13			130/12						
14			150/12						
15		C-6		60	60				
16			230/12						
			2100/12						
17						End of Boring 17' BGS Backfill w/ Bentonite + cement Grout			

LEGEND:
 PE-NO - Type of Sample
 SC - Rock core sample
 SB - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 X - Natural groundwater table

NOTES: See page 1

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: Between NSA 5 + 6 DRILLED BY: P. Brasica BORING NO: B-5B
 DATE START: 10/17/96 DEPTH TO WATER: NM LOGGED BY: J. Holden GROUND EL: NM
 TEST COMPLETED: 10/17/96 DATE & TIME: / / CHECKED BY: TOTAL DEPTH: 30'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			17			0844	S-1a (5) silty SAND. mostly f sand. poorly graded. LTL f gravel - cas sand. trace cas	SM	Natural
			11			0 ppm	S-1b gravel. shells. Black some silt.		
1		S-1	20	24	14		S-2b (9) silty sandy GRAVEL. mostly f- cas	GM	
			28				any gravel. some f- cas sand. LTL silt. Brown		
2			60	6		0906	S-2 weathered bedrock. gray-brown		
		S-2	140	6	12	0 ppm	phyllite/schist		
3							No backfill. allow to collapse		

LEGEND:
 TYPE-NO. - Type of Sample
 SM - Rock core sample
 GM - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 Z - Natural groundwater table

NOTES:
 3" Split Barrel w/300 lb Hammer
 Barge boring. No bedrock core
 78' away from revetment (stake R-8)
 0830 3.5' of water

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-6 DRILLED BY: P. Bresia BORING NO: B-6
 DATE START: 10/21/96 DEPTH TO WATER: NM LOGGED BY: J. Hallow GROUND EL.: NM
 TE COMPLETED: 10/21/96 DATE & TIME: —/—/— CHECKED BY: — TOTAL DEPTH: 19.0'

ELEV. IN FEET	DEPTH IN FEET	S A M P L E				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.C.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
0			8			0800	S-1 gravelly silty SAND. mostly f-cr sand some silt. LTL f SAND gravel. Dense. Gray-brown. (Till?)	SM	Natural
		S-1	22			Oppm			
			41	24	16				
			46						
2			33			0810	S-2a (4) Similar to S-1 S-2b (4) silty sandy GRAVEL. mostly f avg gravel. LTL f-cr sand. LTL silt. Brown. Decomposed bedrock?	SM GM	Natural
		S-2	25			Oppm			
			25	24	13				
			26						
4			11			0834	S-3a (14) Similar to S-1 S-3b (4) Similar to S-2b	SM GM	Natural
		S-3	12			Oppm			
			12	24	18				
			17						
6			28			0840	S-4 similar to S-2b. brown staining decomposed rock in nose	GM	Natural
		S-4	63	12	12	Oppm			
7		NO SAMPLE from 07 to 09							
9						0930			
		C-5	150	12		See page 2			Bedrock

LEGEND:
 TYPE-NO - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 140 lb. hammer falling 30" to drive a split barrel sampler.
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 □ - Natural groundwater table

NOTES:
 3" Split Barrel w/300 lb hammer
 NX core barrel
 4" brvs + wash boring
 Rod borings.

BORING LOG

BROWN AND ROOT ENVIRONMENTAL

PROJECT NO: 4725 LOCATION: NSB-6 DRILLED BY: P. Brescia BORING NO: B-6
 DATE START: 10/21/96 DEPTH TO WATER: NM LOGGED BY: J Holder GROUND EL.: NM
 TIME COMPLETED: 10/21/96 DATE & TIME: — / — CHECKED BY: _____ TOTAL DEPTH: 19.0'

ELEV. IN FEET	DEPTH IN FEET	SAMPLE				REMARKS ON ADVANCE OF BORING	SOIL & ROCK DESCRIPTION	U.S.G.S.	GEO-LOGICAL CONTACT
		TYPE-NO.	BLOWS PER 6"	PEN. in.	REC. in.				
10						0930 Recovery = 13% RQD = 0%	C-5 very broken. poor recovery. Quartz and green schist.		
11			230 12						
12			145 12	60	8		Paul states quartz veins are chewing up core.		Bedrock
13			330 530 12						
14			330 12						
15			5:00 12			1040 Recovery = 78% RQD = 0%	C-6 Quartz veins at top and bottom of core. Rock very broken. green Schist. fractures @ 90° and 30° weathered on fractured surfaces		Bedrock
16			2:30 12	60	47				
17		C-6	220 12						
18			3:00 12						
19			0930 12						
							End of Boring 19.0' Bgs Backfill w/ Bentonite + cement Grout.		

LEGEND:

TYPE-NO. - Type of Sample
 C - Rock core sample
 S - Split barrel sample
 BLOWS PER 6" - 40 lb. hammer falling 30" to drive a split barrel sampler; coring time per foot of rock
 PEN - Penetration length of sampler
 REC - Length of sample recovered
 ∞ - Natural groundwater table

NOTES: See page 1

APPENDIX C

DATA FROM CHEMISTRY ANALYSIS

APPENDIX C-1

**FATE AND TRANSPORT ANALYSIS OF ORGANIC CONTAMINANTS
IN SEDIMENTS FOR THE OFF SHORE ECOLOGICAL RISK ASSESSMENT
AT MCALLISTER POINT LANDFILL
JAMES G. QUINN et.al., URI GSO DECEMBER 9, 1996**

FATE AND TRANSPORT ANALYSIS OF
ORGANIC CONTAMINANTS IN SEDIMENTS
FOR THE
OFFSHORE ECOLOGICAL RISK ASSESSMENT
AT
McALLISTER POINT LANDFILL
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

(Phase III)

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December 9, 1996

Introduction

This report presents the data obtained in the analysis of organic contaminants in sediments from McAllister Point Landfill, Naval Education and Training Center (NETC), Newport, Rhode Island (Phase III). The surface samples were collected in September 1996, and the core samples were collected in October and November 1996. They were stored according to established protocols and were analyzed using standard methods. All procedures used in this investigation have been described in detail in the Final Work/Quality Assurance Project Plan - Narragansett Bay Ecorisk and Monitoring for Navy Sites (URI and SAIC, 1995). The results of the Phase I and II investigations of the McAllister Point Landfill have been previously reported ((Brown and Root Environmental, 1996).

Sediments

All station locations are shown in Figures 3.1-1 and 3.6-1. A total of 18 surface sediments and 7 core sections were analyzed for 27 polychlorinated biphenyl (PCB) congeners and 24 polycyclic aromatic hydrocarbons (PAHs), (Table 1). Station S2BFD is a separate grab sample taken at site S2B. The Σ PCBs (an estimate of total Aroclors) is the sum of the 27 PCB congeners \times 2, and the Σ PAHs is the sum of the 24 PAHs. All values are reported on a dry weight basis (e.g. ng analyte /g dry weight sediment).

Surface Sediments

PCBs

For the Σ PCBs (Figure 1 and Table 2), nearshore stations NSB-3 through NSB-7 exceeded the ERM (effects range median; Long et al., 1995) guidelines of 180 ng/g (parts per billion, ppb) for total PCBs. There was

reasonable agreement between 3 of these stations collected in 1995 and 1996 (NSB-3, NSB-6 and NSB-7; relative percent difference (RPD) of 50% or less). However, the agreement between stations NSB-4 and NSB-5 was very poor; in addition, the 1996 samples were considerably higher than the 1995 samples. Two offshore stations (S2BFD and MCL-12) were also higher in 1996 and exceeded the ERM value.

All of the other stations exceeded the ERL (effects range low) concentration of 22.7 ppb (Long et al., 1995). The nearshore stations were generally higher in 1996, while most of the offshore stations were about the same or slightly higher in 1995. Organic Carbon (OC) normalized values (Figure 2) showed a greater difference at station S2BFD and about the same or smaller differences at the other stations, compared to the sediment based values (Figure 1). Stations NSB-4 and NSB-5 were considerably high in 1996, even after OC normalization.

Figures 3 and 4 show a quantitative comparison of individual PCB congeners at stations NSB-4 and NSB-5, respectively. These congener distributions are similar to that found in Aroclor 1254. The major difference in these samples was the relatively large amount of nonachlorobiphenyl (CB 206 and other congeners of nonachlorobiphenyl) found at station NSB-4 in 1995 and at station NSB-5 in 1996. Congener 206 is not a major constituent of Aroclor 1254 or 1260, the two Aroclor mixtures usually found in Narragansett Bay sediments (URI and SAIC, 1995). The concentrations of PCBs were much higher in the 1996 samples, and therefore, the large amount of CB 206 at NSB-5 cannot be explained at this time.

PAHs

In the comparison of PAHs (Figure 1 and Table 2), 9 of the 1995 samples and 3 of the 1996 samples exceeded the ERL value (4,022 ppb; Long et al., 1995). The greatest differences in the yearly samples were at stations S2B and NSB-3 where the 1995 values were higher; and at stations NSB-6 and MCL-12, which had larger 1996 values. None of the samples exceeded the ERM value of 44,792 ppb (Long et al., 1995). Normalization to OC (Figure 2) showed about the same major trends in concentration versus station as the sediment based values (Figure 1) for most stations. However, stations S2BFD and NSB-6 had considerably larger values in 1996 due to a combination of higher PAH values and lower carbon concentrations.

The distribution of individual PAH components at stations NSB-6 and MCL-12 are shown in Figures 5 and 6, respectively. There are differences in the relative amounts of several PAHs in the yearly samples at both stations (e.g. ratio of phenanthrene to 1-methylphenanthrene). However, the overall qualitative distribution of PAHs is similar both within and between stations, suggesting a contribution of both pyrogenic (e.g. combustion products) and petrogenic (e.g. lubricating oils) PAHs at both locations. There is no evidence of substantial inputs of unweathered (fresh) oil at either of these stations as indicated by the small amounts of naphthalene (NAP) to fluorene (FLU) in the samples. However, there is evidence of a large increase in these low molecular weight PAHs at station NSB-4 in the 1996 samples (Figure 7) suggesting possible inputs of unweathered oil at this station.

Core Sediments

The results of analyses of the 7 core samples are shown in Table 3 and Figure 8. For the PCBs, only station NSB-2 showed a major increase in

concentration for the core sample (O-18 cm) compared to the surface sample (O-6 cm). In the case of the PAHs, however, stations NSB-2 through NSB-4 had substantial increases in the core samples relative to the surface samples.

Conclusions

- 1) There was fair agreement in PCB concentrations between most surface stations collected in 1995 and 1996; however, the comparisons between nearshore stations NSB-4 and NSB-5 were very poor and the 1996 samples were considerably higher in PCB levels than those collected in 1995. Organic carbon normalization did not substantially change the trends obtained using sediment based values. In addition, the distribution of individual PCB congeners in the yearly samples showed a large increase in CB206 at station NSB-5 in 1996. Thus, based on the analyses of the surface samples, there has been a substantial increase in PCBs at station NSB-4 and NSB-5. There has also been a change in the qualitative distribution of the individual congeners at station NSB-5. The differences between the 1995 and 1996 samples suggest different sources and/or environmental modification of the PCBs at these locations.

- 2) The greatest increases for PAHs in yearly surface samples were at stations NSB-6 and MCL-12. Normalization to organic carbon showed about the same trends obtained with the sediment based values. The distribution of individual PAH components was relatively similar, both within and between most stations. However, there was evidence of large increases in low molecular weight PAHs at station NSB-4 in the 1996 samples. Therefore, there is evidence for substantial changes in PAH concentrations and/or qualitative distributions at stations NSB-4 , NSB-6 and MCL-12. Again, these differences in the yearly PAH data suggest different source materials and/or environmental modification at these locations.

- 3) Only station NSB-2 showed a significant increase in concentration of PCBs for the core samples (O-18cm) compared to the surface sediments (O-2 or O-6 cm). For the PAHs, stations NSB-2 through NSB-4 had significant increases in the core samples relative to the surface. Furthermore, station NSB-4 showed the presence of low molecular weight PAHs in the both the surface and core samples. Thus, there is additional evidence for PAH changes in the sediments at stations NSB-2 through NSB-4.

References

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, *Environmental Management*, 19(1): 81-97.

URI and SAIC, 1995. Narragansett Bay Ecorisk and Monitoring for Navy Sites, Final Work/Quality Assurance Project Plan by James G. Quinn, John King, and Greg Tracey, Prepared for Halliburton NUS Corp., 28 July 1995, 57 pp, 3 appendices and 3 addenda.

Brown and Root Environmental, 1996. McAllister Point Landfill, Marine Ecological Risk Assessment Report, Draft Final, Volumes I and II.

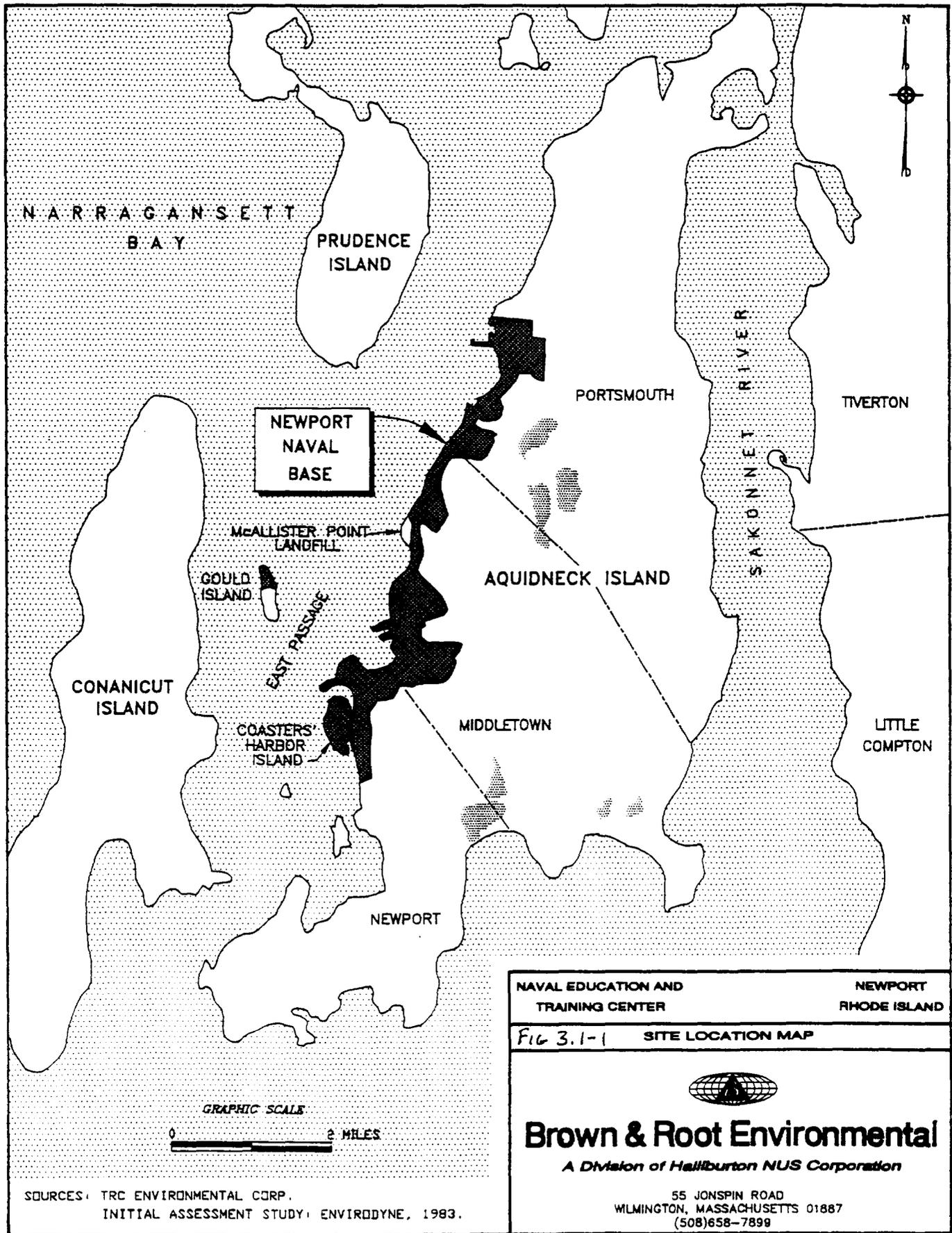
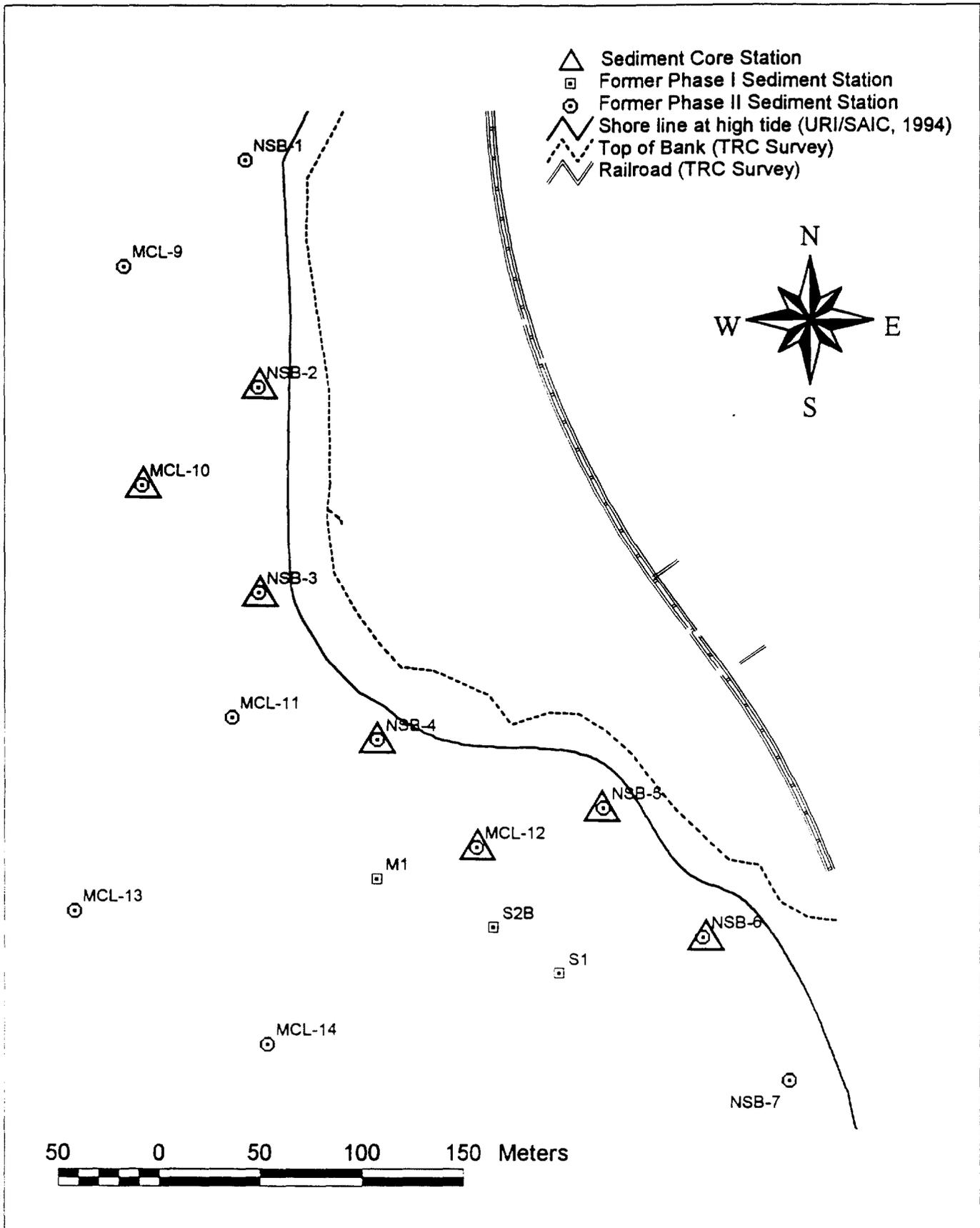


Fig 3.6-1 . Phase III sediment sampling locations for the McAllister Point Marine ERA.



Concentration

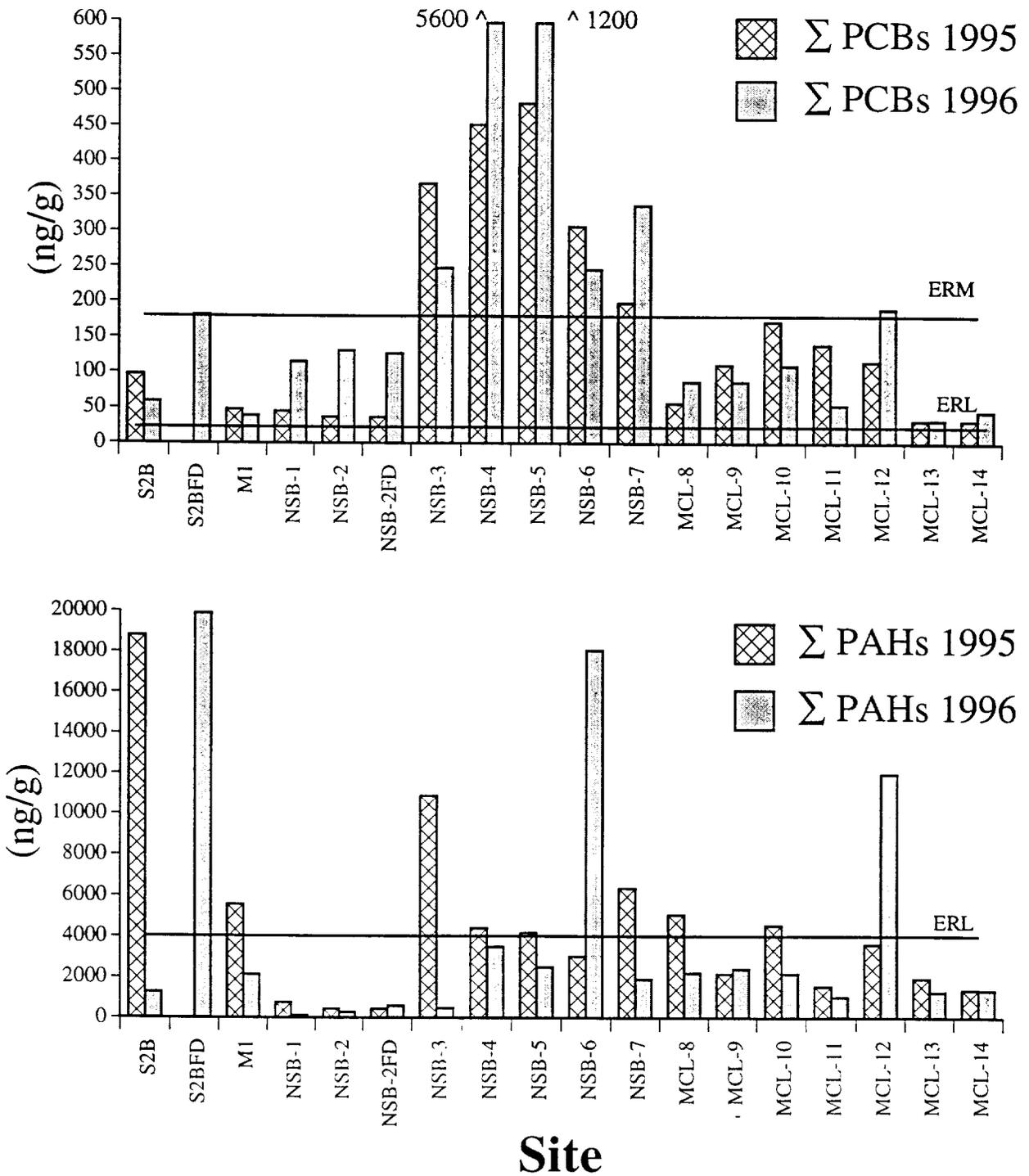


Figure 1. Concentration (ng/g dry weight sediment) of organic contaminants in surface sediments from the Phase III McAllister Point study area. The sample depth at sites NSB-1 through NSB-7 is 0-6 cm. The depth at all other sites is 0-2 cm. The horizontal lines are the ERL and ERM guidelines (Long et al., 1995).

Concentration

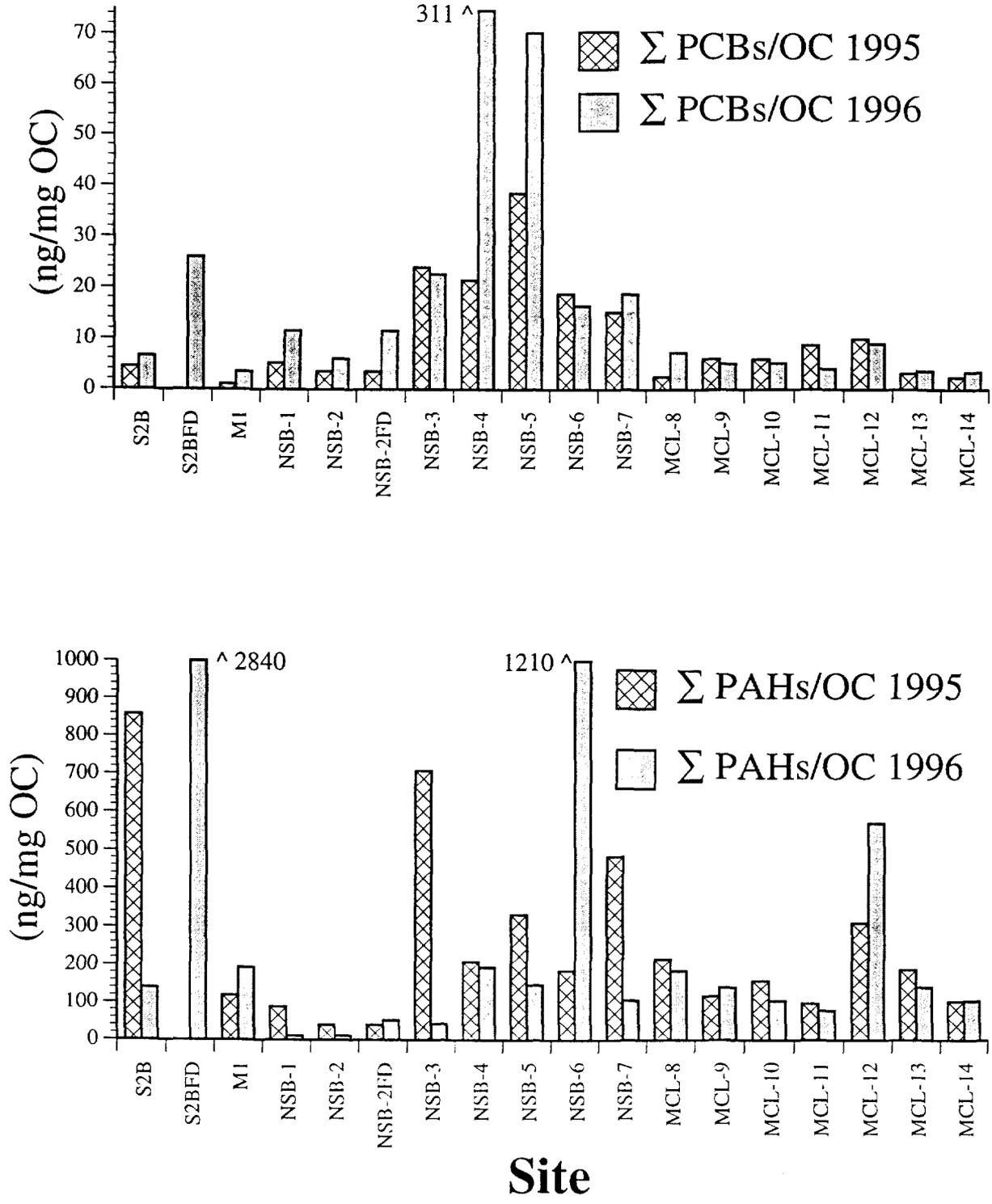


Figure 2. Concentration (ng/mg OC) of organic contaminants normalized to organic carbon (OC) in surface sediments from the Phase III McAllister Point study area. The sample depth at sites NSB-1 through NSB-7 is 0-6 cm. The depth at all other sites is 0-2 cm.

Concentration

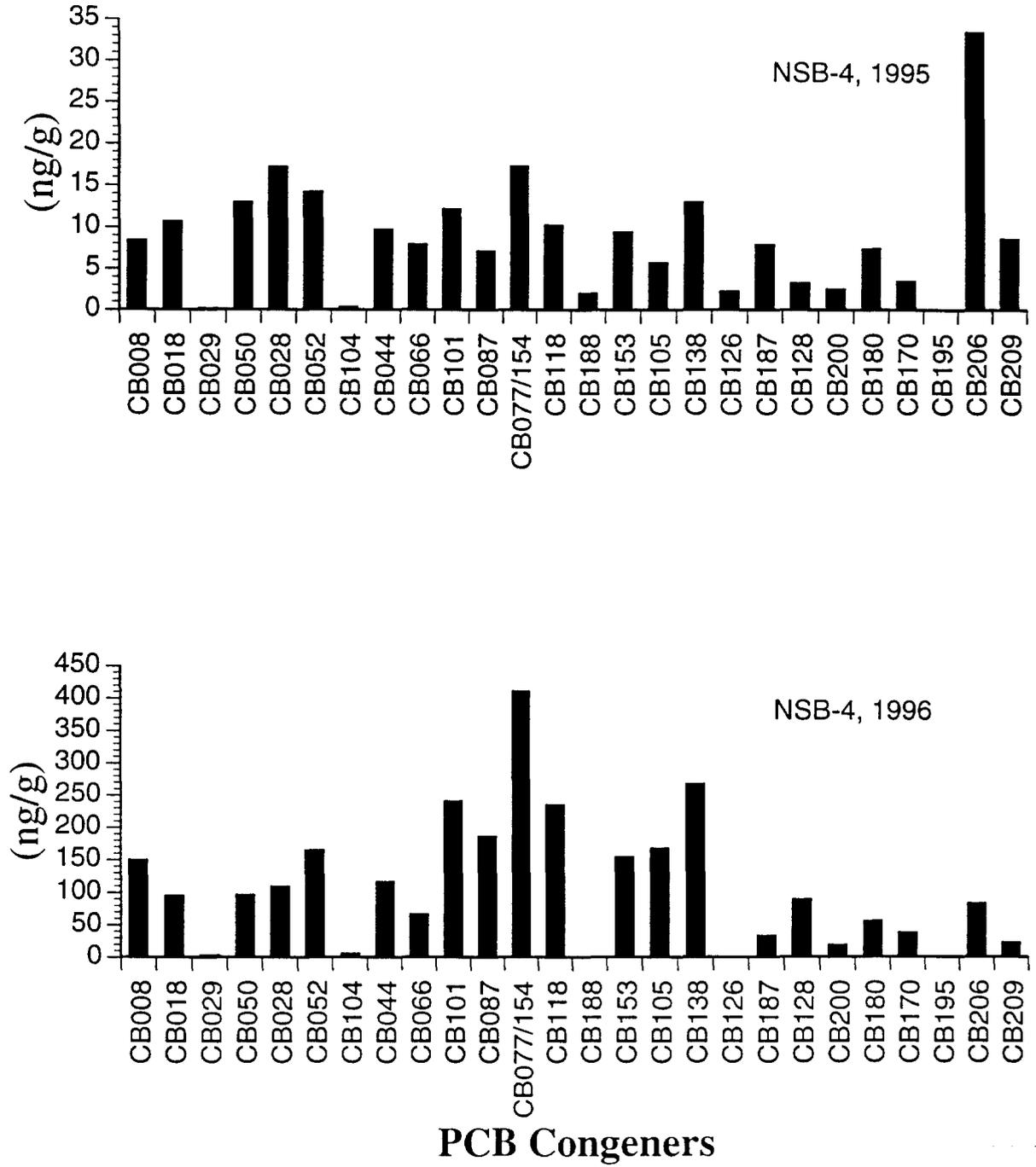


Figure 3. Concentration (ng/g dry weight sediment) of PCB Congeners in surface sediments (0-6 cm) from station NSB-4 in 1995 and 1996.

Concentration

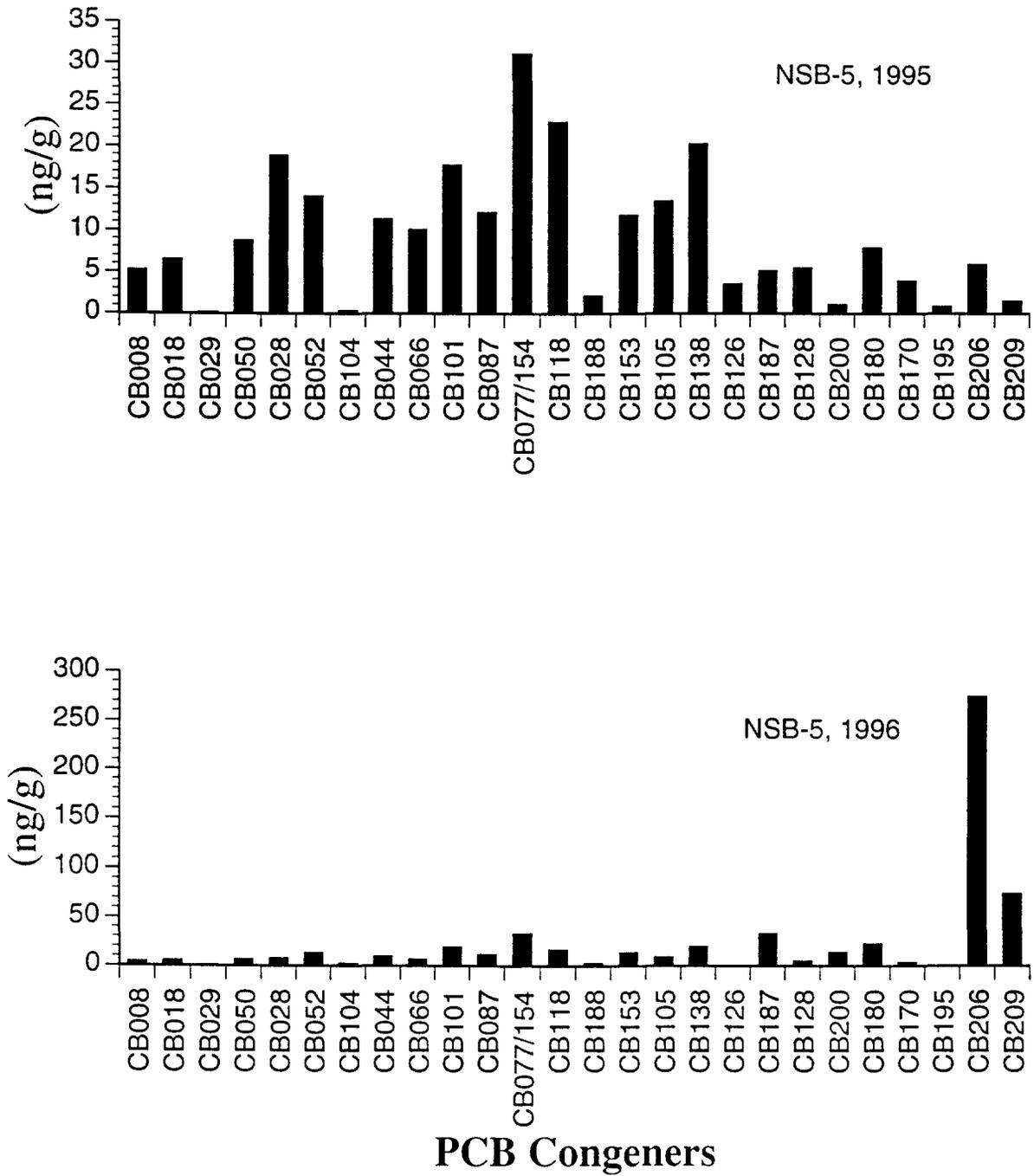


Figure 4. Concentration (ng/g dry weight sediment) of PCB Congeners in surface sediments (0-6 cm) from station NSB-5 in 1995 and 1996.

Concentration

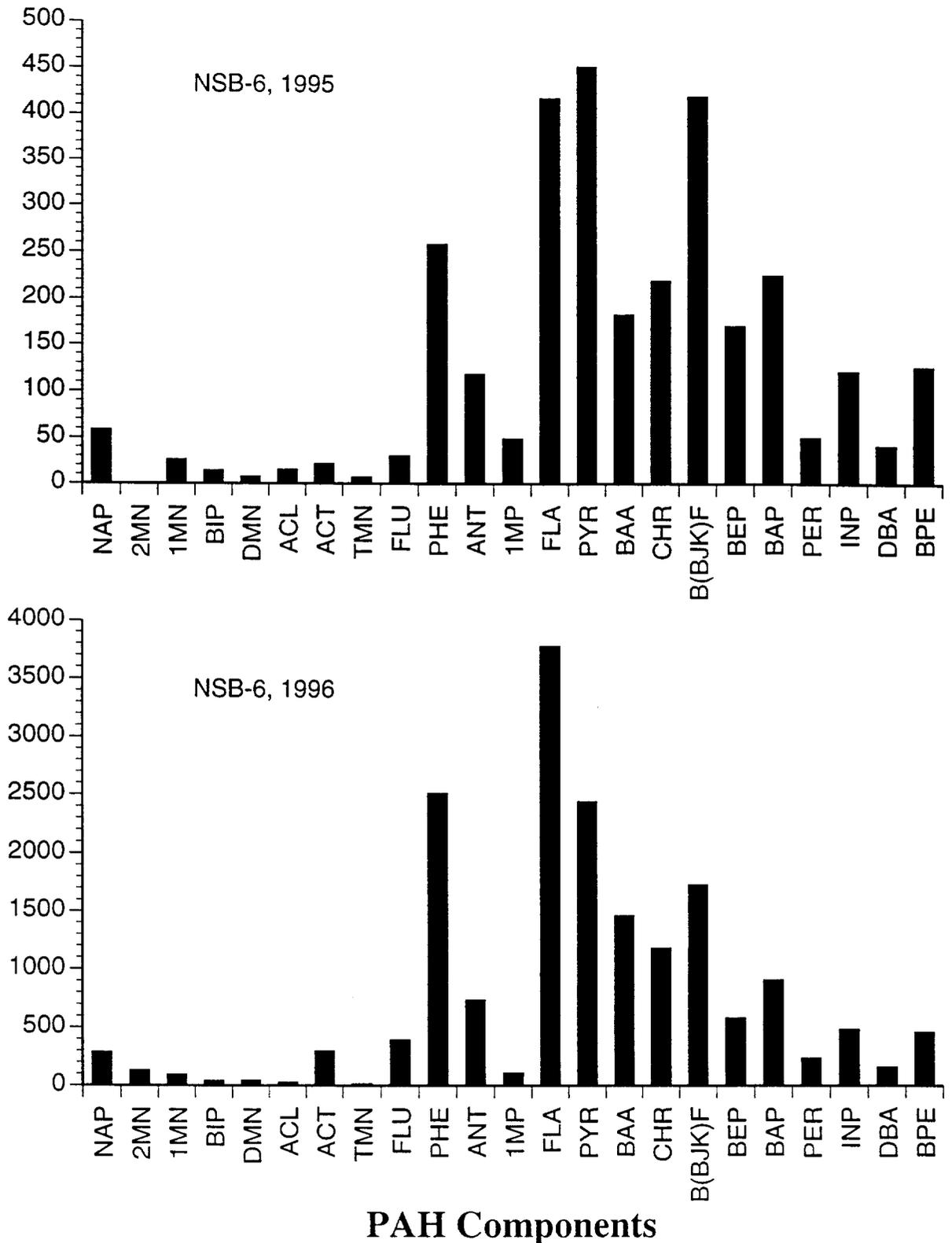


Figure 5. Concentration (ng/g dry weight sediment) of PAH components in surface sediment (0-6 cm) from station NSB-6 in 1995 and 1996.

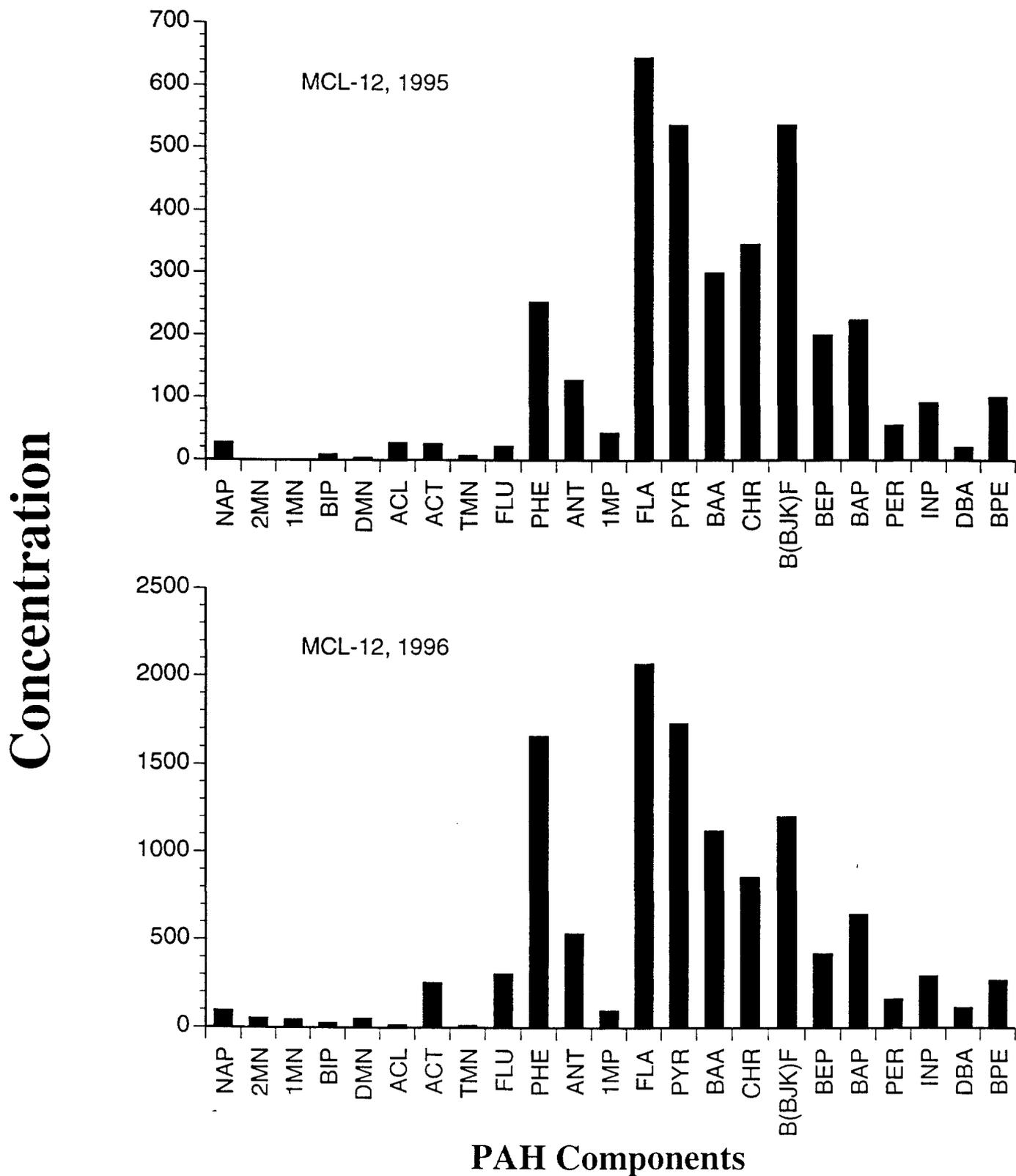
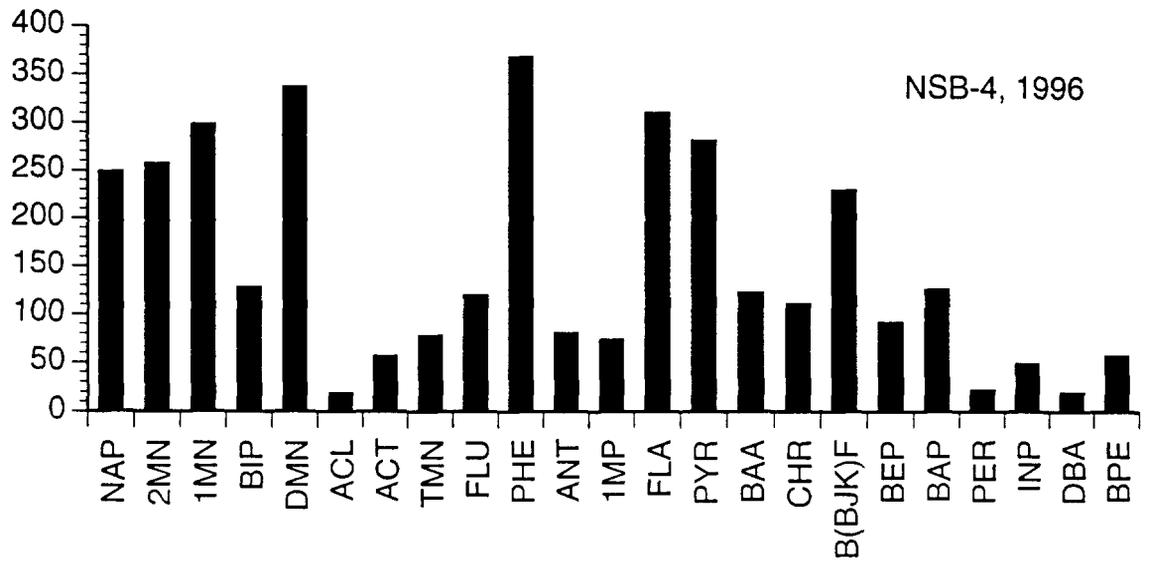
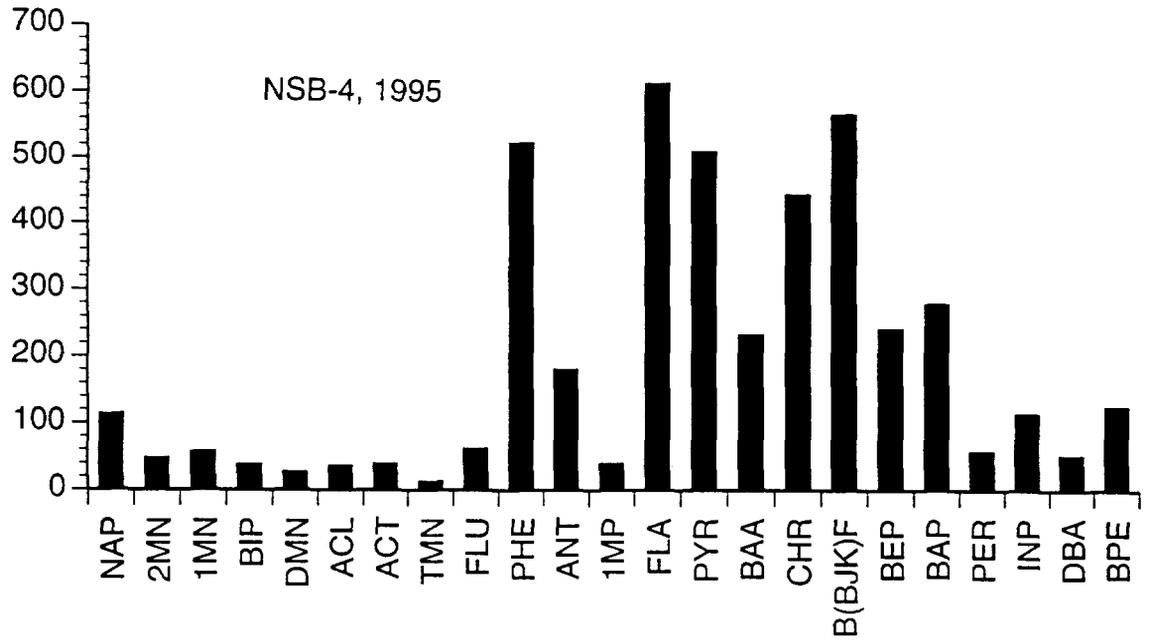


Figure 6. Concentration (ng/g dry weight sediment) of PAH components in surface sediment (0-2 cm) from station MCL-12 in 1995 and 1996.

Concentration



PAH Components

Figure 7. Concentration (ng/g dry weight sediment) of PAH components in surface sediments (0-6 cm) from station NSB-4 in 1995 and 1996.

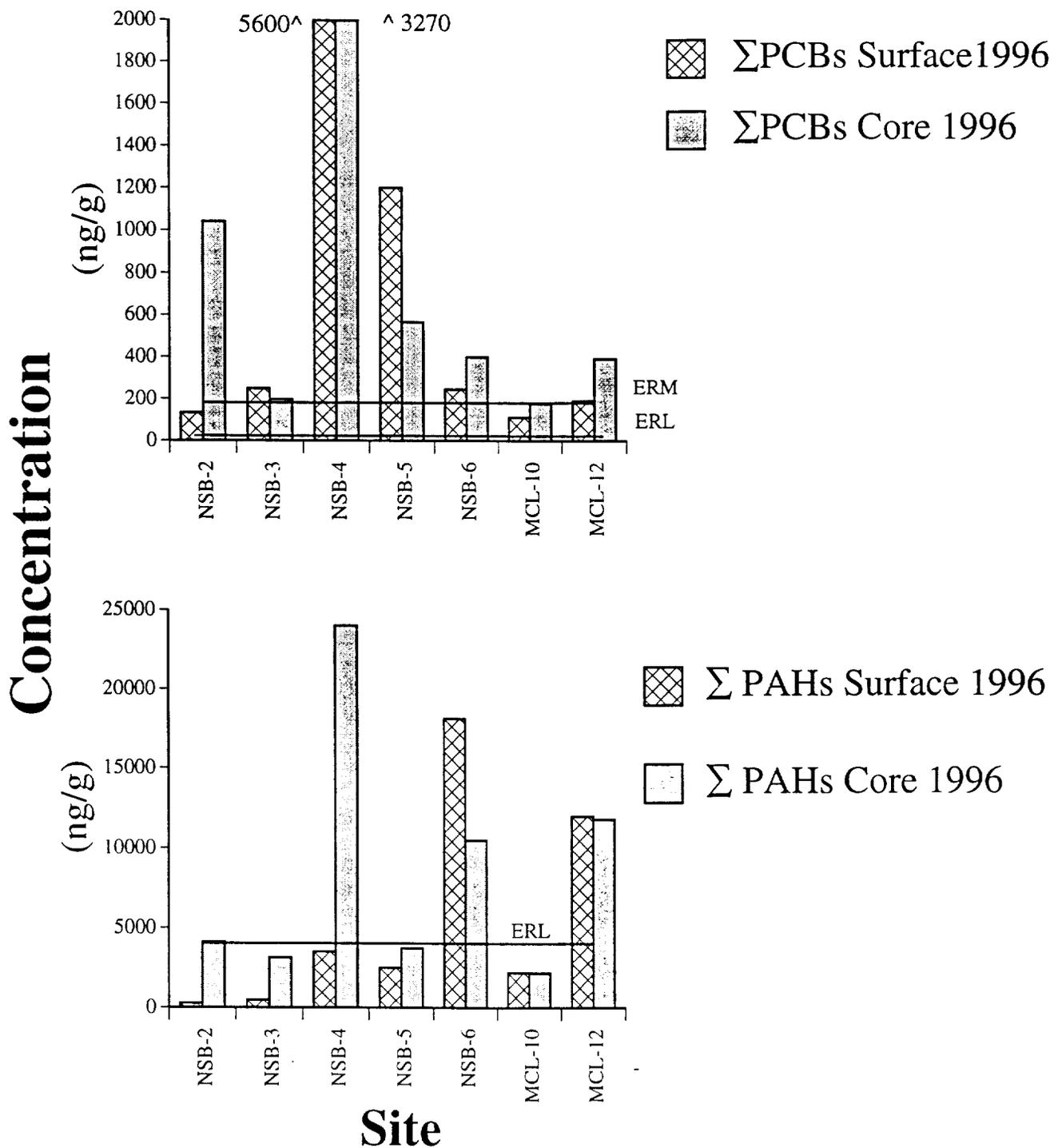


Figure 8. Concentration (ng/g dry weight sediment) of organic contaminants in surface and core sediments from the Phase III McAllister Point study area. The sample depth at sites NSB-2 through NSB-6 is 0-6 cm. The depth at the other sites is 0-2 cm. The horizontal lines are the ERL and ERM guidelines (Long et al., 1995).

Table 1
List of Organic Contaminants
Analyzed in this Investigation

Abbrev.	Component Name	[CAS #]
Polycyclic Aromatic Hydrocarbons (PAHs)		
ACL:	acenaphthylene	208-96-8
ACT:	acenaphthene	83-32-9
ANT:	anthracene	120-12-7
BAA:	benzo (a) anthracene	56-55-3
BAP:	benzo (a) pyrene	50-32-8
BBF:	benzo (b) fluoranthene	205-99-2
BEP:	benzo (e) pyrene	192-97-2
BIP:	biphenyl	92-52-4
BKF:	benzo (k) fluoranthene	207-08-9
BPE:	benzo [ghi] perylene	191-245-2
CHR:	chrysene	218-01-9
DBA:	dibenzo [a,h] anthracene	53-70-3
FLA:	fluoranthene	206-44-0
FLU:	fluorene	86-73-7
INP:	indeno [1,2,3-cd] pyrene	193-39-5
NAP:	naphthalene	91-20-3
1MN:	1-methylnaphthalene	90-12-0
2MN:	2-methylnaphthalene	91-57-6
DMN:	2,6-dimethylnaphthalene	581-42-0
TMN:	2,3,5-trimethylnaphthalene	2245-38-7
PHE:	phenanthrene	85-01-08
1MP:	1-methylphenanthrene	832-69-9
PER:	perylene	198-55-0
PYR:	pyrene	129-00-0
∑ PAHs:	sum of the 24 polycyclic aromatic hydrocarbons	
Polychlorinated Biphenyls (PCBs)		
CB008:	2,4'-dichlorobiphenyl	34883-43-7
CB018:	2,2',5-trichlorobiphenyl	37680-65-2
CB029:	2,4,5-trichlorobiphenyl	15862-07-4
CB050:	2,2',4,6-tetrachlorobiphenyl	62796-65-0
CB028:	2,4,4'-trichlorobiphenyl	7012-37-5
CB052:	2,2',5,5'-tetrachlorobiphenyl	35693-99-3
CB104:	2,2',4,6,6'-pentachlorobiphenyl	56558-16-8
CB044:	2,2',3,5-tetrachlorobiphenyl	41464-39-5
CB066:	2,3',4,4'-tetrachlorobiphenyl	32598-10-0
CB101:	2,2',4,5,5'-pentachlorobiphenyl	37680-73-2
CB087:	2,2',3,4,5'-pentachlorobiphenyl	38380-02-8
CB077:	3,3',4,4'-tetrachlorobiphenyl	32598-13-3
CB154:	2,2',4,4',5,6'-hexachlorobiphenyl	60145-22-4
CB118:	2,3',4,4',5-pentachlorobiphenyl	31508-00-6
CB188:	2,2',3,4',5,6,6'-heptachlorobiphenyl	74487-85-7

List (Continued)

<u>Abbrev.</u>	<u>Component Name</u>	<u>[CAS]</u>
CB153:	2,2',4,4',5,5'-hexachlorobiphenyl	35065-27-1
CB105:	2,3,3',4,4'-pentachlorobiphenyl	32598-14-4
CB138:	2,2',3,4,4',5'-hexachlorobiphenyl	35065-28-2
CB126:	3,3',4,4',5-pentachlorobiphenyl	57465-28-8
CB187:	2,2',3,4',5,5',6-heptachlorobiphenyl	52663-68-0
CB128:	2,2',3,3',4,4'-hexachlorobiphenyl	38380-07-3
CB200:	2,2',3,3',4,5,6,6'-octachlorobiphenyl	512663-73-7
CB180:	2,2',3,4,4',5,5'-heptachlorobiphenyl	35065-29-3
CB170:	2,2',3,3',4,4',5-heptachlorobiphenyl	35065-30-6
CB195:	2,2',3,3',4,4',5,6-octachlorobiphenyl	52663-78-2
CB206:	2,2',3,3',4,4',5,5',6-nonachlorobiphenyl	40186-72-9
CB209:	2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl	2051-24-3
∑ CBs:	sum of the 27 chlorobiphenyls	
∑ PCBs	∑ CBs x 2.0	

Data Qualifiers for Organic Analytical Data

- J = analyte detected but the measured concentration was below the MDL
- Q = measurements are outside of QA limits as specified in the DQOs
- ND = analyte was not detected; these values are reported as < MDL for that analyte/matrix
- I = analytical interference with the analyte
- NA = data was not applicable to the specified analyte

Table 2. Concentration of organic contaminants (per g dry weight sediment or mg OC) in surface sediments from the Phase III McAllister Point Study Area.

	Site	S2B -R	S2B -R -FD	M1 -R	NSB -1-R	NSB -2-R	NSB -2-R -FD	NSB -3-R	NSB -4-R	NSB -5-R	NSB -6-R	NSB -7-R	MCL -8-R	MCL -9-R	MCL -10-R	MCL -11-R	MCL -12-R	MCL -13-R	MCL -14-R
	depth cm	0-2	0-2	0-2	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-2	0-2	0-2	0-2	0-2	0-2	0-2
Contaminant	(units)																		
Σ PCBs	(ng/g)	59	182	39	115	131	127	248	5600	1200	246	337	87	87	110	54	190	33	45
Σ PAHs	(ng/g)	1260	19900	2130	113	264	587	480	3490	2500	18100	1910	2210	2400	2180	1020	12000	1270	1350
Organic Carbon	(mg/g)	9	7	11	10	22	11	11	18	17	15	18	12	17	21	13	21	9	13
Contaminant/ Organic Carbon	(units)																		
Σ PCBs	(ng/mg OC)	6.6	26.0	3.5	11.5	6.0	11.5	22.6	311	70.6	16.4	18.7	7.2	5.1	5.2	4.1	9.0	3.6	3.4
Σ PAHs	(ng/mg OC)	140	2840	194	11	12	53	44	194	147	1210	106	184	141	104	78	571	141	104

MCL = McAllister Point; NSB = near shore biota; OC = organic carbon;

Σ PCBs = Sum of Polychlorinated Biphenyls; Σ PAHs = Sum of Polycyclic Aromatic Hydrocarbons.

Table 3. Concentration of organic contaminants (per g dry weight sediment or mg OC) core sediments from the Phase III McAllister Point Study Area.

	Site	NSB -2	NSB -3	NSB -4	NSB -5	NSB -6	MCL -10	MCL -12
	depth cm	0-18	0-18	0-18	0-18	0-18	0-18	0-18
Contaminant	(units)							
Σ PCBs	(ng/g)	1040	196	3270	566	398	177	390
Σ PAHs	(ng/g)	4090	3130	24000	3710	10500	2160	11800
Organic Carbon	(mg/g)	11	16	65	29	16	20	22
Contaminant/ Organic Carbon	(units)							
Σ PCBs	(ng/mg OC)	94.6	12.3	50.3	19.5	24.9	8.9	17.7
Σ PAHs	(ng/mg OC)	372	196	369	128	656	108	536

MCL = McAllister Point; NSB = near shore biota; OC = organic carbon;

Σ PCBs = Sum of Polychlorinated Biphenyls;

Σ PAHs = Sum of Polycyclic Aromatic Hydrocarbons.



Brown & Root Environmental

INTERNAL CORRESPONDENCE

C-52-11-6-3368W

Date: November 25, 1996

To: Stephen Parker

From: Maureen Parker *MP*

Subject: Tier II Data Validation, Proj No. 4725
 University of Rhode Island Laboratory
 McAllister Point Landfill - Phase III

PAH & PCB: 18 soils/ MCL-8-R, MCL-9-R, MCL-10-R, MCL-11-R, MCL-12-R, M1-R,
 MCL-13-R, MCL-14-R, S2B-R, S2B-R-FD, NSB-1-R, NSB-1-R,
 NSB-2-R, NSB-3-R, NSB-4-R, NSB-5-R, NSB-7-R,
 NSB-2-R-FD, NSB-8-R

A tier II data validation was performed on the Polycyclic Aromatic Hydrocarbons (PAH) and Polychlorinated Biphenyls (PCB) results for the above-listed samples. The data was evaluated based on laboratory blank results; matrix spike recoveries; laboratory duplicate precision; internal standard recoveries and NIST standard reference material analysis.

BLANKS

The contaminants found in associated laboratory blanks are summarized below:

<u>Compound</u>	<u>Maximum Concentration</u>	<u>Action Level</u>
2,4'-dichlorobiphenyl	1.2 ng	6.0 ng
2,2',4,6-tetrachlorobiphenyl	0.6 ng	3.0 ng
2,4,4'-trichlorobiphenyl	0.9 ng	4.5 ng
2,2',5,5'-tertachlorobiphenyl	0.9 ng	4.5 ng
2,2',4,6,6'-pentachlorobiphenyl	3.2 ng	16.0 ng
2,2',4,5,5'-pentachlorobiphenyl	1.8 ng	9.0 ng
3,3',4,4'-tetrachlorobiphenyl and		
2,2'4,4',5,6'-hexachlorobiphenyl	3.8 ng	19.0 ng
2,2',4,4',5,5'-hexachlorobiphenyl	0.7 ng	3.5 ng
2,2',3,4,4',5'-hexachlorobiphenyl	2.0 ng	10.0 ng
3,3',4,4',5-pentachlorobiphenyl	0.5 ng	2.5 ng
2,2',3,4',5,5',6-heptachlorobiphenyl	0.9 ng	4.5 ng
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl	1.2 ng	6.0 ng
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl	0.7 ng	3.5 ng
sum of the 27 chlorobiphenyls	16.0 ng	80.0 ng
sum of CBs x 2.0	33.0 ng	165 ng
acenaphthene	6.0 ng	30.0 ng
anthracene	9.9 ng	49.5 ng
perylene	3.6 ng	18.0 ng
sum PAHs (23 NS&T)	53.0 ng	265 ng
sum PAHs (7LMW)	22.0 ng	110 ng
sum PAHs (6HMW)	22.0 ng	110 ng

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November 25, 1996
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Blank actions are taken for 2,4'-dichlorobiphenyl; 2,4,4'-trichlorobiphenyl; 2,2',4,6,6'-pentachlorobiphenyl; 3,3',4,4'-tetrachlorobiphenyl and 2,2',4,4',5,6'-hexachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl; 2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl; acenaphthene and anthracene in affected samples.

Blank Actions:

- Value < CRQL; report CRQL followed by a U.
- Value > CRQL and < action level; report value followed by a U.
- Value > CRQL and > action level; report value unqualified.

MATRIX SPIKE RECOVERIES

The PAH matrix spike (MS) sample was lost in the extraction process therefore the PAH samples are not qualified for this parameter.

LABORATORY DUPLICATE RESULTS

The Relative Percent Differences (RPDs) for 2,3,3',4,4'-pentachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl; acenaphthene; phenanthrene; fluoranthene and sum of PAHs (7LMW) were above the 35% laboratory quality control limit. The positive results for these analytes were qualified as estimated, (J).

FIELD DUPLICATE PRECISION

The field duplicate sample results were not used for validation purposes since they were co-located samples instead of split samples.

NIST STANDARD REFERENCE MATERIAL RESULTS

The PCB NIST Standard Reference Material (SRM) results for 2,4'-dichlorobiphenyl; 2,2',5-trichlorobiphenyl; 2,2',3,3',4,4'-hexachlorobiphenyl; 2,2',3,4,4',5,5'-heptachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl were above the +/- 30% quality control range. The positive results for these analytes are qualified as estimated, (J); they could be biased high.

The PAH NIST Standard Reference Material (SRM) results for naphthalene; biphenyl; fluorene; 1-methylphenanthrene; indeno[1,2,3-cd]pyrene; benzo[g,h,i]perylene were below the +/- 30% quality control range. The positive results for these analytes are qualified as estimated, (J); they could be biased low.

OVERALL ASSESSMENT

The data should be used as qualified. Blank actions are taken for 2,4'-dichlorobiphenyl; 2,4,4'-trichlorobiphenyl; 2,2',4,6,6'-pentachlorobiphenyl; 3,3',4,4'-tetrachlorobiphenyl and 2,2',4,4',5,6'-hexachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl; 2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl; acenaphthene and anthracene in affected samples. The positive results for 2,3,3',4,4'-pentachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl; acenaphthene; phenanthrene; fluoranthene and sum of PAHs (7LMW) were estimated due to poor lab duplicate precision. The positive results for 2,4'-dichlorobiphenyl; 2,2',5-trichlorobiphenyl; 2,2',3,3',4,4'-hexachlorobiphenyl; 2,2',3,4,4',5,5'-heptachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl; naphthalene; biphenyl; fluorene; 1-methylphenanthrene; indeno[1,2,3-cd]pyrene; benzo[g,h,i]perylene were estimated due to poor NIST SRM recoveries.

Memo to Stephen Parker
November 25, 1996
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NOTE: Several analytes in several samples are qualified as estimated, (J) due to laboratory reported analytical interference with the analyte. They include 2,2',3,4,5'-pentachlorobiphenyl, 2,3',4,4'-tetrachlorobiphenyl; 3,3',4,4'-tetrachlorobiphenyl and 2,2',4,4',5,6'-hexachlorobiphenyl; 2,2',4,4',5,5'-hexachlorobiphenyl; 2,3,3',4,4'-pentachlorobiphenyl; 2,2',3,3',4,4',5-heptachlorobiphenyl; 2,2',3,3',4,4',5,6-octachlorobiphenyl; 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl.

Attachments

cc: File 4725 - 4.10

USN SEDIMENT McAllister Point (phase 3) - PAHs

Chain of Custody	depth cm	MDL	MCL-8-R 0-2	MCL-9-R 0-2	MCL-10-R 0-2	MCL-11-R 0-2	MCL-12-R 0-2	M1-R 0-2	MCL-13-R 0-2	MCL-14-R 0-2
OGL Lab ID		MP199	MP200	MP201	MP202	MP203	MP205	MP206	MP207	
PAHs	units									
* Naphthalene	ng/g	3.6	10.8 J	14.8 J	12.5 J	5.5 J	93.5 J	12.6 J	8.3 J	9.6 J
* 2-Methylnaphthalene	ng/g	3.6	9.2	10.0	10.2	5.0	52.0	9.6	5.1	5.5
1-Methylnaphthalene	ng/g	7.1	6.0 J	8.1	6.5 J	2.9 J	43.5	6.6 J	3.7 J	4.1 J
Biphenyl	ng/g	6.4	5.0 J	4.4 J	5.4 J	2.7 J	24.4 J	4.8 J	2.9 J	3.2 J
2,6-Dimethylnaphthalene	ng/g	8.6	18.8	21.8	28.6	15.2	49.9	11.2	6.6 J	7.1 J
* Acenaphthylene	ng/g	8.2	12.7	10.0	9.9	5.3 J	15.6	5.4 J	5.7 J	6.5 J
* Acenaphthene	ng/g	5.6	22.6 J	31.9 J	22.6 J	6.5 J	254 J	21.9 J	10.9 J	10.7 J
2,3,5-Trimethylnaphthalene	ng/g	4.8	1.6 J	1.4 J	1.7 J	0.6 J	11.7	1.5 J	0.9 J	0.7 J
* Fluorene	ng/g	7.0	27.5 J	35.3 J	23.4 J	7.9 J	305 J	29.4 J	11.8 J	12.7 J
* Phenanthrene	ng/g	10.0	240 J	294 J	229 J	77.5 J	1660 J	260 J	125 J	127 J
* Anthracene	ng/g	8.4	70.9	86.3	64.9	26.5	536	71.3	35.9	37.1
1-Methylphenanthrene	ng/g	6.2	18.2 J	15.0 J	18.5 J	7.8 J	95.7 J	18.1 J	8.1 J	10.5 J
† Fluoranthene	ng/g	9.2	350 J	402 J	413 J	160 J	2070 J	382 J	203 J	212 J
† Pyrene	ng/g	7.6	326	349	4.6 J	148	1730	326	193	200
† Benzo(a)anthracene	ng/g	7.7	182	201	222	82.9	1120	167	106	104
† Chrysene	ng/g	9.9	159	158	197	77.1	856	155	89.4	102
Benzo(b),(k)fluoranthene	ng/g	8.8	294	298	352	146	1200	262	173	188
Benzo(e)pyrene	ng/g	6.0	110	109	133	58.9	419	97.1	69.4	73.0
† Benzo(a)pyrene	ng/g	3.0	139	145	169	66.5	646	119	84.7	89.8
Perylene	ng/g	2.7	37.9	38.1	45.0	19.4	161	31.3	24.0	26.0
Indeno[1,2,3-cd]pyrene	ng/g	4.7	71.3 J	72.6 J	88.8 J	38.2 J	292 J	57.9 J	46.1 J	50.2 J
† Dibenzo[a,h]anthracene	ng/g	2.8	21.8	22.6	31.6	12.4	112	19.8	14.3	15.3
Benzo[g,h,i]perylene	ng/g	4.7	75.2 J	72.3 J	93.6 J	41.2 J	268 J	55.8 J	45.5 J	52.1 J
Sum PAHs (23NS&T)	ng/g		2210	2400	2180	1020	12000	2130	1270	1350
Sum PAHs *(7 LMW)	ng/g		394 J	483 J	373 J	134 J	2910 J	410 J	203 J	209 J
Sum PAHs †(6 HMW)	ng/g		1180	1280	1040	548	6530	1170	690	722

USN SEDIMENT McAllister Point (phase 3) - PAHs

Chain of Custody depth cm		MDL	S2B-R 0-2	S2B- R-FD 0-2	NSB-1-R 0-6	NSB-2-R 0-6	NSB-3-R 0-6	NSB-7-R 0-6	NSB-2-R-FD 0-6
OGL Lab ID			MP208	MP209	MP212	MP213	MP214	MP219	MP220
PAHs	units								
* Naphthalene	ng/g	3.6	4.8 J	301 J	1.4 J	9.3 J	20.4 J	20.1 J	4.9 J
* 2-Methylnaphthalene	ng/g	3.6	4.9	130	2.1 J	8.0	17.4	14.6	2.5 J
1-Methylnaphthalene	ng/g	7.1	4.1 J	96.9	1.4 J	6.0 J	11.9	8.8	2.6 J
Biphenyl	ng/g	6.4	2.7 J	45.0 J	0.7 J	5.2 J	11.2 J	11.0 J	<6.4 nd
2,6-Dimethylnaphthalene	ng/g	8.6	6.6 J	71.0	1.5 J	6.1 J	15.5	11.2	<8.6 nd
* Acenaphthylene	ng/g	8.2	3.6 J	16.7	0.3 J	0.6 J	1.5 J	12.1	1.4 J
* Acenaphthene	ng/g	5.6	11.2 J	455 J	0.7 UJ	3.1 J	14.0 J	11.7 J	5.8 J
2,3,5-Trimetylnaphthalene	ng/g	4.8	1.3 J	11.1	0.6 J	1.4 J	4.7 J	3.1 J	1.8 J
* Fluorene	ng/g	7.0	15.5 J	561 J	0.8 J	3.2 J	18.7 J	14.2 J	4.7 J
* Phenanthrene	ng/g	10.0	131 J	3490 J	5.7 J	25.7 J	86.6 J	152 J	66.9 J
* Anthracene	ng/g	8.4	35.7	1030	1.3 UJ	6.5 J	15.6	38.8	16.5
1-Methylphenanthrene	ng/g	6.2	11.7 J	127 J	1.6 J	4.2 J	8.9 J	19.0 J	7.1 J
† Fluoranthene	ng/g	9.2	213 J	3600 J	13.2 J	33.6 J	71.5 J	313 J	114 J
† Pyrene	ng/g	7.6	206	2850	16.9	33.4	59.9	288	105
† Benzo(a)anthracene	ng/g	7.7	102	1560	7.5 J	15.7	20.0	168	50.9
† Chrysene	ng/g	9.9	91.4	1200	9.6 J	14.7	24.5	156	45.9
Benzo(b),(k)fluoranthene	ng/g	8.8	157	1800	16.0	28.7	28.0	250	57.6
Benzo(e)pyrene	ng/g	6.0	59.6	569	9.6	16.7	14.1	102	25.1
† Benzo(a)pyrene	ng/g	3.0	86.0	932	6.9	13.3	11.5	120	29.2
Perylene	ng/g	2.7	20.6	214	2.1 J	5.1	4.0	29	8.9
Indeno[1,2,3-cd]pyrene	ng/g	4.7	39.8 J	355 J	4.5 J	8.2 J	6.8 J	66.7 J	14.2 J
† Dibenzo[a,h]anthracene	ng/g	2.8	13.2	137	2.0 J	3.6	3.5	23.4	6.5
Benzo[g,h,i]perylene	ng/g	4.7	38.8 J	312 J	6.7 J	11.7 J	9.8 J	77.8 J	16.6 J
Sum PAHs (23NS&T)	ng/g		1260	19900	113	264	480	1910	587
Sum PAHs *(7 LMW)	ng/g		207 J	5980 J	12.3 J	56.3 J	174 J	264 J	103 J
Sum PAHs †(6 HMW)	ng/g		711	10300	56.1	114	191	1070	351

USN SEDIMENT McAllister Point (phase 3) - PAHs

Chain of Custody depth cm		MDI.	NSB- 6-R	NSB-4-R	NSB-5-R
OGL Lab ID			0-6	0-6	0-6
			MP226	MP227	MP228
PAHs	units				
* Naphthalene	ng/g	3.6	283 J	249 J	40.4 J
* 2-Methylnaphthalene	ng/g	3.6	127	257	40.9
1-Methylnaphthalene	ng/g	7.1	91.3	298	18.0
Biphenyl	ng/g	6.4	38.5 J	128 J	12.7 J
2,6-Dimethylnaphthalene	ng/g	8.6	42.9	337	16.4
* Acenaphthylene	ng/g	8.2	23.3	18.4	23.1
* Acenaphthene	ng/g	5.6	293 J	56.7 J	10.5 J
2,3,5-Trimethylnaphthalene	ng/g	4.8	10.6	77.9	4.7 J
* Fluorene	ng/g	7.0	389 J	120 J	16.4 J
* Phenanthrene	ng/g	10.0	2510 J	369 J	200 J
* Anthracene	ng/g	8.4	733	80.7	70.0
1-Methylphenanthrene	ng/g	6.2	107 J	74.0 J	29.4 J
† Fluoranthene	ng/g	9.2	3780 J	311 J	403 J
† Pyrene	ng/g	7.6	2440	282	380
† Benzo(a)anthracene	ng/g	7.7	1460	123	260
† Chrysene	ng/g	9.9	1180	111	194
Benzo(b),(k)fluoranthene	ng/g	8.8	1730	230	277
Benzo(e)pyrene	ng/g	6.0	580	92.0	129
† Benzo(a)pyrene	ng/g	3.0	909	126	124
Perylene	ng/g	2.7	233	21.8	34.5
Indeno[1,2,3-cd]pyrene	ng/g	4.7	482 J	48.6 J	80.2 J
† Dibenzo[a,h]anthracene	ng/g	2.8	156	19.5	31.3
Benzo[g,h,i]perylene	ng/g	4.7	457 J	57.5 J	108 J
Sum PAHs (23NS&T)	ng/g		18100	3490	2500
Sum PAHs *(7 LMW)	ng/g		4360 J	1150 J	401 J
Sum PAHs †(6 HMW)	ng/g		9920	972	1390

USN SEDIMENT McAllister Point (phase3) -PCBs

Chain of Custody depth cm	MDL	MCL-8-R 0-2	MCL-9-R 0-2	MCL-10-R 0-2	MCL-11-R 0-2	MCL-12-R 0-2	M1-R 0-2	MCL-13-R 0-2	
OGL Lab ID		MP199	MP200	MP201	MP202	MP203	MP205	MP206	
PCBs	units								
2,4'-Dichlorobiphenyl	ng/g	0.32	0.5 UJ	0.4 UJ	0.8 J	0.3 UJ	1.5 J	0.7 J	0.6 J
2,2'5-Trichlorobiphenyl	ng/g	0.69	0.3 J	0.3 J	0.6 J	0.3 J	1.8 J	0.3 J	0.2 J
2,4,5-Trichlorobiphenyl	ng/g	0.67	0.1 J	<0.7 nd	0.1 J	<0.7 nd	0.1 J	0.1 J	0.1 J
2,2',4,6-Tetrachlorobiphenyl	ng/g	0.45	0.6	0.6	1.0	0.5	3.0	0.5	0.3 J
2,4,4'-Trichlorobiphenyl	ng/g	0.72	0.9	0.9	1.5	0.8	4.2	0.8	0.6 J
2,2',5,5'-Tetrachlorobiphenyl	ng/g	0.73	1.1	1.0	1.7	0.6 J	4.2	0.8	0.5 J
2,2',4,6,6'-Pentachlorobiphenyl	ng/g	0.58	0.4 UJ	0.3 UJ	0.5 UJ	0.3 UJ	1.0 U	0.3 UJ	0.3 UJ
2,2',3,5-Tetrachlorobiphenyl	ng/g	0.49	0.6	0.7	1.1	0.4 J	2.8	0.5	0.2 J
2,3',4,4'-Tetrachlorobiphenyl	ng/g	0.53	1.0 J	1.0 J	1.2 J	0.7 J	2.7 J	0.5 J	0.4 J
2,2',4,5,5'-Pentachlorobiphenyl	ng/g	0.59	2.7	2.4	3.4	1.5	6.7	1.2	1.0
2,2',3,4,5'-Pentachlorobiphenyl	ng/g	0.55	0.8	0.8	1.3	0.7	3.3	0.5 J	0.3 J
3,3',4,4'-Tetrachlorobiphenyl/ o,p'-DDE and 2,2,4,4',5,6'-Hexachlorobiphenyl	ng/g	1.05	3.5 J	3.6 J	5.2 J	2.5 J	11.5 J	2.0 J	1.2 UJ
2,3',4,4',5-Pentachlorobiphenyl	ng/g	0.71	2.4	2.5	3.3	1.6	6.8	1.2	1.0
2,2',3,4',5,6,6'-Heptachlorobiphenyl	ng/g	0.57	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd
2,2',4,4',5,5'-Hexachlorobiphenyl	ng/g	0.44	6.1	5.1	6.0	3.1	8.1	2.1	2.2
2,3,3',4,4'-Pentachlorobiphenyl	ng/g	0.56	0.9 J	1.1 J	1.5 J	0.7 J	4.0 J	0.4 J	0.2 J
2,2',3,4,4',5'-Hexachlorobiphenyl	ng/g	0.58	6.4	5.8	7.0	3.7	11.3	2.5	2.4
3,3',4,4',5-Pentachlorobiphenyl	ng/g	0.48	<0.5 nd	<0.5 nd	<0.5 nd	<0.5 nd	<0.5 nd	<0.5 nd	<0.5 nd
2,2',3,4',5,5',6-Heptachlorobiphenyl	ng/g	0.47	3.0	2.4	2.8	1.4	3.3	0.9	1.0
2,2',3,3',4,4'-Hexachlorobiphenyl	ng/g	0.44	0.9 J	1.2 J	1.3 J	0.6 J	2.0 J	0.4 J	0.3 J
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	ng/g	0.51	0.4 J	0.6	0.6	0.2 J	0.6	0.2 J	0.1 J
2,2',3,4,4',5,5'-Heptachlorobiphenyl	ng/g	0.53	4.5 J	3.8 J	4.5 J	2.2 J	5.4 J	1.3 J	1.4 J
2,2',3,3',4,4',5-Heptachlorobiphenyl	ng/g	0.53	2.3 J	2.3 J	2.3 J	1.1 J	2.9 J	0.6 J	0.6 J
2,2',3,3',4,4',5,6-Octachlorobiphenyl	ng/g	0.57	0.6 J	0.6 J	0.5 J	0.3 J	0.5 J	0.1 J	0.1 J
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	ng/g	0.51	1.8 J	4.2 J	4.4 J	2.1 J	5.9 J	0.6 J	0.6 J
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	ng/g	0.52	1.3	1.8	2.3	1.1	1.3	0.9	0.7
sum of the 27 chlorobiphenyls	ng/g		43	43	55	27	95	19	16
sum of the 27 chlorobiphenyls x 2.0	ng/g		87	87	110	54	190	39	33

USN SEDIMENT McAllister Point (phase3) -PCBs

Chain of Custody depth cm		MDL	MCL-14-R 0-2	S2B-R 0-2	S2B-R-FD 0-2	NSB-1-R 0-6	NSB-2-R 0-6	NSB-3-R 0-6	NSB-7-R 0-6
OGL Lab ID			MP207	MP208	MP209	MP212	MP213	MP214	MP219
PCBs	units								
2,4'-Dichlorobiphenyl	ng/g	0.32	0.5 UJ	1.2 J	1.7 J	0.3 UJ	1.0 J	9.8 J	4.1 J
2,2',5'-Trichlorobiphenyl	ng/g	0.69	0.2 J	0.6 J	1.7 J	0.2 J	1.3 J	13.1 J	7.7 J
2,4,5'-Trichlorobiphenyl	ng/g	0.67	0.1 J	<0.7 nd	0.2 J	0.1 J	0.1 J	0.2	0.2 J
2,2',4,6'-Tetrachlorobiphenyl	ng/g	0.45	0.3 J	0.6	2.9	0.3 J	1.3	9.7	9.5
2,4,4'-Trichlorobiphenyl	ng/g	0.72	0.5 J	1.0	4.6	0.3 UJ	1.6	11.2	11.9
2,2',5,5'-Tetrachlorobiphenyl	ng/g	0.73	0.5 J	1.2	4.1	1.2	6.6	11.0	9.9
2,2',4,6,6'-Pentachlorobiphenyl	ng/g	0.58	0.3 UJ	0.6 U	2.4	<0.6 nd	<0.6 nd	0.6 U	0.7 U
2,2',3,5'-Tetrachlorobiphenyl	ng/g	0.49	0.3 J	0.6	3.0	0.5 J	2.9	7.3	7.9
2,3',4,4'-Tetrachlorobiphenyl	ng/g	0.53	0.6 J	0.8 J	2.5 J	0.3 J	2.7 J	3.7 J	4.6 J
2,2',4,5,5'-Pentachlorobiphenyl	ng/g	0.59	1.2	2.3	6.4	1.5	7.5	8.9	12.8
2,2',3,4,5'-Pentachlorobiphenyl	ng/g	0.55	0.4 J	1.1	3.0	0.8	4.4	5.2	8.1
3,3',4,4'-Tetrachlorobiphenyl/ o,p'-DDD and	ng/g	1.05	1.6 J	3.6 J	10.8 J	2.4	12.5	14.4	23.8
2,2,4,4',5,6'-Hexachlorobiphenyl									
2,3',4,4',5'-Pentachlorobiphenyl	ng/g	0.71	1.1	2.4	6.4	1.0	5.7	6.7	11.1
2,2',3,4',5,6,6'-Heptachlorobiphenyl	ng/g	0.57	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd	<0.6 nd
2,2',4,4',5,5'-Hexachlorobiphenyl	ng/g	0.44	3.2	3.5	7.4	41.0 J	3.9	4.7	9.7
2,3,3',4,4'-Pentachlorobiphenyl	ng/g	0.56	0.3 J	1.2 J	3.3 J	0.5 J	2.7 J	3.4 J	7.1 J
2,2',3,4,4',5'-Hexachlorobiphenyl	ng/g	0.58	3.4	3.6	10.8	1.8	5.6	6.7	15.3
3,3',4,4',5'-Pentachlorobiphenyl	ng/g	0.48	<0.5 nd	<0.5 nd	<0.5 nd	0.3 J	0.6	0.8	<0.5 nd
2,2',3,4',5,5',6'-Heptachlorobiphenyl	ng/g	0.47	1.6	0.7	3.4	0.9	0.8	1.1	3.4
2,2',3,3',4,4'-Hexachlorobiphenyl	ng/g	0.44	0.4 J	0.8 J	2.0 J	0.3 J	1.4 J	1.6 J	4.0 J
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	ng/g	0.51	0.2 J	0.2 J	0.8	0.1 J	0.2 J	0.3 J	1.0
2,2',3,4,4',5,5'-Heptachlorobiphenyl	ng/g	0.53	2.6 J	1.0 J	5.0 J	2.1 J	1.5 J	1.9 J	4.6 J
2,2',3,3',4,4',5'-Heptachlorobiphenyl	ng/g	0.53	1.2 J	0.5 J	2.6 J	0.8 J	0.7 J	1.1 J	2.5 J
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	ng/g	0.57	0.3 J	0.1 J	0.5 J	0.3 J	0.1 J	0.2 J	0.5 J
2,2',3,3',4,4',5,5',6'-Nonachlorobiphenyl	ng/g	0.51	1.0 J	1.6 J	3.8 J	0.2 UJ	0.2 UJ	0.5 J	4.5 J
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	ng/g	0.52	0.8	0.5 J	1.8	0.1 UJ	0.1 UJ	0.2 UJ	3.7
sum of the 27 chlorobiphenyls	ng/g		22	30	91	57	66	124	169
sum of the 27 chlorobiphenyls x 2.0	ng/g		45	59	182	115	131	248	337

USN SEDIMENT McAllister Point (phase3) -PCBs

Chain of Custody depth cm		MDL	NSB-2-R-FD 0-6	NSB-6-R 0-6	NSB-4-R 0-6	NSB-5-R 0-6
OGL Lab ID			MP220	MP226	MP227	MP228
PCBs	units					
2,4'-Dichlorobiphenyl	ng/g	0.32	0.9 J	2.0 J	149 J	4.0 J
2,2'5-Trichlorobiphenyl	ng/g	0.69	1.4 J	2.6 J	94.7 J	5.1 J
2,4,5-Trichlorobiphenyl	ng/g	0.67	0.1 J	0.1 J	2.3	0.2 J
2,2',4,6-Tetrachlorobiphenyl	ng/g	0.45	1.2	3.5	96.0	6.0
2,4,4'-Trichlorobiphenyl	ng/g	0.72	1.5	4.1	109	7.3
2,2',5,5'-Tetrachlorobiphenyl	ng/g	0.73	5.1	7.6	164	12.9
2,2',4,6,6'-Pentachlorobiphenyl	ng/g	0.58	0.6 U	1.2 U	4.9	1.8 U
2,2',3,5-Tetrachlorobiphenyl	ng/g	0.49	2.4	5.1	116	9.1
2,3',4,4'-Tetrachlorobiphenyl	ng/g	0.53	1.8 J	3.7 J	66.0 J	6.4 J
2,2',4,5,5'-Pentachlorobiphenyl	ng/g	0.59	6.9	10.8	240	19.0
2,2',3,4,5'-Pentachlorobiphenyl	ng/g	0.55	3.9	5.7	186 J	11.3
3,3',4,4'-Tetrachlorobiphenyl/ o,p'-DDD and 2,2,4,4',5,6'-Hexachlorobiphenyl	ng/g	1.05	11.1	19.6	410	32.5
2,3',4,4',5-Pentachlorobiphenyl	ng/g	0.71	5.7	10.1	235	16.2
2,2',3,4',5,6'-Heptachlorobiphenyl	ng/g	0.57	<0.6 nd	<0.6 nd	<0.6 nd	2.5
2,2',4,4',5,5'-Hexachlorobiphenyl	ng/g	0.44	3.9	8.5	154	13.5
2,3,3',4,4'-Pentachlorobiphenyl	ng/g	0.56	3.1 J	5.7 J	167 J	8.7 J
2,2',3,4,4',5'-Hexachlorobiphenyl	ng/g	0.58	6.1	13.5	267	19.4
3,3',4,4',5-Pentachlorobiphenyl	ng/g	0.48	<0.5 nd	<0.5 nd	<0.5 nd	<0.5 nd
2,2',3,4',5,5',6-Heptachlorobiphenyl	ng/g	0.47	0.6	3.4	32.3	32.6
2,2',3,3',4,4'-Hexachlorobiphenyl	ng/g	0.44	1.5 J	3.1 J	88.8 J	4.7 J
2,2',3,3',4,5,6,6'-Octachlorobiphenyl	ng/g	0.51	0.3 J	0.9	18.1	13.4
2,2',3,4,4',5,5'-Heptachlorobiphenyl	ng/g	0.53	1.3 J	4.8 J	55.2 J	22.3 J
2,2',3,3',4,4',5-Heptachlorobiphenyl	ng/g	0.53	1.7 J	2.1 J	37.1 J	3.2 J
2,2',3,3',4,4',5,6-Octachlorobiphenyl	ng/g	0.57	0.2 J	0.3 J	<0.6 nd	<0.6 nd
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	ng/g	0.51	1.4 J	3.9 J	82.5 J	275 J
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	ng/g	0.52	0.6	1.3	21.8	73.9
sum of the 27 chlorobiphenyls	ng/g		63	123	2800	601
sum of the 27 chlorobiphenyls x 2.0	ng/g		127	246	5600	1200

REGION I
Data Review Worksheets

Site Name McAllister Point
Reference Number C-SD-11-6-3368W

REGION I REVIEW OF ORGANIC
CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) URI data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

Case No. 4725 SAS No. _____ Sampling Date(s) _____
SDG No. _____ Matrix SOIL Shipping Date(s) _____
No. of Samples 18 Date Rec'd by Lab _____

Traffic Report Nos: see holding times

Trip Blank No.: _____
Equipment Blank No.: _____
Field Dup Nos: _____

SOW No. _____ requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-LV, and SMO. The general criteria used to determine the performance were based on an examination of:

- Data Completeness
- Holding Times
- GC/MS Tuning
- Calibrations
- Blanks
- Surrogate Recoveries
- Matrix Spike/Matrix Spike Dup
- Field Duplicates
- Internal Standard Performance
- Pesticide Inst. Performance
- Compound Identification
- Compound Quantitation

Overall comments TIER II Data validation

Definitions and Qualifiers:

- A - Acceptable data.
- J - Approximate data due to quality control criteria.
- R - Reject data due to quality control criteria.
- U - Compound not detected.

Reviewer: Maurice Poirer Date: Nov 1996

Tron
so greater extraction date

**REGION I
 Data Review Worksheets**

II. HOLDING TIMES Complete table for all samples and circle the fractions which are not within criteria.

SAMPLE ID	DATE SAMPLED	VOA DATE ANAL	PAH		PEST	
			DATE EXTR	DATE ANAL	DATE EXTR	DATE ANAL
MCL-8-R	9/12/96		9/13/96	9/19/96	9/13/96	9/19/96
MCL-9-R	9/12/96		9/13/96	9/20/96	9/13/96	9/20/96
MCL-10-R	9/12/96		9/13/96	9/19/96	9/13/96	9/20/96
MCL-11-R	9/12/96		9/13/96	9/19/96	9/13/96	9/20/96
MCL-12-R	9/10/96		9/13/96	9/19/96	9/13/96	9/20/96
M1-R	9/10/96		⑩ 9/20/96	9/30/96	9/20/96	9/27/96
MCL-13-R	9/12/96		⑧ 9/20/96	9/30/96	9/20/96	9/27/96
MCL-14-R	9/10/96		⑩ 9/20/96	9/30/96	9/20/96	9/27/96
S2B-R	9/10/96		⑩ 9/20/96	9/30/96	9/20/96	9/27/96
S2B-R-FP	9/10/96		⑩ 9/20/96	9/30/96	9/20/96	9/27/96
NSB-1-R	9/20/96		① 9/27/96	10/03/96	9/27/96	10/09/96
NSB-2-R	9/20/96		③ 9/27/96	10/03/96	9/27/96	10/09/96
NSB-3-R	9/20/96		① 9/27/96	10/03/96	9/27/96	10/10/96
NSB-7-R	9/18/96		⑩ 10/04/96	10/09/96	10/04/96	10/11/96
NSB-2-R-FP	9/20/96		⑩ 10/04/96	11/20/96	10/04/96	11/27/96

VOA - Unpreserved: Aromatic within 7 days, non-aromatic within 14 days of sample collection.
 Preserved : Both within 14 days of sample collection.
 Soils : Both within 14 days of sample collection.

BNA & PEST - Extracted within 7 days, analyzed within 40 days, soils and water.

- ACTION:**
1. If holding times are exceeded all positive results are estimate (J) and non-detects are estimated (UJ).
 2. If holding times are grossly exceeded, the reviewer may determine that non-detects are unusable(*).

REGION I
Data Review Worksheets

II. HOLDING TIMES

Complete table for all samples and circle the fractions which are not within criteria.

PAH

PCB

SAMPLE ID	DATE SAMPLED	VOA DATE ANAL	BNA		PEST	
			DATE EXTR	DATE ANAL	DATE EXTR	DATE ANAL
NSB-7-R						
NSB-4-R-PD						
NSB-6-R	9/20/96		(J) 9/16/96	10/21/96	10/16/96	10/21/96
NSB-4-R	9/18/96		(J) 10/16/96	10/21/96	10/16/96	10/22/96
NSB-5-R	9/18/96		(J) 10/14/96	10/21/96	10/14/96	10/22/96

VOA - Unpreserved: Aromatic within 7 days, non-aromatic within 14 days of sample collection.
 Preserved : Both within 14 days of sample collection.
 Soils : Both within 14 days of sample collection.

BNA & PEST - Extracted within 7 days, analyzed within 40 days, soils and water.

- ACTION:
1. If holding times are exceeded all positive results are estimate (J) and non-detects are estimated (UJ).
 2. If holding times are grossly exceeded, the reviewer may determine that non-detects are unusable(*).

REGION I
Data Review Worksheet

PCBS

V A. BLANK ANALYSIS RESULTS (Sections 1 & 2)

List the contamination in the blanks below.

1. Laboratory Blanks

Level: _____

DATE	LAB ID	FRACTION/ MATRIX	COMPOUND	CONCENTRATION/ UNITS	mg
		PCB	CB008 2,4-dichlorobiphenyl	1.2 mg X5	6
			CB050	0.6 mg	3
			CB028	0.9 mg	4.5
			CB052	0.9 mg	4.5
			CB104	3.2 mg	16
			CB101	1.2	9
			CB 77/154 1,0, P'-DPP	3.8	19
			CB153	0.7	3.5
			CB138	2.0	10
			CB126	0.5	2.5
			CB187	0.9	4.5
			CB206	1.2	6

2. Equipment and Trip Blanks

DATE	TR #	FRACTION/ MATRIX	COMPOUND	CONCENTRATION/ UNITS	mg
			CB209	0.7	3.5
			Σ PCBs	16	80
		VI	Σ PCBs	33	165

A separate worksheet should be used for low and medium level blanks.

is blank
2,4-dichlorobiphenyl

REGION I
Data Review Worksheet

PAHs

V A. BLANK ANALYSIS RESULTS (Sections 1 & 2)

List the contamination in the blanks below.

1. Laboratory Blanks

Level: soil

DATE	LAB ID	FRACTION/ MATRIX	COMPOUND	CONCENTRATION/ UNITS
		PAH	ACT	6.0 x 5 = 30
		PAH	ANT	9.9 x 5 = 49.5
		PAH	PER	3.6 x 5 = 18
			Sum PAHs (23 NS+T)	53 x 5 = 265
			Sum PAHs (7 Lmw)	22 x 5 = 110
		∇	Sum PAHs (4 Hmw)	22 x 5 = 110

2. Equipment and Trip Blanks

DATE	TR #	FRACTION/ MATRIX	COMPOUND	CONCENTRATION/ UNITS

A separate worksheet should be used for low and medium level blanks.

No qualifications
all 7 5x BLANK
cont.

REGION I
Data Review Worksheets

PCB
all met. criteria
No PAH -
fraction lost

VII B. MATRIX SPIKE/MATRIX SPIKE DUPLICATE (Section 2)

3. Matrix Spike Duplicate - Unspiked Compounds

TR Nos. MCL-11-R spike, MCL-11-R

List the concentrations of the unspiked compounds and determine the percent RSD's of the unspiked sample, matrix spike, and matrix spike duplicate. No limits have been developed for the RSD values of the unspiked compounds. .

<u>FRACTION</u>	<u>COMPOUND</u>	<u>SAMPLE, MS, MSD CONC</u>	<u>%RSD</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

The reviewer must use professional judgement to determine if there is a need to qualify any of the unspiked compounds in the sample.

REGION I
Data Review Worksheets

*Samples were collocated
not split samples therefore
they cannot be used as
comparative field dups.*

VIII. FIELD DUPLICATE PRECISION

TR Nos. S20-R , S2B-R-FD

Matrix: _____

List the concentrations of the compounds which do not meet the following RPD criteria:

1. An RPD of <30% for water duplicates.
2. An RPD of <50% for soil duplicates.

<u>FRACTION</u>	<u>COMPOUND</u>	<u>SAMPLE CONC</u>	<u>DUP SAMPLE CONC</u>	<u>RPD</u>
<u>PAH</u>	<u>Naphthalene</u>	<u>4.8</u>	<u>301</u>	
	<u>2-methylnaphthalene</u>	<u>4.9</u>	<u>130</u>	

ACTIONS: -

1. If the results for any compounds do not meet the RPD criteria, flag the positive results for that compound as estimated.
2. If one value is non-detected, and one is above the CRQL:
 - a. Flag the positive result as estimated (J).
 - b. Flag the non-detected result as estimated (UJ).

NOTE: Professional judgement may be utilized to apply duplicate actions to all samples of a similar matrix.

A separate worksheet should be filled out for each field duplicate pair.

PCB NIST SRM

	conc.	found.	
2,4-dichlorobiphenyl CB 008	1.4	2.9	↑
2,2',5-Trichlorobiphenyl CB 018	1.2	2.2	↑
2,2',3,3',4,4'-hexachlorobiphenyl CB 128	1.9	5.5	↑
2,2',3,4,4',5,5'-heptachlorobiphenyl CB 180	5.8	9.0	↑
2,2',3,3',4,4',5,5',6-octachlorobiphenyl CB 204	3.7	7.7	↑

J+ results. could be
biased high.

Accept ~~was~~ nondetected.

PAH NIST SRM

Naphthalene NAP	1010	606	↓
Biphenyl BIP	175	62.8	↓
Fluorene FLU	97.3	50.3	↓
1-methylphenanthrene 1MP	101	49.2	↓
Indeno[1,2,3-cd]pyrene INP	501	286	↓
Benzo[a]pyrene B[a]P	505	314	↓

J(+) results results
could be biased low
UJ non detected
results could be
biased low.

REGION I
Data Review Worksheets

30-130²
all met criteria

IX. INTERNAL STANDARD PERFORMANCE

List the internal standard areas of samples which do not meet the criteria of +100% or -50% of the internal standard area in the associated continuing calibration standard.

<u>SAMPLE ID</u>	<u>DATE</u>	<u>IS OUT</u>	<u>IS AREA/ RT</u>	<u>ACCEPTABLE RANGE</u>	<u>ACTION</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

ACTION:

1. If an IS area count is outside the criteria -50% or +100% of the associated standard:
 - a. Positive results for compounds quantitated using that IS are flagged as estimated (J) for that sample fraction.
 - b. Non-detects for compounds quantitated using that IS are flagged as estimated (UJ) for that sample fraction.
 - c. If extremely low area counts are reported, or if performance exhibits a major drop-off, then a severe loss of sensitivity is indicated. Non-detects should then be flagged as unusable (R).

2. If an IS retention time varies more than 30 seconds, the chromatographic profile for that sample must be examined to determine if any false positives or negatives exist. For shifts of a large magnitude, the reviewer may consider partial or total rejection of the data for that sample fraction.

APPENDIX C-2

**FATE AND TRANSPORT ANALYSIS OF INORGANIC CONTAMINANTS
IN SEDIMENTS FOR THE OFF SHORE ECOLOGICAL RISK ASSESSMENT
AT MCALLISTER POINT LANDFILL
JOHN KING AND CAROL GIBSON, URI GSO DECEMBER 11, 1996**

Fate and Transport Analysis of Inorganic
Contaminants in Sediments
for the
Offshore Ecological Risk Assessment
at
McAllister Point Landfill
Naval Education and Training Center
Newport, Rhode Island

(Phase III)

John W. King and Carol Gibson

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Narragansett, RI 02882-1197*

December 11, 1996

Introduction

This report presents the data obtained in the collection and analysis of the lithology and inorganic contaminants of sediments from McAllister Point Landfill, Naval Education and Training Center (NETC), Newport, Rhode Island (Phase III). The surface samples were collected in September, 1996 and the core samples were collected in October and November 1996. Samples were stored and analyzed according to protocols and methods described in the Final Work/Quality Assurance Project Plan - Narragansett Bay Ecorisk and Monitoring for Navy Sites (URI and SAIC, 1995). The results of the Phase I and Phase II investigations have been previously reported (Brown and Root Environmental, 1996).

Field Observations

A total of 18 surface sediments and cores were recollected from stations NSB-1–NSB-7, MCL-8–MCL-14, S2B, and M1. Duplicate samples were collected from stations S2B and NSB-2. Core samples were analyzed from 7 stations, NSB-2–NSB-6, MCL-10 and MCL-12. General observations concerning visual changes in the field area that occurred in the interval between Phase II and Phase III were made. These include: (1) in general, 1-2 feet of sediment were eroded from the area at the base of the revetment including the locations of stations NSB-1–NSB-6, whereas the area around NSB-7 remained visually unchanged; (2) during the Phase III sampling abundant surficial metal debris was observed at station NSB-2 and in the area between NSB-1 and NSB-2, whereas metal debris was not observed in this area at the time of the Phase II sampling; and (3) during the Phase III sampling the surficial sediment at station S2B was a well oxygenated (light brown), well-sorted, silty clay whereas at station S2B-FD, located 5 meters offshore from S2B, the surficial sediment was a *Crepidula* dominated silty sand. The silty clay now located at station S2B is likely to be part

of an offshore sand bar that consists of material eroded from the beach on the south shore of McAllister Point Landfill.

Sediment Lithology

A comparison of the % organic carbon results obtained in Phase III (1996) and Phases I and II (1994 and 1995) is shown in Figure 1. The results from the majority of stations are comparable. However, significantly higher organic carbon concentrations were found during Phase III at stations, NSB-2 and MCL-12, whereas significantly lower concentrations were found at stations MCL-8, MCL-10, S2B, and M1. The organic carbon results are summarized in Table 1.

A comparison of the grain size results obtained in Phase III (1996) and Phases I and II (1994 and 1995) is shown in Figure 2. Significantly finer-grained sediments were present at stations NSB-1, NSB-6, MCL-8, MCL-9, MCL-12 and S2B, whereas significantly coarser-grained sediments were observed at stations MCL-10 and MCL-11. The most dramatic change in grain size was observed at station S2B where silty clay now comprises the surface sediment. The lithology at the S2B field duplicate station located further offshore was similar to that observed at S2B during Phases I and II. The grain size results are summarized in Table 2.

Inorganic Contaminants

Twelve metals were analyzed for the Phase III surface samples and the results are summarized in Table III. A comparison of the results obtained from the SRM PACS-1 analyzed in conjunction with samples from Phases I–III are shown in Figure 3. These results indicate that the data obtained from McAllister Point samples in Phases I–III are comparable. Comparisons of the results for individual trace metals obtained from Phases I–III with

sediment quality guidelines (Long et al., 1995) are shown in Figures 4–12. In general, concentrations are much higher for several metals at stations NSB-2, NSB-3, NSB-4, NSB-5, NSB-7 and MCL-10. In addition, the arsenic concentrations shown in Figure 10 have increased significantly at stations NSB-1 and NSB-2 and all offshore stations. However, arsenic concentrations at stations showing significant increases are still near or below the ER-L value of Long et al., 1995 (Figure 10) and therefore do not represent a major increase in contamination.

A comparison of the results obtained from the lithogenic metals (i.e. primarily derived from bedrock sources) are shown in Figures 13–15. The aluminum concentrations shown in Figure 13 are generally more consistent over time than any other metal. Increases in concentration are observed at all nearshore stations, MCL-8 and MCL-12, whereas decreases are observed at stations MCL-11, MCL-13, MCL-14, S2B and M1. An increase in aluminum concentration is generally interpreted as an increase in the proportion of clay minerals present, and vice-versa. Iron concentrations are observed (Figure 14) to be higher at stations NSB-1–5 and MCL-9, whereas all other stations have comparable values. Manganese concentrations are observed (Figure 15) to be higher at stations NSB-1–5, NSB-7, MCL-10 and MCL-12, whereas lower concentrations are observed at S2B and M1.

Trace metal concentrations were normalized to aluminum in order to examine the possible effects of lithologic variation on the results. The normalized results are summarized in Table 4, and are shown in Figures 16–26. The only change that normalization produces in the patterns discussed previously in this report and in earlier reports (Brown and Root Environmental, 1996) is that normalized trace metal concentrations for several metals do not increase as dramatically at station NSB-5 between Phases II and III.

Conclusions

1. Major macroscopic changes observed in the study area during Phase III sampling include: (1) removal of 1–2 feet of sediment from the base of the revetment, (2) exposure of new metal debris at and immediately north of station NSB-2 and rapid deposition of silty clay at station S2B.
2. Metal concentrations analyzed during Phase III were higher for several metals at stations NSB-2, NSB-3, NSB-4, NSB-5, NSB-7 and MCL-10 than metal concentrations determined during Phases I and II.
3. Aluminum normalization for lithologic variation of McAllister Point samples does not change the general spatial pattern of trace metal contamination observed in previous studies, although normalization does indicate that increases at station NSB-5 are less dramatic than is indicated by the concentration data.
4. Erosion at McAllister Point landfill has exposed more contaminated sediments with respect to trace metals at stations NSB-2, NSB-3, NSB-4 and NSB-7. In addition, station MCL-10 may represent an area of offshore deposition for contaminated sediments eroded from the shoreline.

References

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, *Environmental Management*, 19(1): 81-97.

URI and SAIC, 1995. Narragansett Bay Ecorisk and Monitoring for Navy Sites, Final Work/Quality Assurance Project Plan by James G. Quinn, John King, and Greg Tracey, Prepared for Halliburton NUS Corp., 28 July 1995, 57 pp, 3 appendices and 3 addenda.

Brown and Root Environmental, 1996. McAllister Point Landfill, Marine Ecological Risk Assessment Report, Draft Final, Volumes I and II.

Table 1
McAllister Point Phase III Total Organic Carbon

SAMPLE NAME	Interval (cm)	Crucible wt (g)	DRY WEIGHT IN GRAMS				Total %	% Organic
			WET	100C	550C	% WATER	Organic	Carbon
NSB-1R	0-6	4.620	1.552	5.937	5.905	15.1	2.4	1.0
NSB-2R	0-6	4.706	1.609	6.038	5.971	17.2	5.0	2.2
NSB-2R-FD	0-6	4.772	1.778	6.158	6.122	22.0	2.6	1.1
NSB-3R	0-6	4.742	1.892	6.244	6.205	20.6	2.6	1.1
NSB-4R	0-6	4.721	1.617	5.919	5.870	25.9	4.1	1.8
NSB-5R	0-6	4.916	1.621	6.172	6.123	22.5	3.9	1.7
NSB-6R	0-6	4.852	2.017	6.471	6.416	19.7	3.4	1.5
NSB-7R	0-6	4.694	1.741	6.023	5.968	23.7	4.1	1.8
MCL-8R	0-2	4.393	1.955	5.751	5.714	30.5	2.7	1.2
MCL-9R	0-2	4.541	1.736	5.643	5.599	36.5	4.0	1.7
MCL-10R	0-2	4.221	1.601	5.190	5.143	39.5	4.9	2.1
MCL-11R	0-2	4.236	1.903	5.618	5.577	27.4	3.0	1.3
MCL-12R	0-2	4.876	1.828	6.131	6.069	31.3	4.9	2.1
MCL-13R	0-2	4.548	2.022	6.095	6.064	23.5	2.0	0.9
MCL-14R	0-2	4.248	1.890	5.586	5.546	29.2	3.0	1.3
S2B-R	0-2	4.957	1.836	6.378	6.350	22.6	2.0	0.9
S2B-R-FD	0-2	4.758	1.836	6.378	6.350	11.8	1.7	0.7
M1-R	0-2	4.279	1.955	5.751	5.714	24.7	2.5	1.1

Table 2
McAllister Point Phase III - Grain Size

SAMPLE NAME	Interval (cm)	% SAND	% SILT	% CLAY	% SILT	
					63-15.6u	<15.6u
NSB-1R	0-6	87.6	12.2	0.2	6.4	6.0
NSB-2R	0-6	98.9	1.0	0.0	0.5	0.5
NSB-2R FD	0-6	97.2	2.8	0.0	1.5	1.3
NSB-3R	0-6	99.0	1.0	0.0	0.6	0.4
NSB-4R	0-6	95.6	4.4	0.0	2.4	2.0
NSB-5R (2)	0-6	97.8	2.2	0.0	1.5	0.8
NSB-6R (2)	0-6	88.7	11.3	0.1	7.8	3.5
NSB-7R (2)	0-6	97.2	2.7	0.0	1.5	1.2
MCL-8R	0-2	59.5	40.3	0.2	29.8	10.7
MCL-9R	0-2	71.2	28.2	0.6	16.5	12.3
MCL-10R	0-2	69.7	30.1	0.2	21.1	9.1
MCL-11R	0-2	84.3	15.5	0.1	10.4	5.3
MCL-12R	0-2	80.1	19.7	0.2	14.1	5.7
MCL-13R	0-2	84.7	15.2	0.1	11.9	3.3
MCL-14R	0-2	80.7	19.2	0.1	14.3	5.0
S2B-R	0-2	3.5	55.0	41.4	2.7	93.7
S2B-R-FD	0-2	75.9	23.9	0.2	16.3	7.8
M1-R	0-2	87.6	12.3	0.1	9.0	3.4

Table 3
McAllister Point Phase III
Concentration (µg/g) of Metals in Sediment (Total Digestion Method)

Sample	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Manganese	Nickel	Silver	Zinc
NSB-1R	29185	8.8	0.08	41.0	29.5	51344	17.8	0.159	563.1	26.6	<0.13	159.8
NSB-2R	31408	12.9	1.68	155.8	7629	174430	5405	0.267	1030.0	87.4	22.1	2135.1
NSB-2-FD	43515	18.8	0.49	128.1	820.9	91305	1269	0.192	700.5	16.7	6.7	1195.0
NSB-3R	40325	15.2	4.35	127.4	1006	163366	718.4	1.171	1032.3	75.9	4.0	2878.2
NSB-4R	37904	15.7	6.50	164.2	8466	178862	1478	2.926	1087.1	223.9	5.3	6912.9
NSB-5R	40391	14.3	2.54	109.5	590.8	115054	526.1	1.124	653.1	120.4	4.7	2132.2
NSB-6R	36170	8.6	0.50	69.7	164.7	47585	134.6	0.278	439.5	56.9	0.6	251.5
NSB-7R	28022	11.6	0.51	53.8	177.0	69491	215.3	0.377	541.9	39.9	1.7	1576.4
MCL-8R	47150	6.1	0.19	43.2	26.2	33558	44.3	0.280	483.2	23.3	0.3	83.7
MCL-9R	49103	5.2	0.19	39.9	24.5	26159	44.1	0.232	460.2	16.5	0.3	65.1
MCL-10R	50869	7.0	0.81	54.8	250.0	36838	61.0	0.291	577.9	18.9	0.5	649.7
MCL-11R	33231	3.6	0.11	38.5	12.9	32554	28.0	0.154	354.3	18.2	0.2	< 2.3
MCL-12R	49396	5.0	0.40	49.3	49.4	38760	58.6	0.367	444.0	20.8	0.5	287.2
MCL-13R	23849	2.8	0.09	35.9	13.2	24032	25.1	0.164	308.7	9.4	0.1	< 2.3
MCL-14R	26490	4.5	0.07	36.1	4.5	30819	28.3	0.135	354.5	17.8	0.2	862.0
S2B-R	26515	4.5	0.21	34.0	25.1	28901	33.1	0.173	234.4	11.4	0.2	< 2.3
S2B-R-FD	41536	6.3	0.48	73.5	51.5	32411	70.2	1.008	369.4	22.6	0.9	103.1
M1-R	29115	3.2	0.11	33.3	14.5	25075	25.7	0.213	316.7	6.9	<0.13 (B)	< 2.3 (B)
9-20-96 Field Blank	493	<1.3 (B)	<0.05 (B)	0.5	3.1	<15 (B)	1.93	< 0.5 (B)	11.6	<2.0 (B)	<0.13 (B)	< 2.3 (B)

NOTES:

1: "<" signs designate concentrations in ug/g below the Method Limit of Quantitation (MLQ). These concentrations are flagged with a data qualifier (B) indicating that they are below the Contract Required Detection Limit.

Table 4
McAllister Point Phase III
Concentration of Metals in Sediment, Normalized to Aluminum

Sample	Silver	Arsenic	Chromium	Copper	Lead	Cadmium	Iron	Manganese	Zinc	Mercury	Nickel
NSB-1R	2.23E-06	3.01E-04	1.40E-03	1.01E-03	6.10E-04	2.74E-06	1.76E+00	1.93E-02	5.48E-03	5.45E-06	9.11E-04
NSB-2R	7.04E-04	4.11E-04	4.96E-03	2.43E-01	1.72E-01	5.35E-05	5.55E+00	3.28E-02	6.80E-02	8.50E-06	2.78E-03
NSB-3R	9.92E-05	3.77E-04	3.16E-03	2.49E-02	1.78E-02	1.08E-04	4.05E+00	2.56E-02	7.14E-02	2.90E-05	1.88E-03
NSB-4R	1.40E-04	4.14E-04	4.33E-03	2.23E-01	3.90E-02	1.71E-04	4.72E+00	2.87E-02	1.82E-01	7.72E-05	5.91E-03
NSB-5R	1.16E-04	3.54E-04	2.71E-03	1.46E-02	1.30E-02	6.29E-05	2.85E+00	1.62E-02	5.28E-02	2.78E-05	2.98E-03
NSB-6R	1.66E-05	2.38E-04	1.93E-03	4.55E-03	3.72E-03	1.38E-05	1.32E+00	1.22E-02	6.95E-03	7.69E-06	1.57E-03
NSB-7R	6.07E-05	4.14E-04	1.92E-03	6.32E-03	7.68E-03	1.82E-05	2.48E+00	1.93E-02	5.63E-02	1.35E-05	1.42E-03
MCL-8R	6.36E-06	1.29E-04	9.16E-04	5.56E-04	9.40E-04	4.03E-06	7.12E-01	1.02E-02	1.78E-03	5.94E-06	4.94E-04
MCL-9R	6.11E-06	1.06E-04	8.13E-04	4.99E-04	8.98E-04	3.87E-06	5.42E+00	9.37E-03	1.33E-03	4.72E-06	3.36E-04
MCL-10R	9.83E-06	1.38E-04	1.08E-03	4.91E-03	1.20E-03	1.59E-05	7.24E-01	1.14E-02	1.28E-02	5.72E-06	3.72E-04
MCL-11R	6.02E-06	1.08E-04	1.16E-03	3.88E-04	8.43E-04	3.31E-06	9.80E-01	1.07E-02	3.46E-05	4.63E-06	5.48E-04
MCL-12R	1.01E-05	1.01E-04	9.98E-04	1.00E-03	1.19E-03	8.10E-06	7.85E-01	8.99E-03	5.81E-03	7.43E-06	4.21E-04
MCL-13R	4.19E-06	1.17E-04	1.51E-03	5.53E-04	1.05E-03	3.77E-06	1.01E+00	1.29E-02	4.82E-05	6.88E-06	3.94E-04
MCL-14R	7.55E-06	1.70E-04	1.36E-03	1.70E-04	1.07E-03	2.64E-06	1.16E+00	1.34E-02	3.25E-02	5.10E-06	6.72E-04
S2B-R	7.54E-06	1.70E-04	1.28E-03	9.47E-04	1.25E-03	7.92E-06	1.09E+00	8.84E-03	4.34E-05	6.52E-06	4.30E-04
M1-R	2.23E-06	1.10E-04	1.14E-03	4.98E-04	8.83E-04	3.78E-06	8.61E-01	1.09E-02	3.95E-05	7.32E-06	2.37E-04

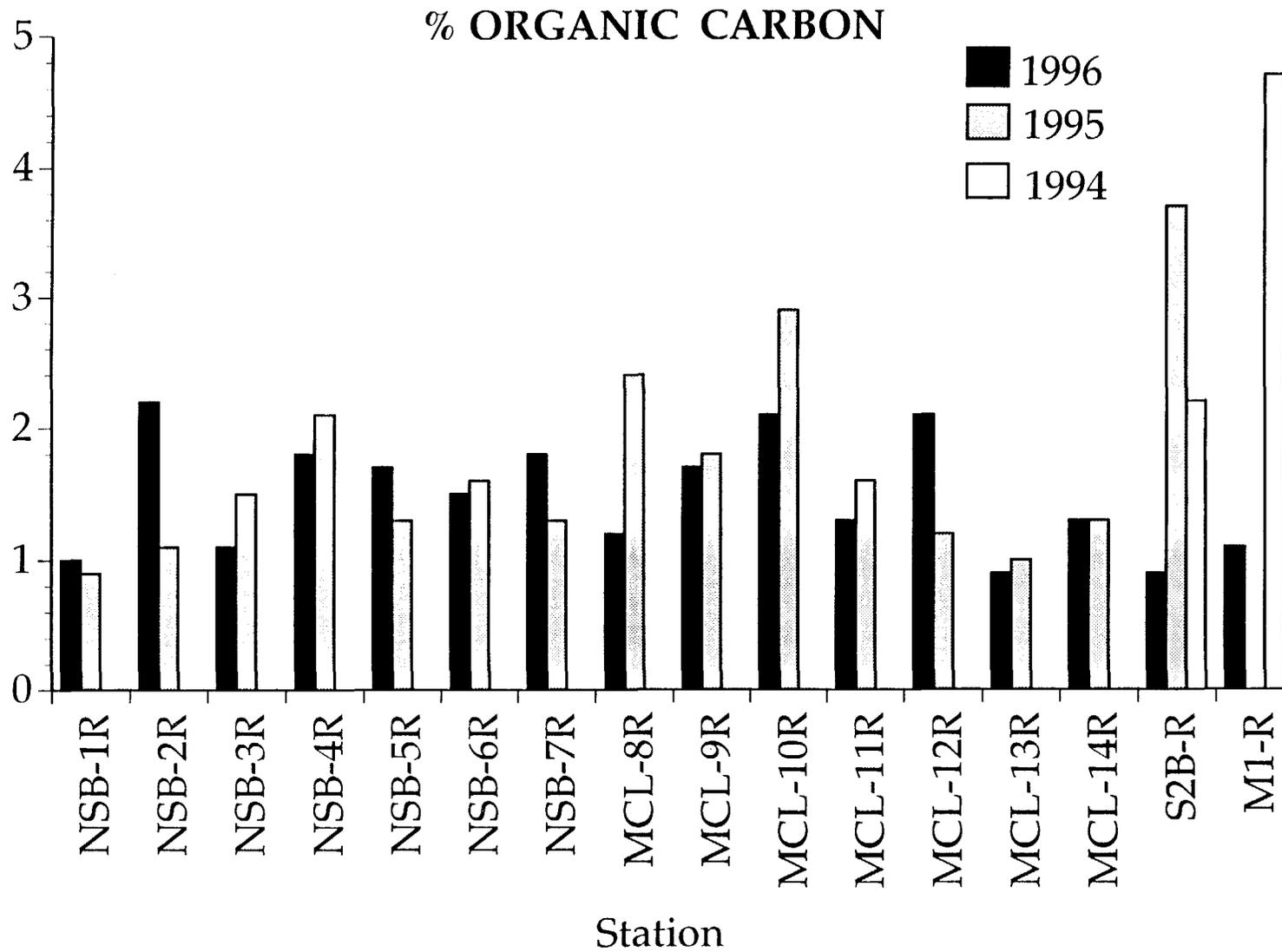


Figure 1 - % Organic Carbon from surface samples at McAllister Point Landfill.

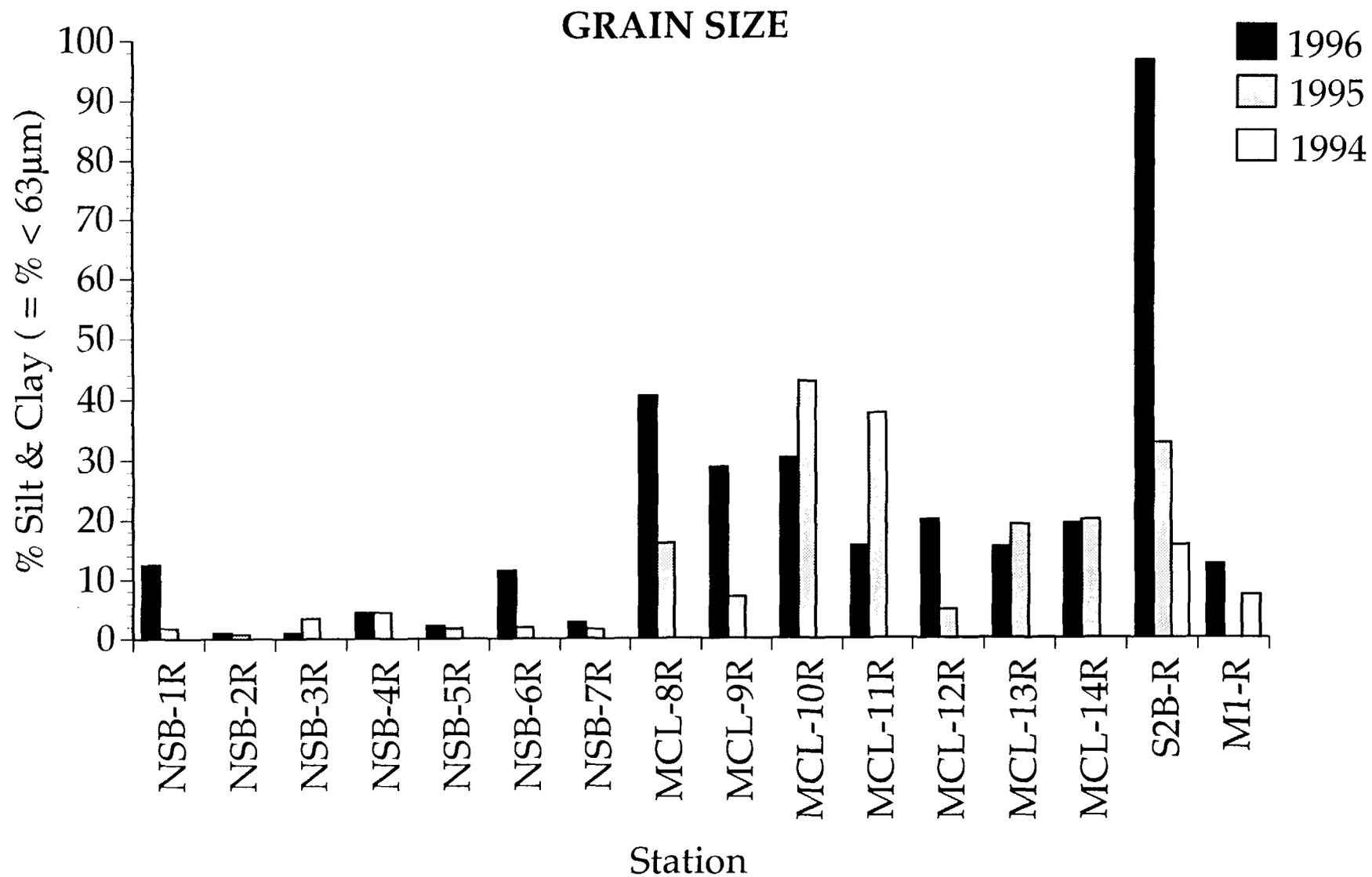


Figure 2 - % Silt and clay from surface samples at McAllister Point Landfill.

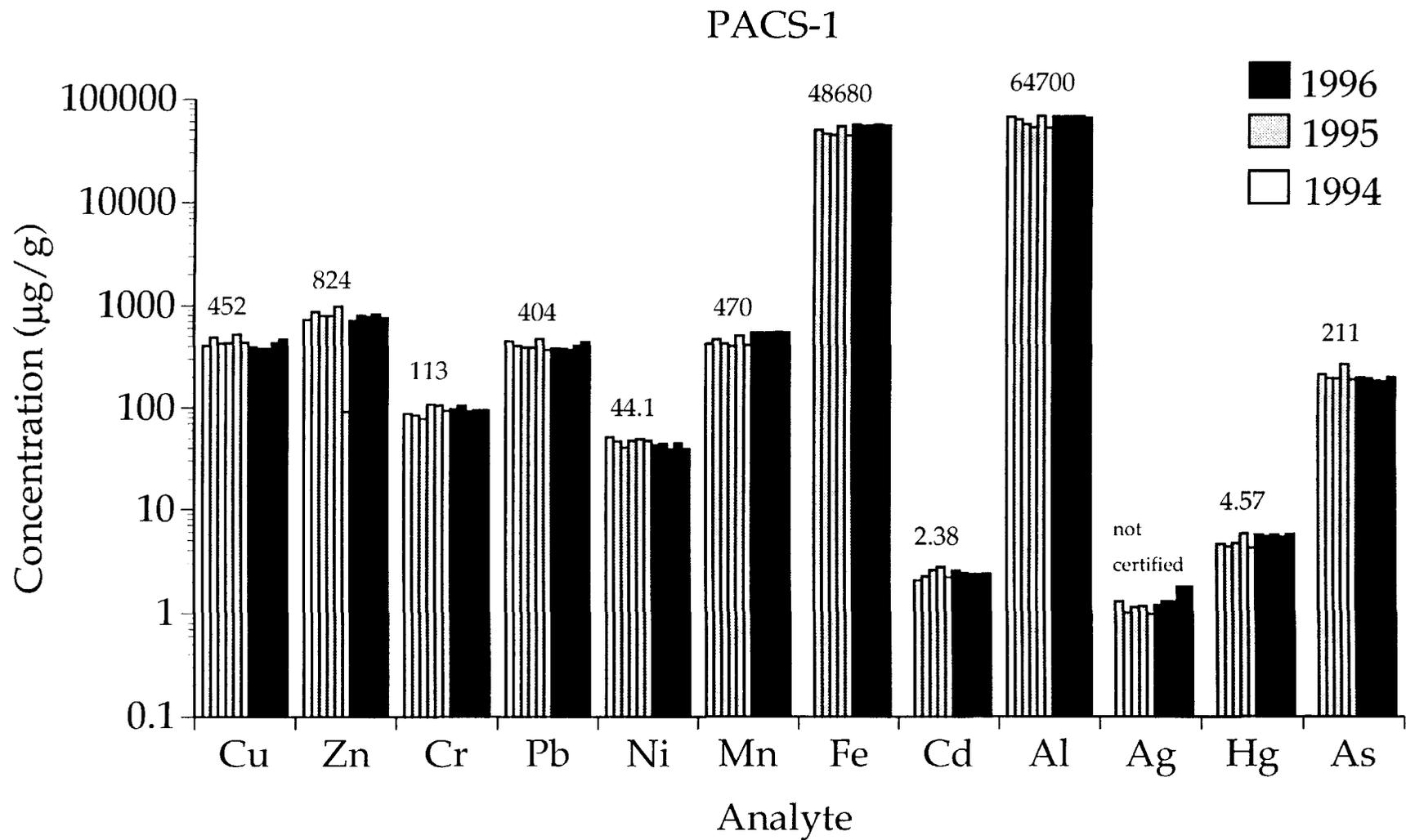


Figure 3 - Metal concentrations obtained by total digestion of the standard reference material PACS - 1. The certified concentrations of each analyte are listed above the bars.

ZINC

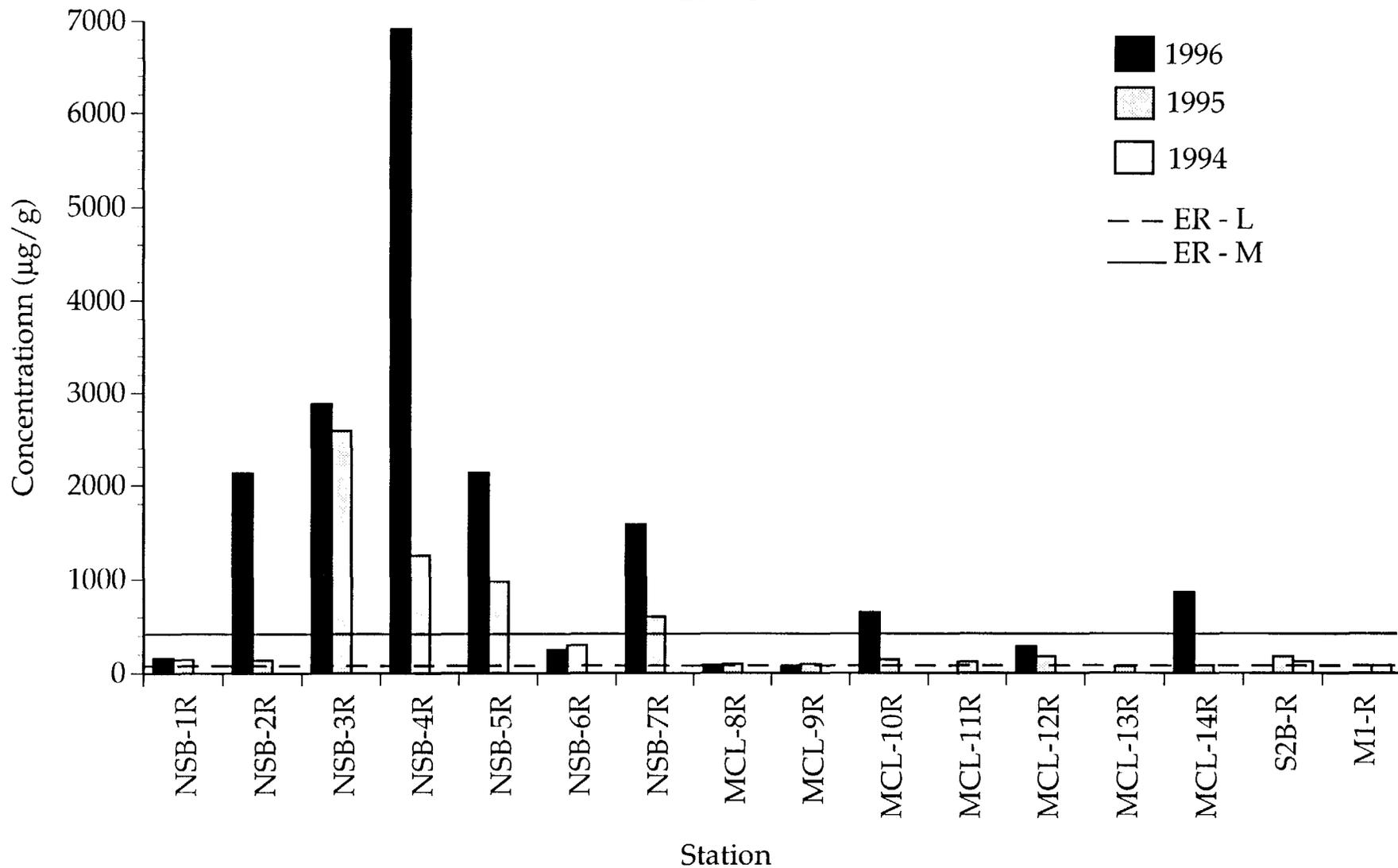


Figure 4 - Comparison of zinc concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

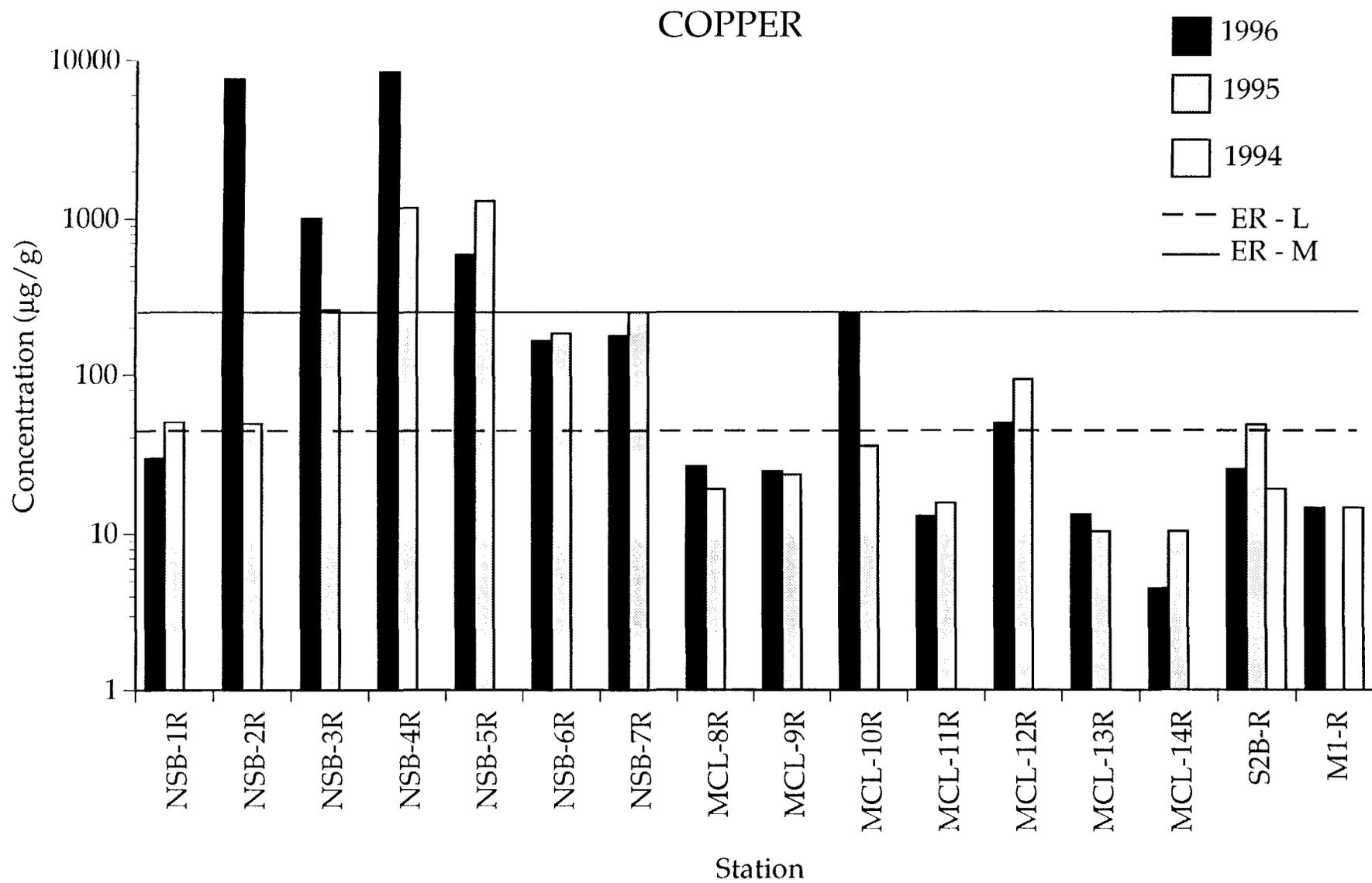


Figure 5 - Comparison of copper concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

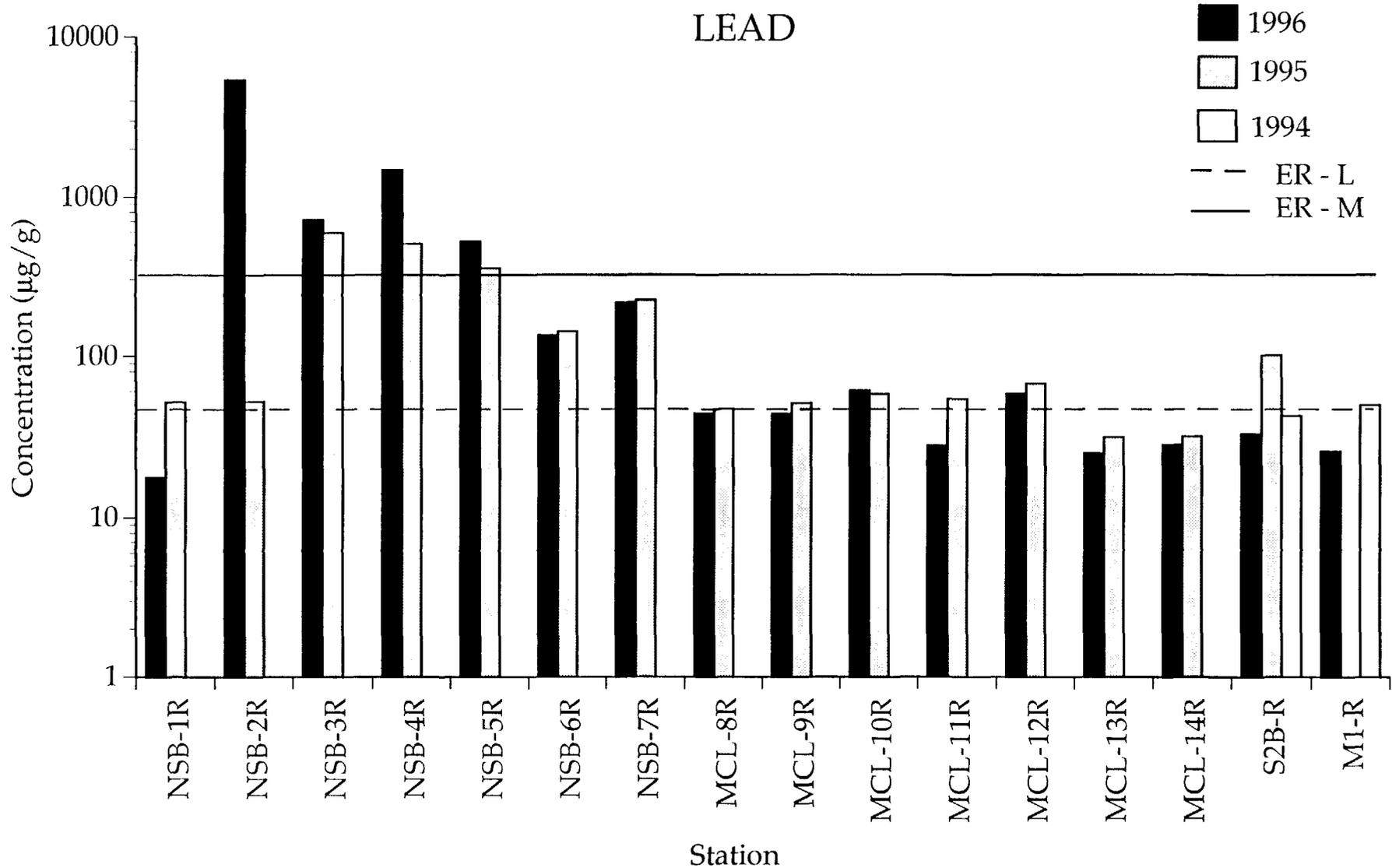


Figure 6 - Comparison of lead concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

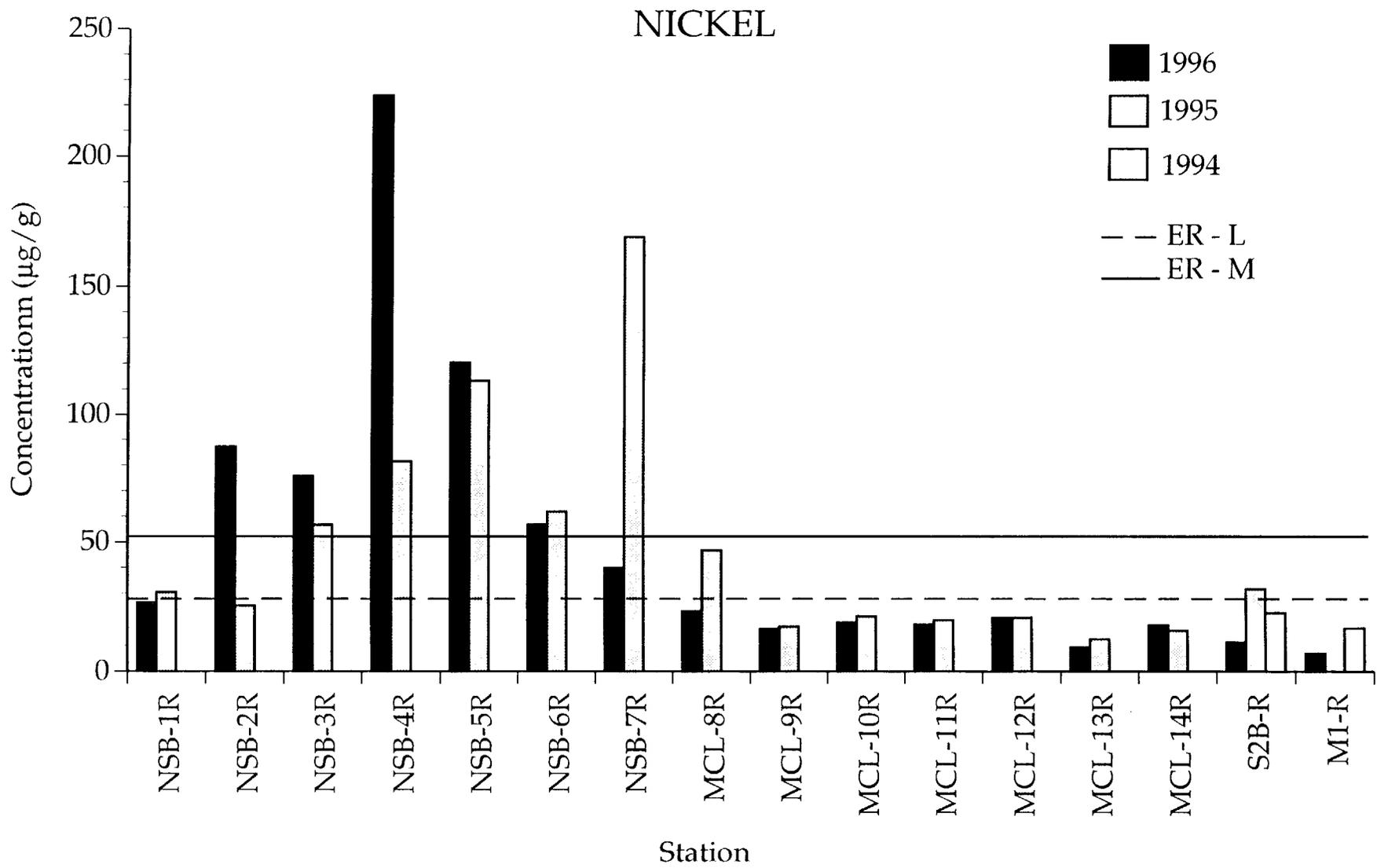


Figure 7 - Comparison of nickel concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

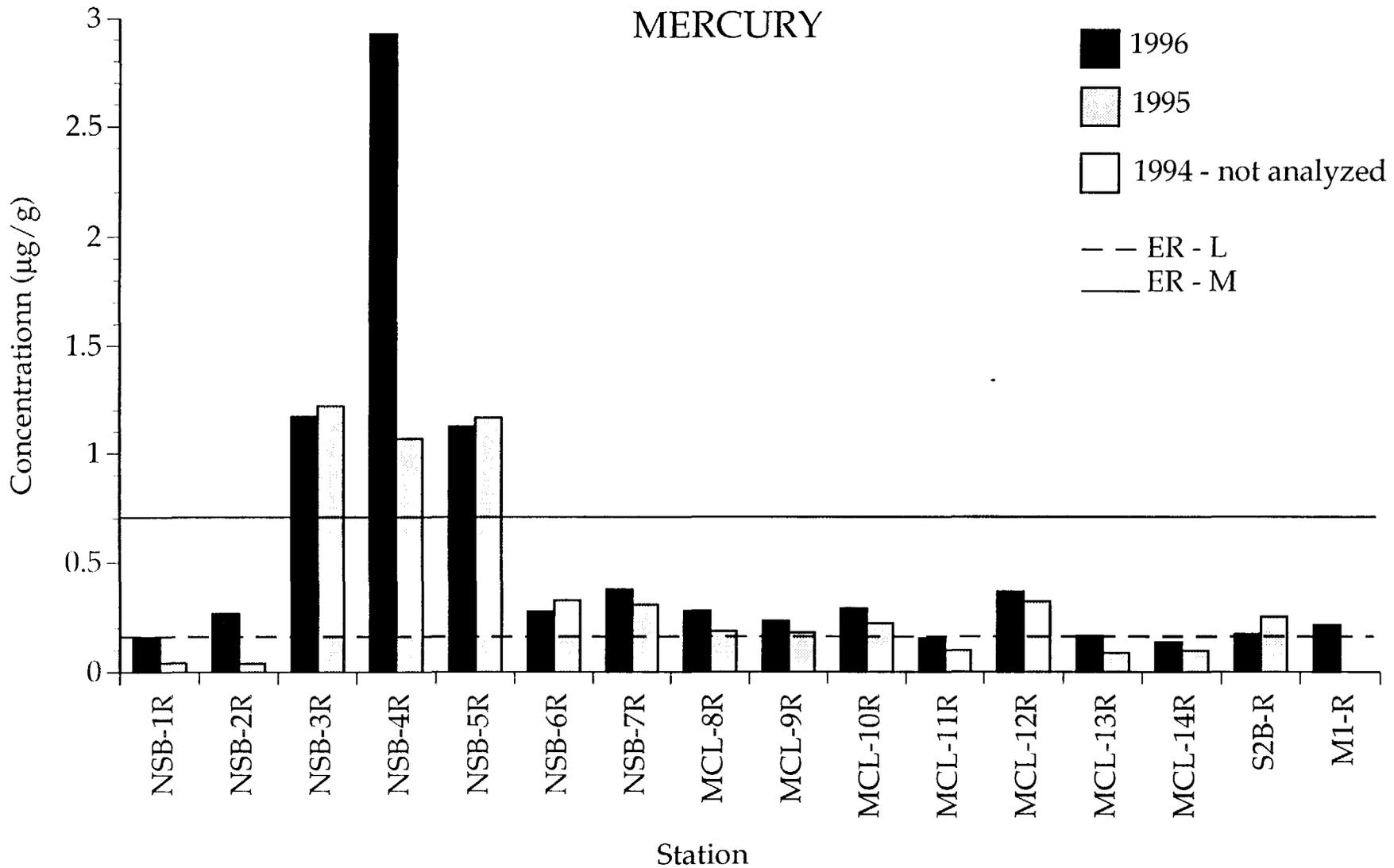


Figure 8 - Comparison of mercury concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

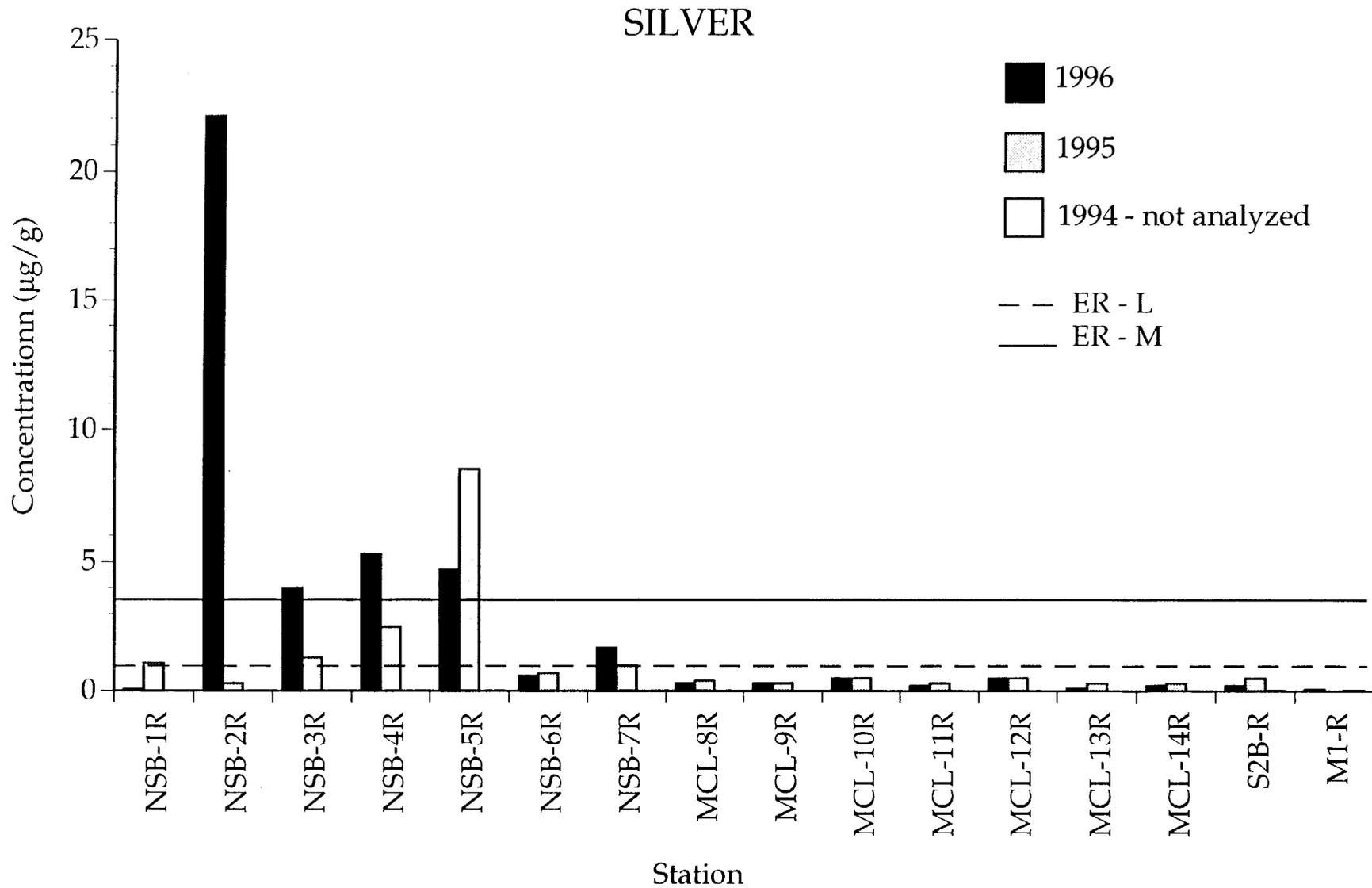


Figure 9 - Comparison of silver concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

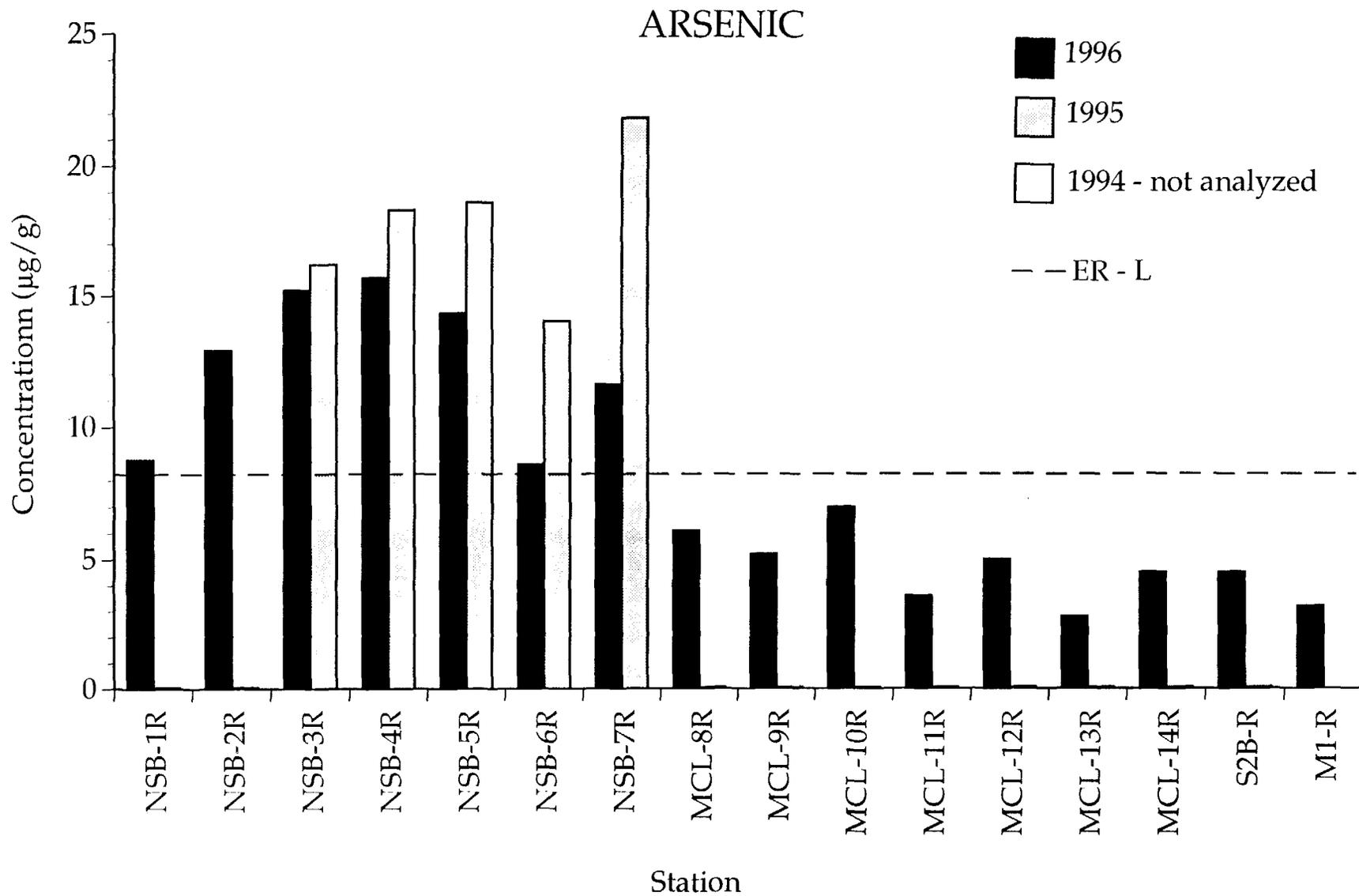


Figure 10 - Comparison of arsenic concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

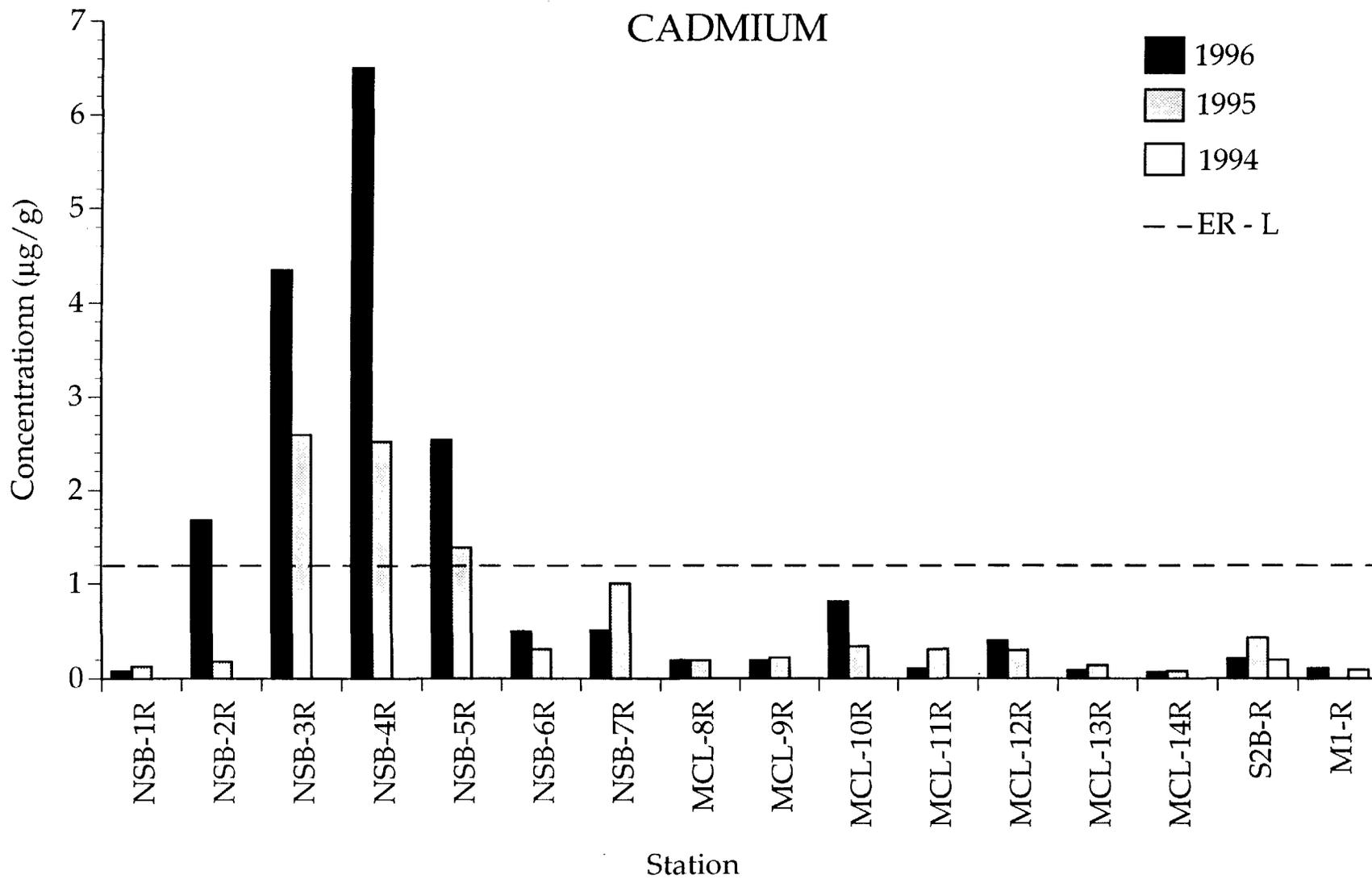


Figure 11 - Comparison of cadmium concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

CHROMIUM

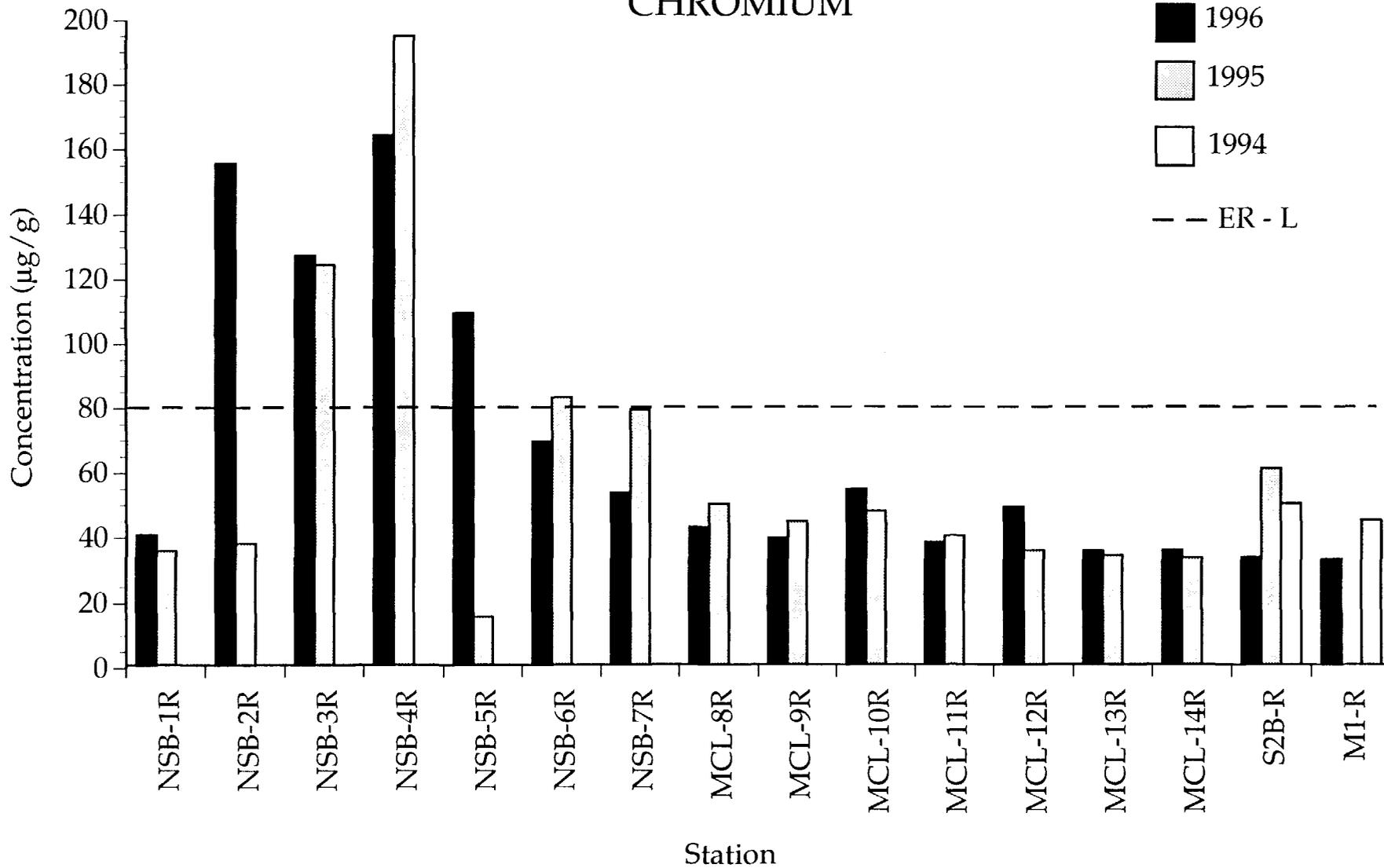


Figure 12 - Comparison of chromium concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

ALUMINUM

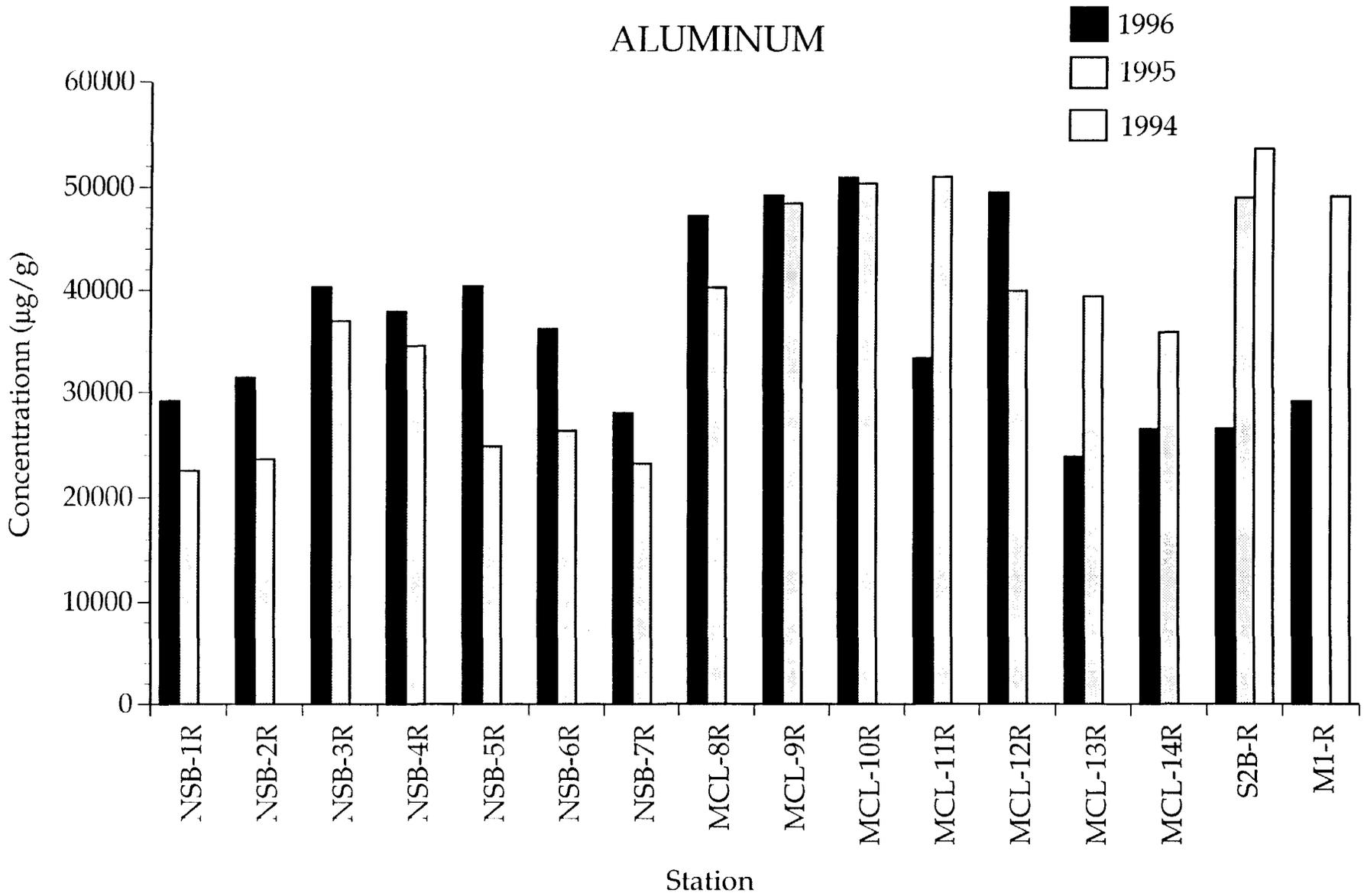


Figure 13 - Comparison of aluminum concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

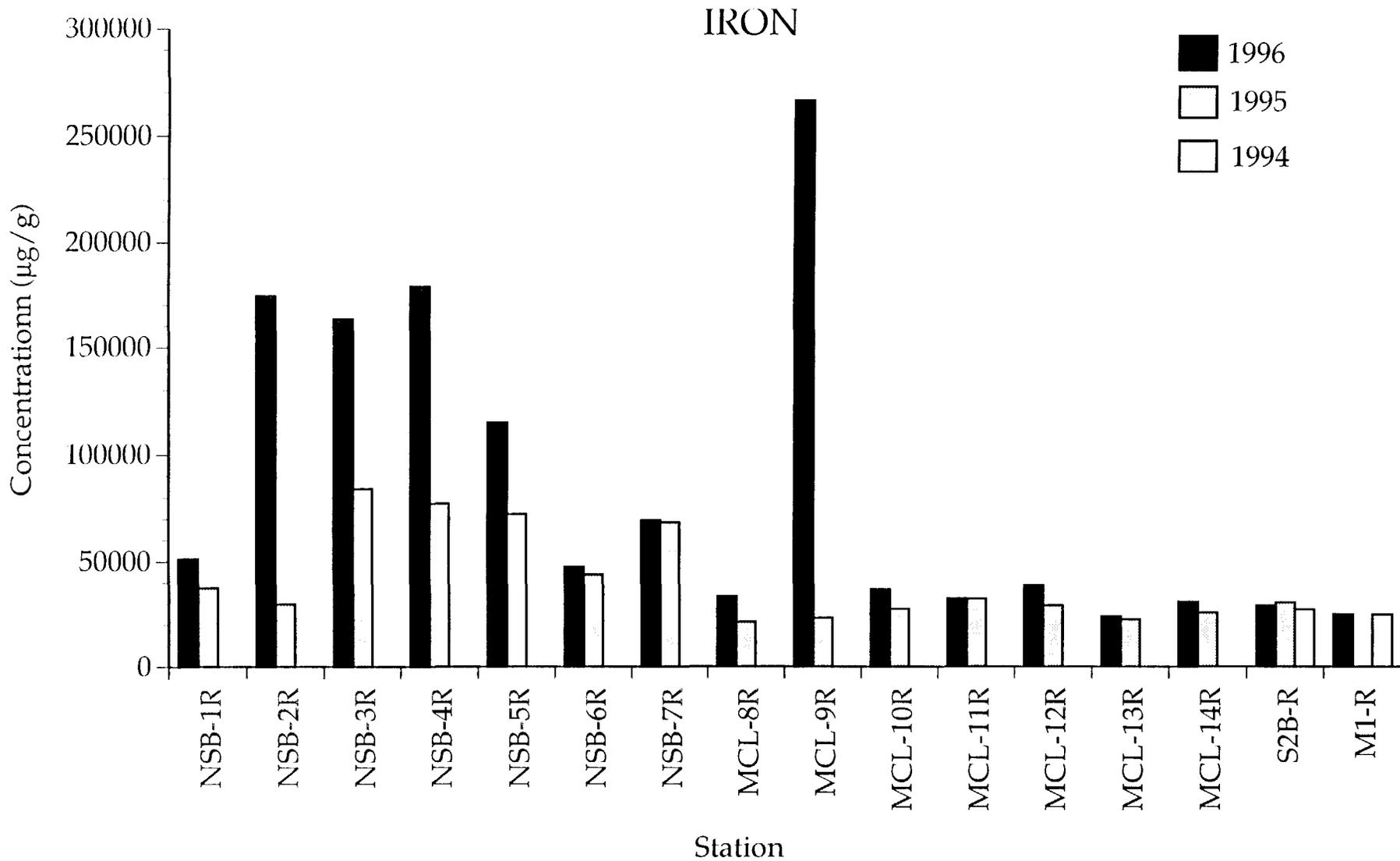


Figure 14 - Comparison of iron concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

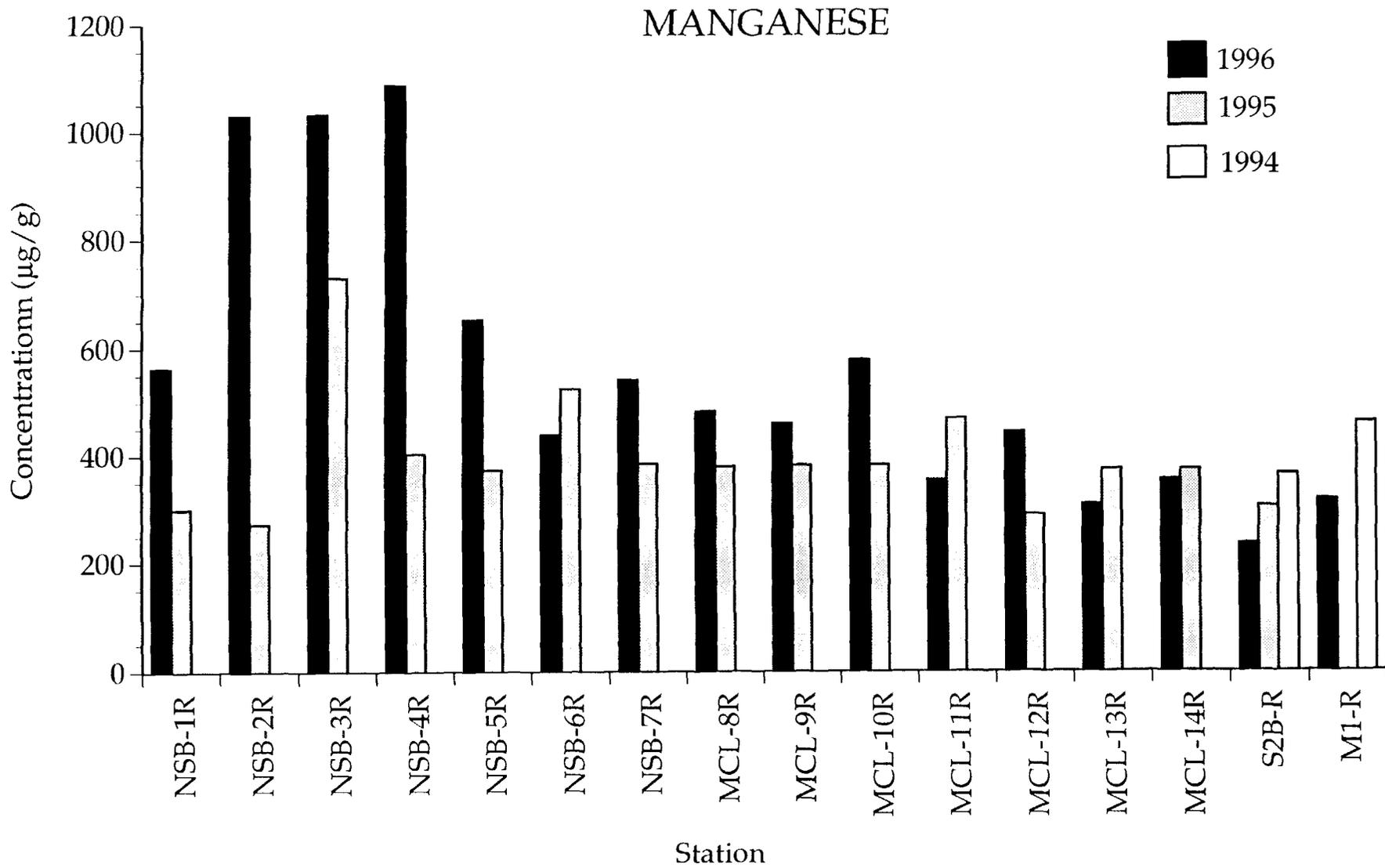


Figure 15 - Comparison of manganese concentrations for Total Digestion of surface samples from McAllister Point Landfill, Phases I - III.

ZINC, NORMALIZED TO ALUMINUM

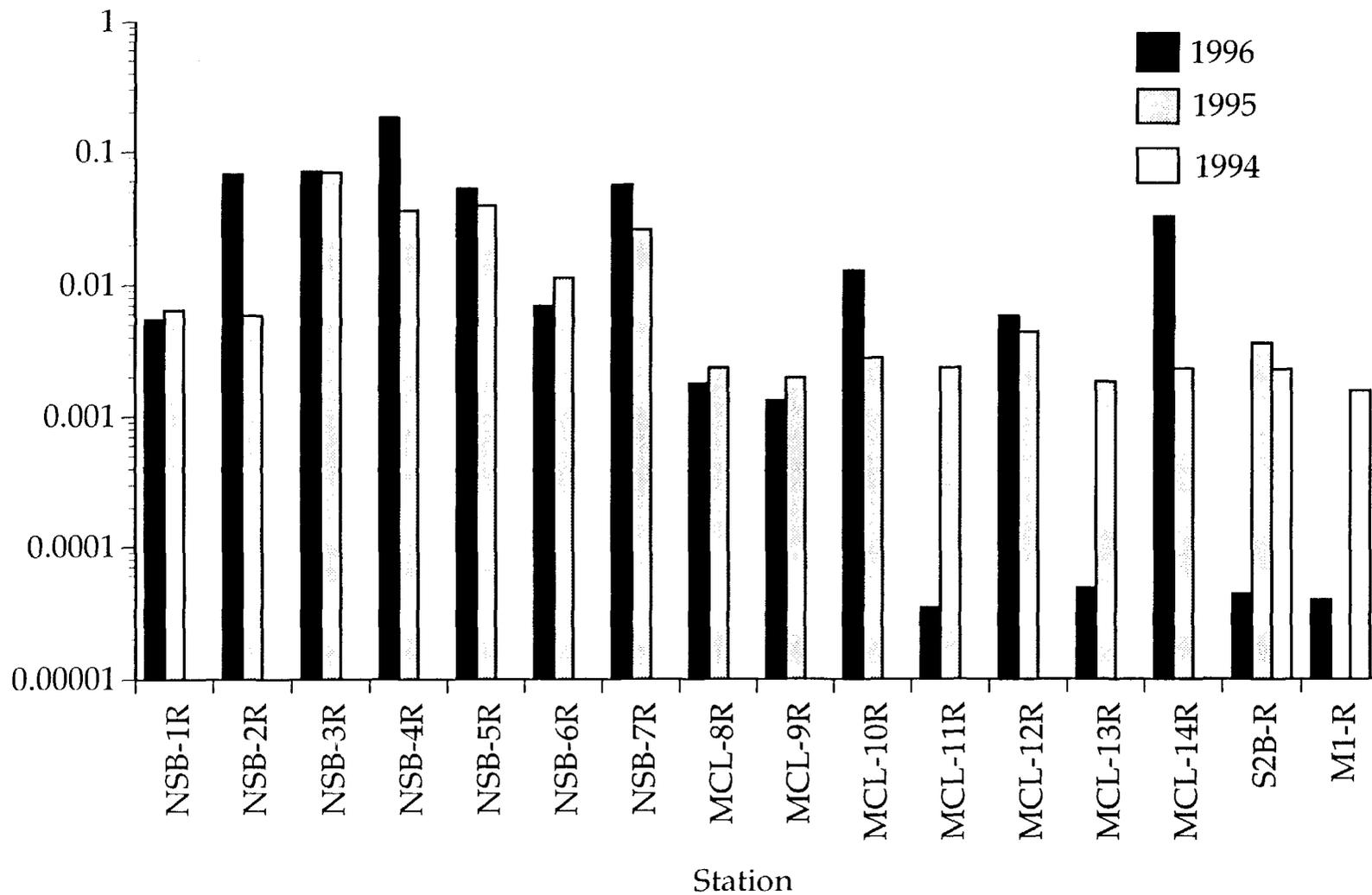


Figure 16 - Comparison of normalized zinc concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

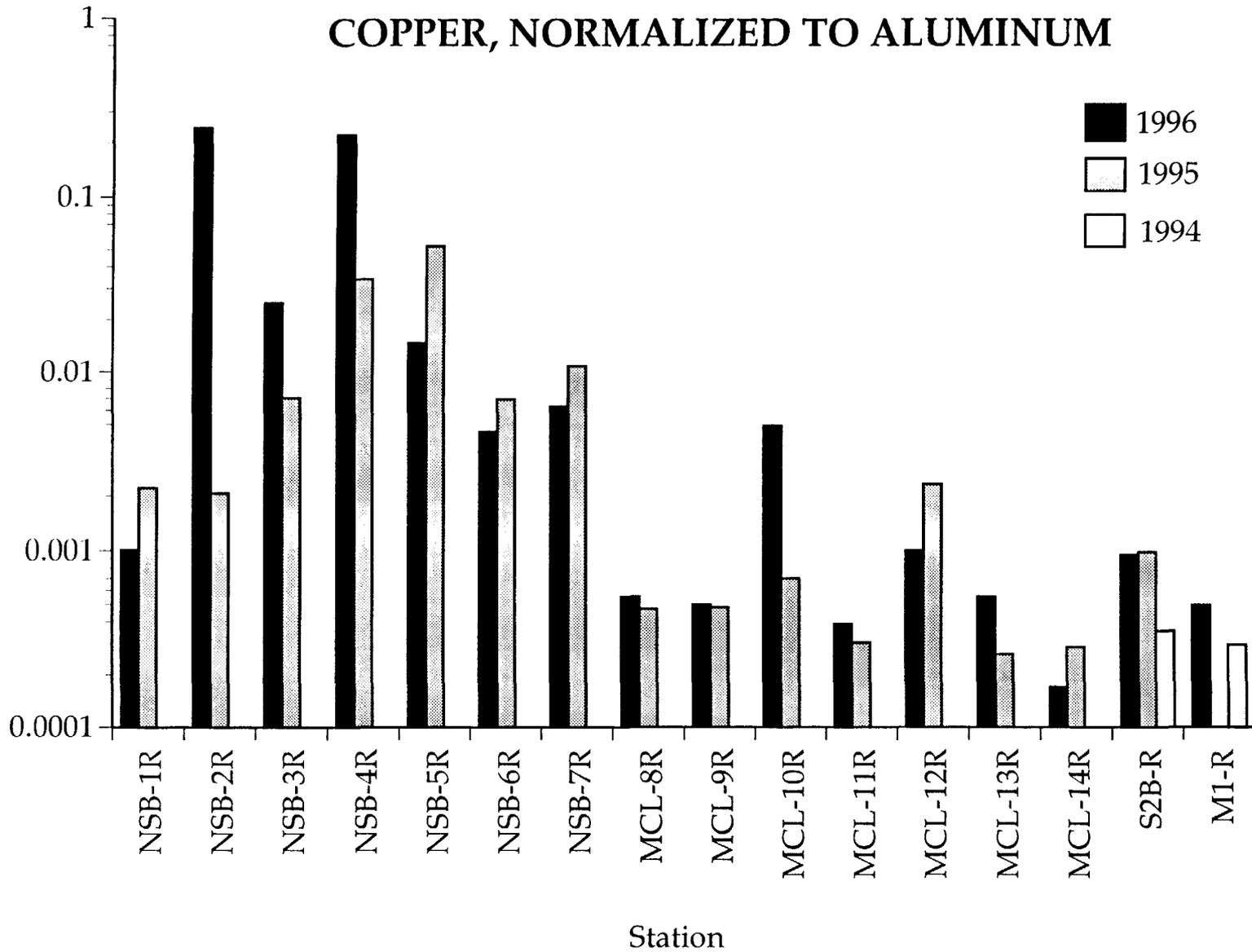


Figure 17 - Comparison of normalized copper concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

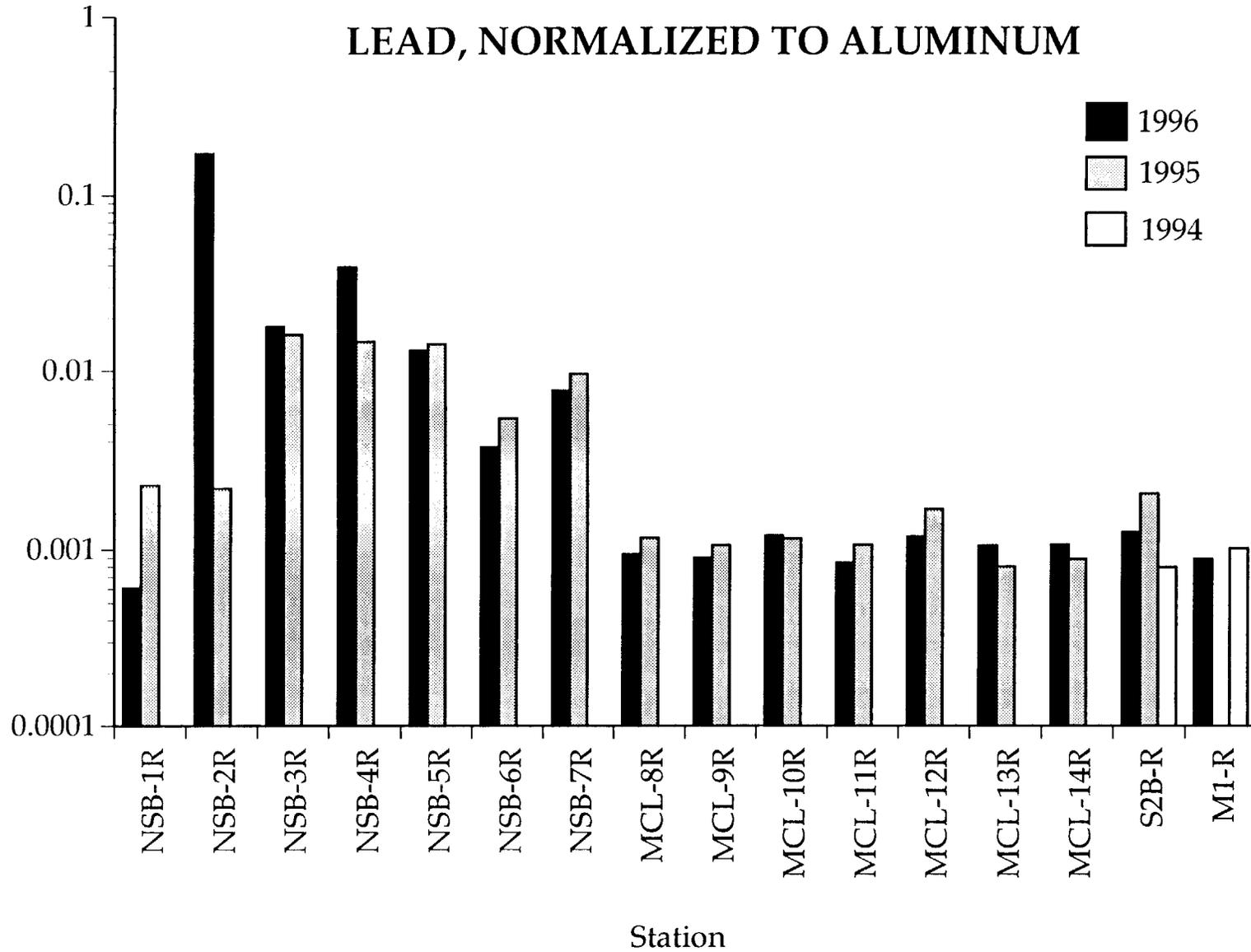


Figure 18 - Comparison of normalized lead concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

NICKEL, NORMALIZED TO ALUMINUM

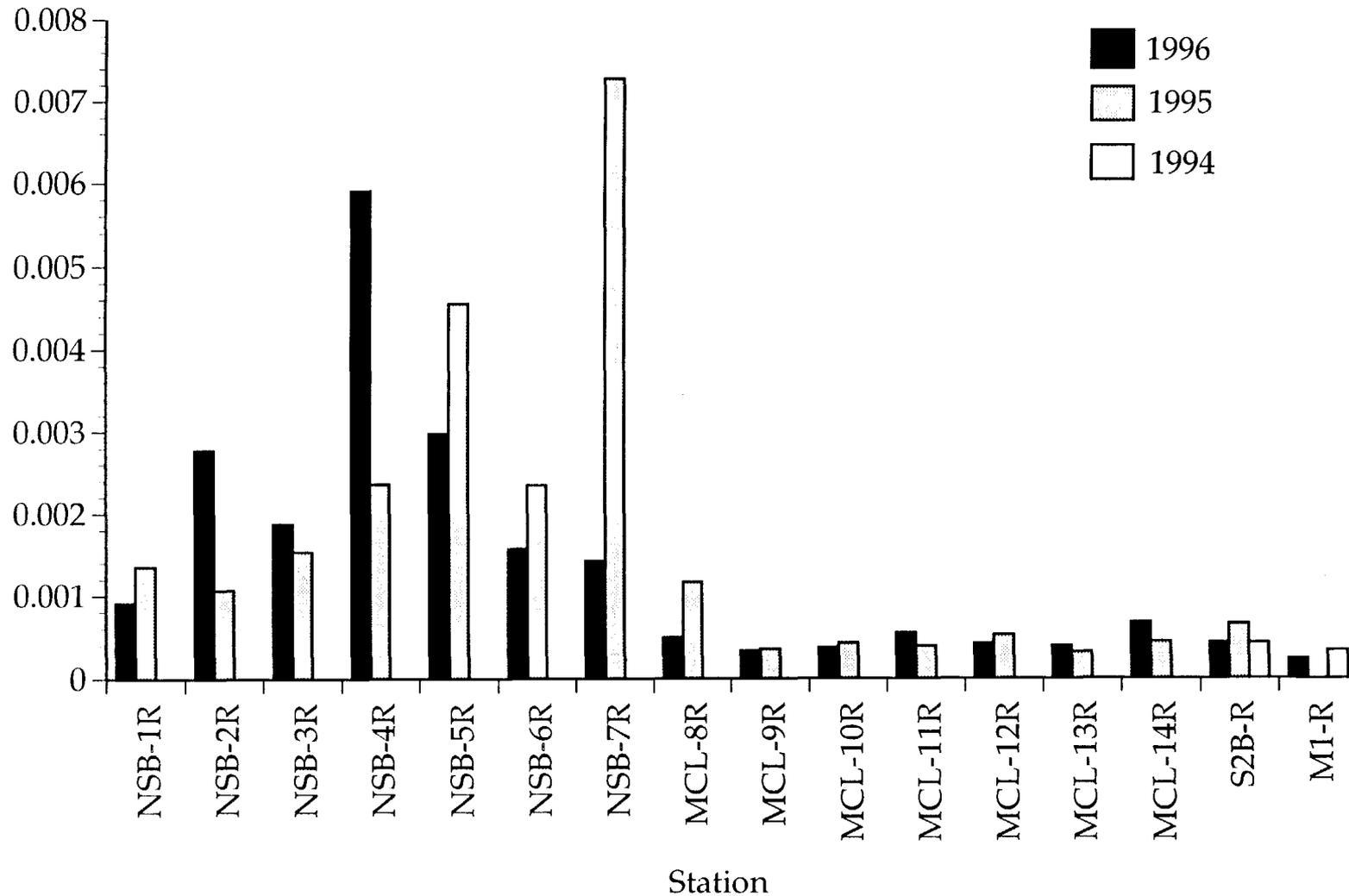


Figure 19 - Comparison of normalized nickel concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

MERCURY, NORMALIZED TO ALUMINUM

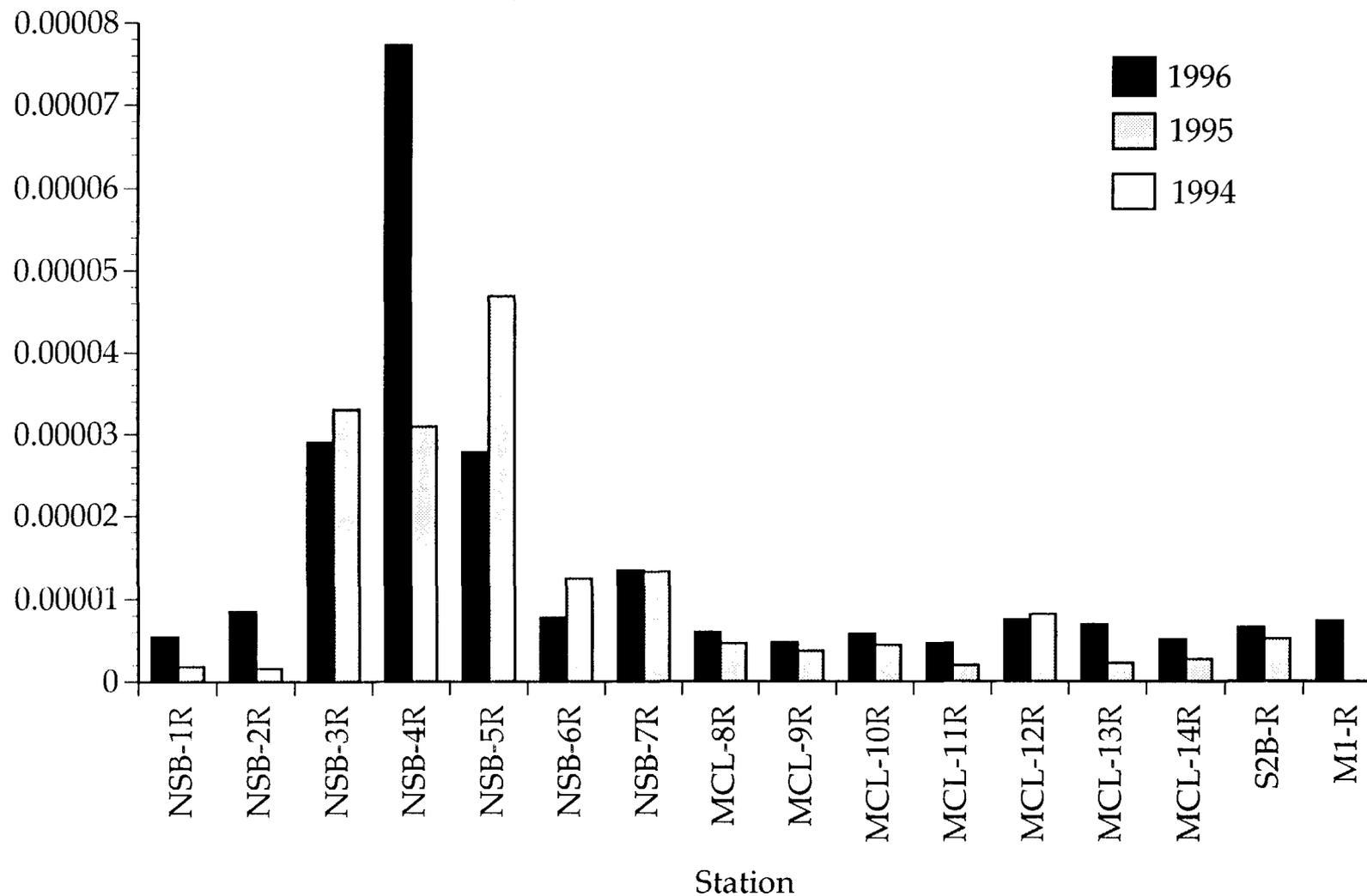


Figure 20 - Comparison of normalized mercury concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

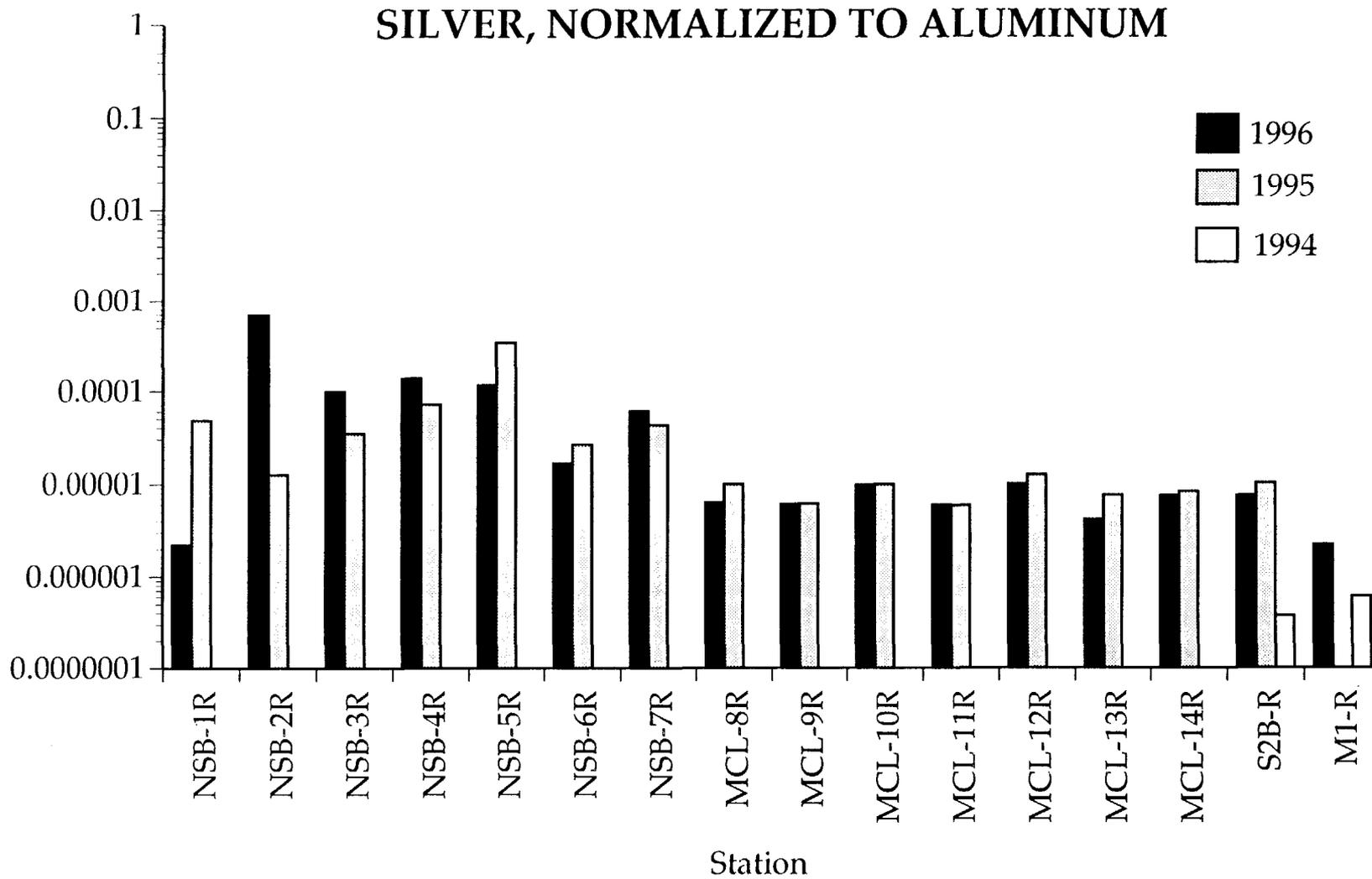


Figure 21 - Comparison of normalized silver concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

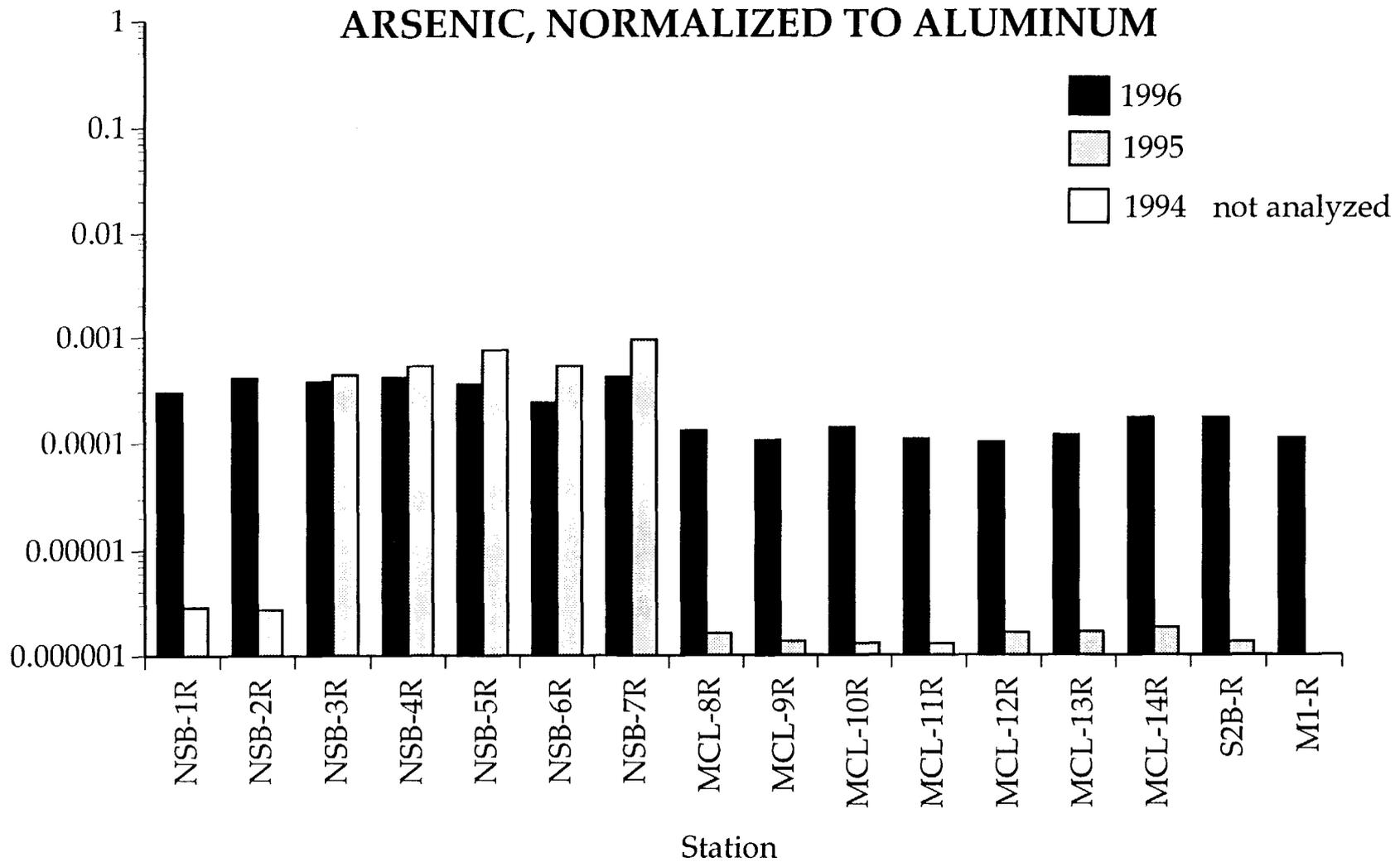


Figure 22 - Comparison of normalized arsenic concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

CADMIUM, NORMALIZED TO ALUMINUM

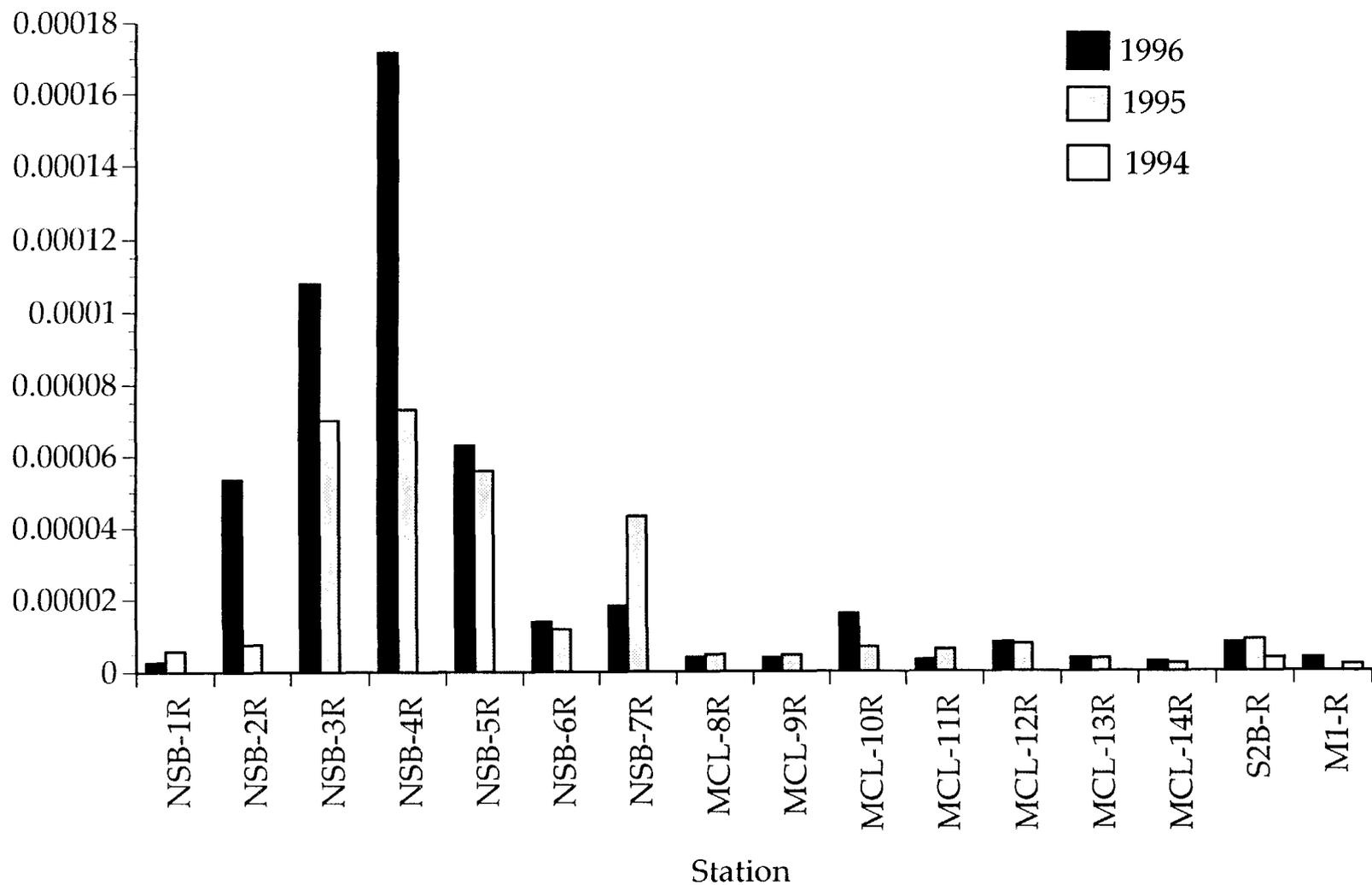


Figure 23 - Comparison of normalized cadmium concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

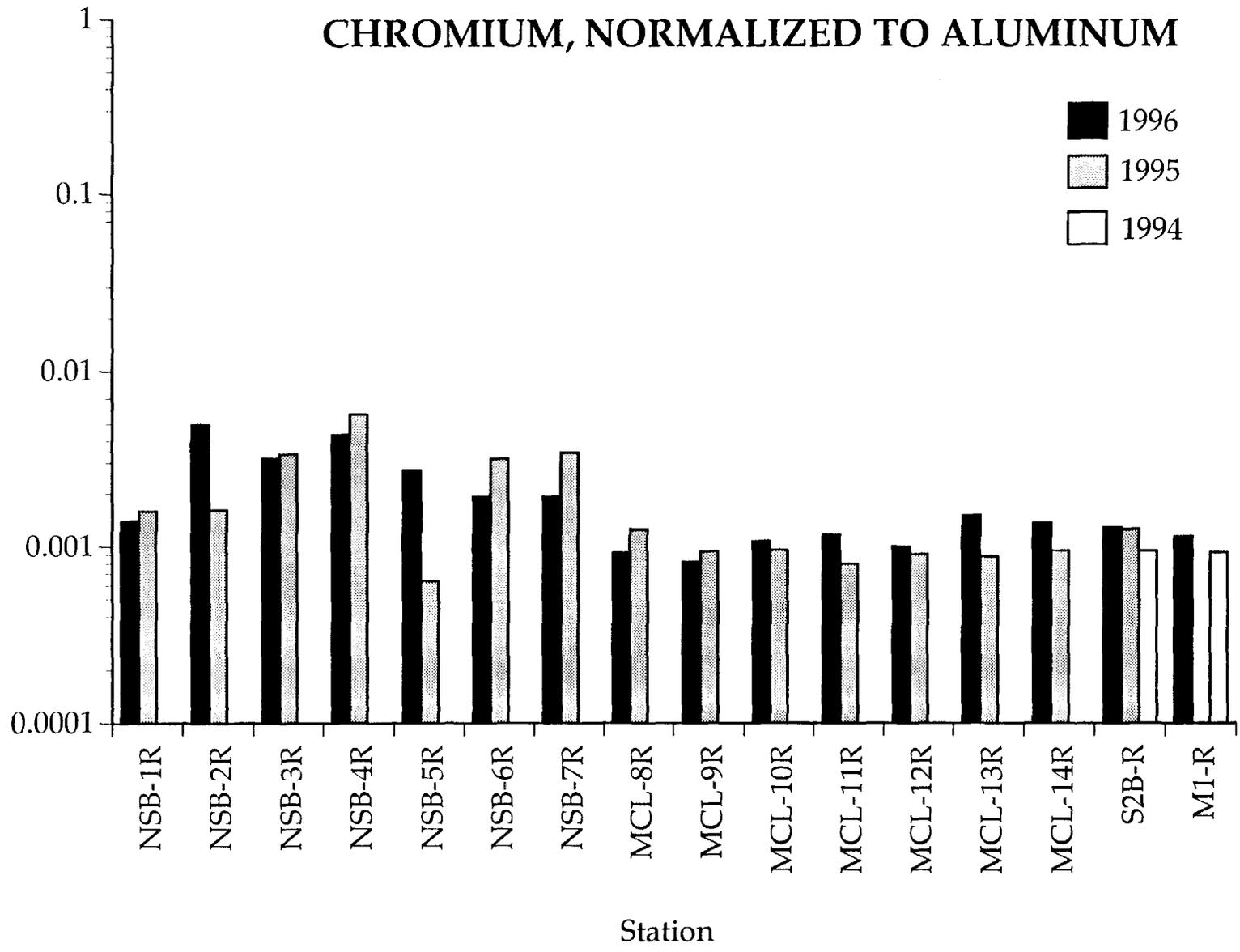


Figure 24 - Comparison of normalized chromium concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

IRON, NORMALIZED TO ALUMINUM

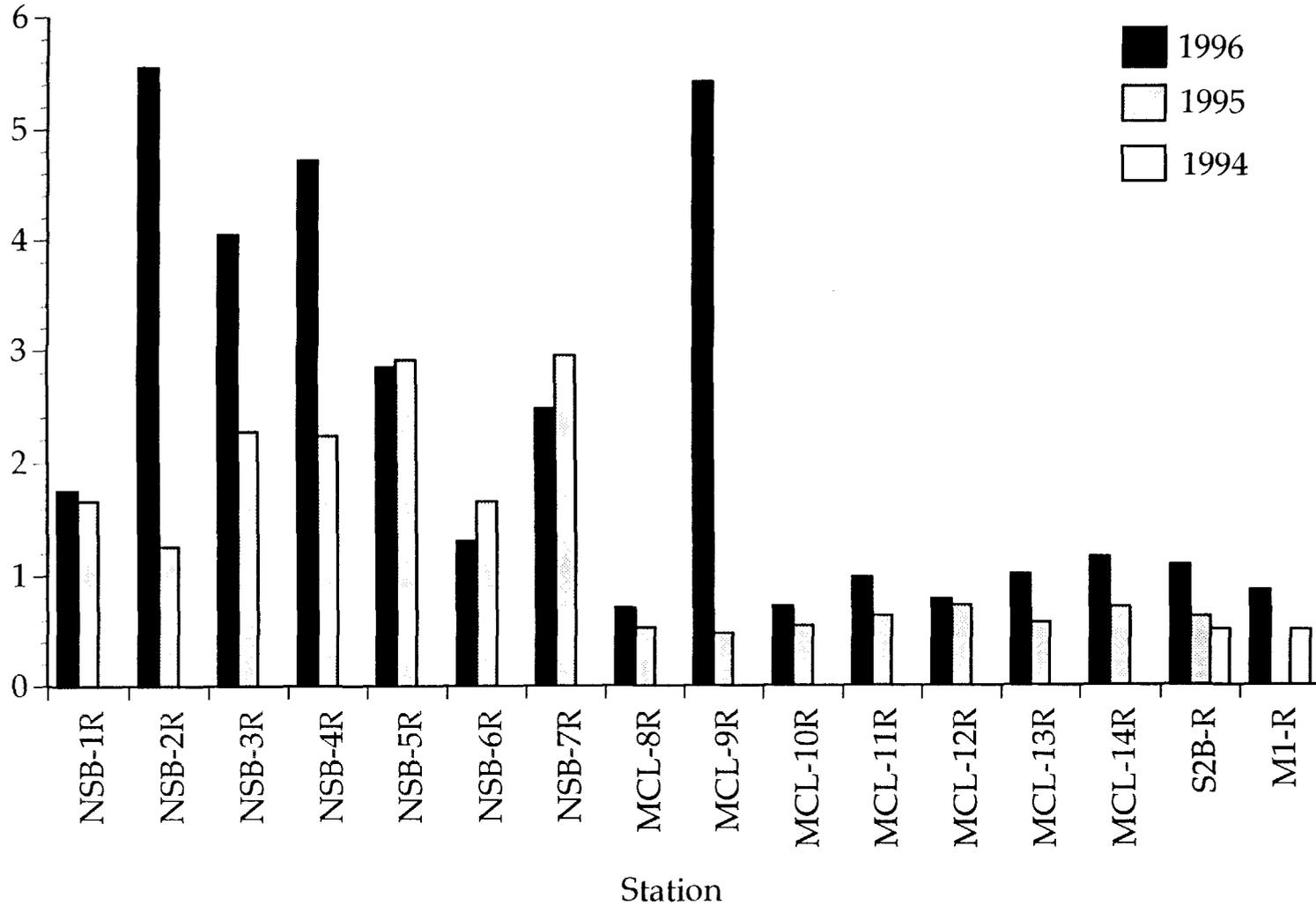


Figure 25 - Comparison of normalized iron concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

MANGANESE, NORMALIZED TO ALUMINUM

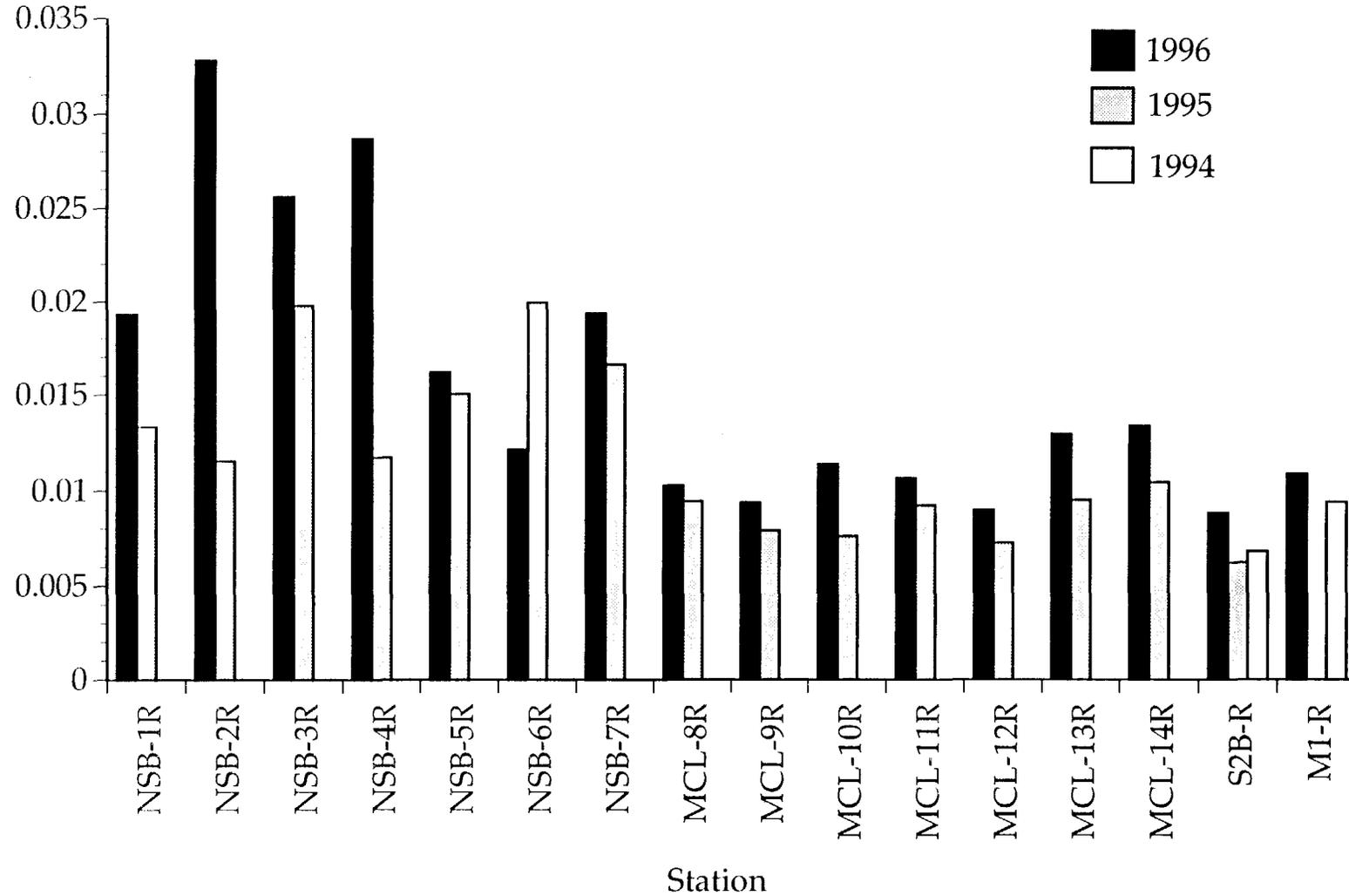


Figure 26 - Comparison of normalized manganese concentrations for Total Digestion of McAllister Point surface samples, phases I - III.

**McAllister Point Phase III Core Samples:
Total Organic Carbon**

CORE SAMPLES

SAMPLE NAME	Interval (cm)	Crucible wt (g)	DRY WEIGHT IN GRAMS				Total % Organic	% Organic Carbon
			WET	100C	550C	% WATER		
NSB-2: 0-18 cm	0-18	4.713	1.709	6.097	6.061	19.0	2.6	1.1
NSB-3: 0-18 cm	0-18	4.953	1.760	6.337	6.287	21.4	3.6	1.6
NSB-4: 0-18 cm	0-18	4.177	1.458	5.112	4.971	35.9	15.1	6.5
NSB-5: 0-18 cm	0-18	4.467	1.629	5.84	5.748	15.7	6.7	2.9
NSB-6: 0-18 cm	0-18	4.838	1.975	6.473	6.412	17.2	3.7	1.6
MCL-10: 0-18 cm	0-18	4.653	1.636	5.627	5.583	40.5	4.5	2.0
MCL-12: 0-18 cm	0-18	4.690	1.672	5.719	5.666	38.5	5.2	2.2

PROCEDURAL DUPLICATES

NSB-4 dup	0-18	4.702	1.537	5.705	5.553	34.7	15.2	6.5
-----------	------	-------	-------	-------	-------	------	------	-----

**McAllister Point Phase III - Core Samples:
Grain Size**

SAMPLE NAME	Interval (cm)	DRY WEIGHT (g)		% Vol					%SILT	
		>63	<63	>3.9u	>15.6u	% SAND	% SILT	%CLAY	63-15.6u	<15.6u
NSB-2	0-18	3.2249	0.1372	99.14	57.63	95.9	4.0	0.0	2.4	1.7
NSB-3	0-18	2.4030	0.4162	99.35	72.47	85.2	14.7	0.1	10.7	4.1
NSB-4	0-18	1.7010	0.7614	98.82	53.39	69.1	30.6	0.4	16.5	14.4
NSB-5	0-18	3.3903	0.2531	99.27	62.33	93.1	6.9	0.1	4.3	2.6
NSB-6	0-18	3.8900	0.8080	99.71	73.04	82.8	17.1	0.0	12.6	4.6
MCL-10	0-18	1.2230	0.8623	99.18	67.57	58.6	41.0	0.3	27.9	13.4
MCL-12	0-18	1.6952	0.8330	99.23	63.71	67.1	32.7	0.3	21.0	12.0

Procedural Duplicate

SAMPLE NAME	Interval (cm)	DRY WEIGHT (g)		% Vol					%SILT	
		>63	<63	>3.9u	>15.6u	% SAND	% SILT	%CLAY	63-15.6u	<15.6u
NSB-4 DUP	0-18	1.2944	0.6992	98.60	47.86	64.9	34.6	0.5	16.8	18.3

**McAllister Point Phase III - Core Samples:
Concentration ($\mu\text{g/g}$) of Metals in Sediment (total digestion method)**

Sample	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Manganese	Nickel	Silver	Zinc
NSB-2: 0-18 cm	39833	15.1	2.5	287.1	614.8	113233	365.3	2.06	917.9	260.2	4.1	4660.0
NSB-3: 0-18 cm	36706	9.7	0.5	65.5	211.2	86831	1051.0	16.77	580.2	56.4	0.8	859.7
NSB-4: 0-18 cm	33780	14.1	4.5	133.0	1384	209084	1181.2	13.02	1018.5	162.8	3.3	24468
NSB-5: 0-18 cm	27325	16.8	1.1	611.0	1227	115459	738.5	3.82	625.1	18.6	8.0	1289.0
NSB-6: 0-18 cm	22542	9.3	0.4	29.2	68.5	35175	125.6	0.69	221.0	18.8	0.4	265.4
MCL-10: 0-18 cm	24478	6.2	0.3	44.8	102.4	24062	46.6	0.21	485.2	14.8	0.1	197.1
MCL-12: 0-18 cm	27901	6.2	0.3	55.3	40.5	39122	75.3	0.26	282.4	16.8	0.4	289.2



Brown & Root Environmental

INTERNAL CORRESPONDENCE

C-52-12-6-3389W

Date: December 9, 1996

To: Stephen Parker

From: Maureen Parker *MP*

Subject: Tier II Data Validation, Proj No. 4725
 University of Rhode Island Laboratory
 Navy CLEAN, McAllister Point Phase III

Metals: 19 soils/ NSB-1R, NSB-2R, NSB-2R-FD, NSB-3R, NSB-4R, NSB-5R,
 NSB-6R, NSB-7R, MCL-8R, MCL-9R, MCL-10R, MCL-11R,
 MCL-12R, MCL-13R, MCL-14R, S2B-R, S2B-R-FD, M1-R,
 Field Blank

A tier II data validation was performed on the inorganic analytical data from sediment samples collected at McAllister Point. The data were evaluated based on the following parameters:

- o Data Completeness
- * o Holding Times
- * o Calibrations
- o Laboratory and Field Blank Results
- o Standard Reference Materials
- * o Matrix Spike/Matrix Spike Duplicate Results
- * o Laboratory Duplicate Sample Results
- o Field Duplicate Precision
- o Internal Check Standard Performance

* All quality control criteria were met for this parameter.

DATA COMPLETENESS

The laboratory was contacted on December 6, 1996 because the data package did not contain a chain of custody form, but it is assumed that since the laboratory that collected the samples also performed the analysis, the chain of custody was intact throughout. A list of the Standard Reference Material (SRM) samples and the corresponding field samples was also requested and the laboratory faxed the information to Brown and Root on December 6, 1996.

BLANKS

The contaminants found in associated laboratory and field blanks are summarized below:

<u>Compound</u>	<u>Maximum Concentration</u>	<u>Action Level</u>
Aluminum	508 µg/g	2540 µg/g
Chromium	0.5 µg/g	2.5 µg/g
Copper	3.1 µg/g	15.5 µg/g
Iron	133 µg/g	665 µg/g
Lead	1.9 µg/g	9.6 µg/g

Memo to Stephen Parker
December 9, 1996
Page Two

<u>Compound</u>	<u>Maximum Concentration</u>	<u>Action Level</u>
Manganese	12.0 µg/g	60 µg/g
Zinc	182.3 µg/g	911.5 µg/g

Blank actions are necessary for aluminum, manganese, copper and zinc in the affected field samples.

Blank Actions:

- Value < CRQL; report CRQL followed by a U.
- Value > CRQL and < action level; report value followed by a U.
- Value > CRQL and > action level; report value unqualified.

STANDARD REFERENCE MATERIAL RECOVERIES

The percent recoveries (%Rs) for chromium, mercury and zinc were outside the 75-125% quality control criteria for the Standard Reference Material (SRM) BCSS-1 in Batch 1. The SRM BCSS-1 was analyzed mainly because it is certified for the analyte silver. The SRM PACS-1A was analyzed in conjunction with BCSS-1 and chromium, mercury and zinc were within the QC criteria; therefore no action was taken for these analytes.

LABORATORY DUPLICATE SAMPLE RESULTS

The Relative Percent Differences (RPDs) for cadmium, chromium, nickel, silver and zinc exceeded the 35% quality control criteria for the laboratory duplicate results. Positive results for these analytes are qualified as estimated, (J) in affected field samples.

FIELD DUPLICATE PRECISION

The field duplicate sample NSB-2R-FD was collected ten days after the original sample NSB-2R. Samples NSB-2R/NSB-2R-FD and S2B-R/S2B-R-FD are co-located samples instead of split samples and therefore this parameter is not used for data validation.

INTERNAL CHECK STANDARD SAMPLE RESULTS

The Internal Check Standard (ICS) results for chromium and nickel are not within the 75 - 125% recovery range in several batches. No further actions are necessary since the positive results for chromium and nickel are already qualified due to poor laboratory duplicate precision.

OVERALL ASSESSMENT

The data should be used as qualified. Blank actions are taken for aluminum, manganese, copper and zinc in affected samples. The positive results for cadmium, chromium, nickel, silver and zinc are qualified in the field samples due to poor laboratory duplicate precision.

Attachments

cc: File 4725 - 4.10

**McAllister Point Phase III:
Concentration ($\mu\text{g/g}$) of Metals in Sediment (Total Digestion Method)**

Sample	NSB-1R		NSB-2R		NSB-2-FD		NSB-3R		NSB-4R		NSB-5R		NSB-6R		NSB-7R		MCL-8R	
Aluminum	29185		31408		43515		40325		37904		40391		36170		28022		47150	
Arsenic	8.8		12.9		18.8		15.2		15.7		14.3		8.6		11.6		6.1	
Cadmium	0.08	J	1.68	J	0.49	J	4.35	J	6.50	J	2.54	J	0.50	J	0.51	J	0.19	J
Chromium	41.0	J	155.8	J	128.1	J	127.4	J	164.2	J	109.5	J	69.7	J	53.8	J	43.2	J
Copper	29.5		7629		820.9		1006		8466		590.8		164.7		177.0		26.2	
Iron	51344		174430		91305		163366		178862		115054		47585		69491		33558	
Lead	17.8		5405		1269		718.4		1478		526.1		134.6		215.3		44.3	
Mercury	0.159		0.267		0.192		1.171		2.926		1.124		0.278		0.377		0.280	
Manganese	563.1		1030.0		700.5		1032.3		1087.1		653.1		439.5		541.9		483.2	
Nickel	26.6	J	87.4	J	16.7	J	75.9	J	223.9	J	120.4	J	56.9	J	39.9	J	23.3	J
Silver	0.1	U	22.1	J	6.7	J	4.0	J	5.3	J	4.7	J	0.6	J	1.7	J	0.3	J
Zinc	159.8	UJ	2135.1	J	1195.0	J	2878.2	J	6912.9	J	2132.2	J	251.5	UJ	1576.4	J	83.7	UJ

NOTES: Sediment sample results are in dry weight.
 J - Quantitation is approximate due to limitations identified in the quality control review.
 U - Value is not detected, or detection limit is raised due to blank contamination.
 UJ - Detection limit is approximate.

**McAllister Point Phase III:
Concentration ($\mu\text{g/g}$) of Metals in Sediment (Total Digestion Method)**

Sample	MCL-9R	MCL-10R	MCL-11R	MCL-12R	MCL-13R	MCL-14R	S2B-R	S2B-R-FD	M1-R
Aluminum	49103	50869	33231	49396	23849	26490	26515	41536	29115
Arsenic	5.2	7.0	3.6	5.0	2.8	4.5	4.5	6.3	3.2
Cadmium	0.19 J	0.81 J	0.11 J	0.40 J	0.09 J	0.07 J	0.21 J	0.48 J	0.11 J
Chromium	39.9 J	54.8 J	38.5 J	49.3 J	35.9 J	36.1 J	34.0 J	73.5 J	33.3 J
Copper	24.5	250.0	12.9 U	49.4	13.2 U	4.5 U	25.1	51.5	14.5 U
Iron	26159	36838	32554	38760	24032	30819	28901	32411	25075
Lead	44.1	61.0	28.0	58.6	25.1	28.3	33.1	70.2	25.7
Mercury	0.232	0.291	0.154	0.367	0.164	0.135	0.173	1.008	0.213
Manganese	460.2	577.9	354.3	444.0	308.7	354.5	234.4	369.4	316.7
Nickel	16.5 J	18.9 J	18.2 J	20.8 J	9.4 J	17.8 J	11.4 J	22.6 J	6.9 J
Silver	0.3 J	0.5 J	0.2 J	0.5 J	0.1 J	0.2 J	0.2 J	0.9 J	0.1 U
Zinc	65.1 UJ	649.7 UJ	2.3 U	287.2 UJ	2.3 U	862.0 UJ	2.3 U	103.1 UJ	2.3 U

NOTES: Sediment sample results are in dry weight.
 J - Quantitation is approximate due to limitations identified in the quality control review.
 U - Value is not detected, or detection limit is raised due to blank contamination.
 UJ - Detection limit is approximate.

**McAllister Point Phase III:
Concentration ($\mu\text{g/g}$) of Metals in Sediment (Total Digestion Method)**

Sample	9-20-96 Field Blank	
Aluminum	493	U
Arsenic	1.3	U
Cadmium	0.05	U
Chromium	0.5	J
Copper	3.1	
Iron	15	
Lead	1.93	
Mercury	0.500	U
Manganese	11.6	U
Nickel	2.0	U
Silver	0.1	U
Zinc	2.3	U

NOTES:

Sediment sample results are in dry weight.

J - Quantitation is approximate due to limitations identified in the quality control review.

U - Value is not detected, or detection limit is raised due to blank contamination.

UJ - Detection limit is approximate.

REGION I
Data Review Worksheets

Site Name McAllister Point Phase 3
Reference Number 5-21-7289 W

REGION I REVIEW OF INORGANIC
CONTRACT LABORATORY DATA PACKAGE

The hardcopied (laboratory name) URE data package received at Region I has been reviewed and the quality assurance and performance data summarized. The data review included:

Case No. 4725 SAS No. _____ Sampling Date(s) _____
SDG. No. _____ Matrix sediment Shipping Date(s) _____
No. of Samples 19 Date Rec'd by Lab _____

Traffic Report Nos: See notes on times.
Trap Blank No.: _____
Equipment Blank No.: _____
Field Cup Nos: _____

SOW No. _____ requires that specific analytical work be done and that associated reports be provided by the laboratory to the Regions, EMSL-IV, and SMO. The general criteria used to determine the performance were based on an examination of:

- Data Completeness
- Holding Times
- Calibrations
- Blanks
- ICP Interference Check Results
- Matrix Spike Recoveries
- Laboratory Duplicates
- Field Duplicates
- Lab Control Sample Results
- Furnace AA Results
- ICP Serial Dilution Results
- Detection Limit Results
- Sample Quantitation

Overall Comments: ✓ ER = data validation

Definitions and Qualifiers:

- 1 - Acceptable data.
- 2 - Approximate data due to quality control criteria.
- 3 - Reject data due to quality control criteria.
- 4 - Analyte not detected.

Reviewer: Maurice Furbush Date: Dec 7, 1996

REGION I
Data Review Worksheets

I. DATA COMPLETENESS

MISSING INFORMATION

DATE LAB CONTACTED

DATE REC'D

There was no chain of custody included in the package -
it is assumed since the laboratory collected and analyzed the samples
custody remained intact throughout.

Carol Gibson
to: 874-6182

REGION I
Data Review Worksheets

II. HOLDING TIMES Complete table for all samples and circle the analysis date for samples not within criteria.

SAMPLE ID	DATE SAMPLED	HG DATE ANALYSIS	CYANIDE DATE ANALYSIS	OTHERS DATE ANALYSIS	pH	ACTION
NSB-1R	9/20/96	47 9/11/96	NR	all within 90 days	Soils N/A	None
NSB-2R	9/20/96	47				
NSB-2-FD	9/30/96	37				
NSB-2R	9/20/96	47				
NSB-4R	9/18/96	49				
NSB-5R	9/18/96	49				
NSB-6R	9/20/96	47				
NSB-7R	9/18/96	49				
MCL-8R	9/12/96	55				
MCL-9R	9/12/96	55				
MCL-10R	9/12/96	55				
MCL-11R	9/12/96	55				
MCL-12R	9/10/96	57				
MCL-13R	9/12/96	55				
MCL-14R	9/10/96	57 ✓	✓			✓

Samples were freeze dried therefore no qualification for mercury.

METALS - 180 DAYS FROM SAMPLE COLLECTION
MERCURY - 30 DAYS FROM SAMPLE COLLECTION
CYANIDE - 14 DAYS FROM SAMPLE COLLECTION

ACTION:

- If holding times are exceeded all positive results are estimated (E) and non-detects are estimated (ND).
- If holding times are grossly exceeded, the reviewer may determine that non-detects are unusable (R).

REGION I
Data Review worksheets

III A. INSTRUMENT CALIBRATION (Section 1)

1. Recovery Criteria

List the analytes which did not meet the percent recovery (%R) criteria for Initial or Continuing Calibration.

<u>DATE</u>	<u>ICV/CCV#</u>	<u>ANALYTE</u>	<u>%R</u>	<u>ACTION</u>	<u>SAMPLES AFFECTED</u>
	Batch 3	0.989	R ² - 0.950	✓	

ACTIONS:

If any analyte does not meet the %R criteria follow the actions stated below:

For Positive Results:

	<u>Accept</u>	<u>Estimate (E)</u>	<u>Reject (R)</u>
Metals	90-110%R	75-89%R, 111-125%R	<75%R, >125%R
Mercury	80-110%R	65-79%R, 121-135%R	<65%R, >135%R
Cyanide	85-115%R	70-84%R, 116-130%R	<70%R, >130%R

For Non-detected Results:

	<u>Accept</u>	<u>Estimate (E)</u>	<u>Reject (R)</u>
Metals	90-125%R	75-89%R	<75%R, >125%R
Mercury	80-135%R	65-79%R	<65%R, >135%R
Cyanide	85-130%R	70-84%R	<70%R, >130%R

CRDL standard analyses: (80-120% R criteria)

Analyte %R Actions

REGION I
Data Review Worksheet

IV A. BLANK ANALYSIS RESULTS (Sections 1-3)

List the blank contamination in Sections 1 & 2 below. A separate worksheet should be used for soil and water blanks.

1. Laboratory Blanks

MATRIX: soil

DATE	ICB/CCB#	PREP BL	ANALYTE	CONC./UNITS
	<u>Blank B</u>		<u>Mn</u>	<u>11.3 ug/g</u>
	<u>Blank C</u>		<u>Al</u>	<u>508 ug/g</u>
			<u>Fe</u>	<u>133 ug/g</u>
			<u>Mn</u>	<u>12 ug/g</u>
			<u>Zn</u>	<u>182.3 ug/g</u>

2. Equipment/Trip Blanks

DATE	EQUIP BL#	ANALYTE	CONC./UNITS
	<u>Field Blank</u>	<u>Aluminum</u>	<u>493 ug/g</u>
		<u>Chromium</u>	<u>0.5 ug/g</u>
		<u>Copper</u>	<u>3.1 ug/g</u>
		<u>Lead</u>	<u>1.93 ug/g</u>
		<u>Manganese</u>	<u>11.6 ug/g</u>

3. Frequency Requirements

- A. Was a preparation blank analyzed for each matrix, for every 20 samples and for each digestion batch? Yes or No
- B. Was a calibration blank run every 10 samples or every 8 hours whichever is more frequent? Yes or No

If No,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below, and list the samples affected.

REGION I
Data Review Worksheets

IV B. BLANK ANALYSIS RESULTS (Section 4)

4. Blank Actions

The Action Levels for any analyte is equal to five times the highest concentration of that element's contamination in any blank. The action level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor. No positive sample result should be reported unless the concentration of the analyte in the sample exceeds the Action Level (AL). Specific actions are as follows:

1. When the concentration is greater than the IDL, but less than the Action Level, report the sample concentration detected with a U.
2. When the sample concentration is greater than the Action Level, report the sample concentration unqualified.

MATRIX: _____

MATRIX: _____

<u>ELEMENT</u>	<u>MAX. CONC./</u> <u>UNITS</u> <i>ug/g</i>	<u>AL/</u> <u>UNITS</u> <i>ug/g</i>	<u>ELEMENT</u>	<u>MAX. CONC./</u> <u>UNITS</u>	<u>AL/</u> <u>UNITS</u>
Al	508	2540			
Fe	133	665			
Mn	12	60			
Cr	0.5	2.5			
Cu	3.1	15.5			
Pb	1.93	9.65			
Zn	182.3	911.5			

NOTE: Blanks analyzed during a soil case must be converted to mg/kg in order to compare them with the sample results.

$$\text{Conc. in } \mu\text{g/L} \times \frac{\text{Volume diluted to (300ml)}}{\text{Weight digested (1gram)}} \times \frac{1\text{L}}{1000\text{ml}} \times \frac{1000\mu\text{g}}{1\text{mg}} \times \frac{1\text{kg}}{1000\text{g}} = \text{mg/kg}$$

Multiplying this result by 5 to arrive at the action level gives a final result in mg/kg which can then be compared to sample results.

Cr, Cu
Al, Fe, Pb, Mn, Zn

Blank - 0.000
AL 0.000

REGION I
Data Review Worksheets

Standard Reference Materials

- 75-125% recovery

V A. ~~ICP INTERFERENCE CHECK~~ SAMPLE (Sections 1 & 2)

1. Recovery Criteria

List any elements in the ICS AB solution which did not meet the criteria for %R.

DATE	ELEMENT	%R	ACTION	SAMPLES AFFECTED
BCSS-1	Cr	74	None	BCSS-1 was analyzed for silver
BCSS-1	Hg	182	None	↓ only - the associated PACS
BCSS-1	Zn	60	None	was all within QC criteria

ACTIONS:

If an element does not meet the %R criteria, follow the actions stated below:

	PERCENT RECOVERY		
	<50%	50-79%	>120%
Positive Sample Results	R	J	J
Non-detected Sample Results	R	UJ	A

2. Frequency Requirements

Were Interference QC samples run at the beginning and end of each sample analysis run or a minimum of twice per 8 hour working shift, whichever is more frequent? Yes or No

If no,

The data may be affected. Use professional judgement to determine the severity of the effect and qualify the data accordingly. Discuss any actions below and list the samples affected.

REGION I
Data Review Worksheets

VI. MATRIX SPIKE

TR = MCL-9R

MATRIX: soil

1. Recovery Criteria

List the percent recoveries for analytes which did not meet the required criteria.

S - amount of spike added
SSR - spikes sample result
SR - sample result

Analyte	SSR	SR	S	%R	Action
Pb	74298	26159	37500	128	lab QC criteria 50-150% NO action
Hg	0.889	0.232	0.5	131	50-150% No action

Matrix Spike Actions apply to all samples of the same matrix.

ACTIONS:

- If the sample concentration exceeds the spike concentration by a factor of 4 or more, no action is taken.
- If any analyte does not meet the %R criteria follow the actions stated below:

	PERCENT RECOVERY		
	<10%	10%-74%	>125%
Positive Sample Results	J	J	J
Non-detected Results	R	UU	A

3. Frequency Criteria

- Was a matrix spike prepared at the required frequency? Yes or No
- Was a post digestion spike analyzed for elements that did not meet required criteria for matrix spike recovery? Yes or No

A separate worksheet should be used for each matrix spike pair.

REGION I
Data Review Worksheets

VI. MATRIX SPIKE

TR = MCL-10R

MATRIX: Soil

1. Recovery Criteria

List the percent recoveries for analytes which did not meet the required criteria.

S - amount of spike added
SSR - spikes sample result
SR - sample result

Analyte	SSR	SR	S	%R	Action
Hl	82268	30869	25000	126	Lab QC Criteria 50-150% No action
Mn	1295.8	577.9	500	144	50-150% No action

Matrix Spike Actions apply to all samples of the same matrix.

ACTIONS:

- If the sample concentration exceeds the spike concentration by a factor of 4 or more, no action is taken.
- If any analyte does not meet the %R criteria follow the actions stated below:

	PERCENT RECOVERY		
	<30%	30%-74%	>125%
Positive Sample Results	J	J	J
Non-detected Results	R	UJ	A

2. Frequency Criteria

- Was a matrix spike prepared at the required frequency? Yes or No
- Was a post digestion spike analyzed for elements that did not meet required criteria for matrix spike recovery? Yes or No

A separate worksheet should be used for each matrix spike pair.

REGION I
Data Review Worksheets

Estimate positive results for nickel silver + zinc

VII. LABORATORY DUPLICATES

List the concentrations of any analyte not meeting the criteria for duplicate precision. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate precision by circling either the RPD or CRDL for each element.

MATRIX: soil

Element	CRDL		Sample # <u>NSB-SR</u>	Duplicates <u>NSB-SR₂</u>	RPD	Action
	water ug/L	soil mg/kg				
Aluminum	200					
Antimony	60					
Arsenic	10					
Barium	200					
Beryllium	5					
Cadmium	5					
Calcium	5000					
Chromium	10					
Cobalt	50					
Copper	25					
Iron	100					
Lead	5					
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	40		75.5	120.4	46	(+)
Potassium	5000					
Selenium	5					
Silver	10		8.2	4.7	54	(-)
Sodium	5000					
Thallium	10					
Vanadium	50					
Zinc	20		366.6	2132.2	53	(+)
Cyanide	10					

Laboratory Duplicate Actions should be applied to all other samples of the same matrix type.

ACTIONS:

1. Estimate (J) positive results for elements which have an RPD >20% for waters and >35% for soils.
2. If sample results are less than 5x the CRDL, estimate (J) positive results for elements whose absolute difference is >CRDL. (1xCRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

*Cadmium
Chromium
Nickel
Silver
Zinc*

REGION I
Data Review Worksheets

*Estimate
Cadmium, Chromium
Silver + Zinc*

VIII. LABORATORY DUPLICATES

List the concentrations of all analytes in the field duplicate pair. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate the precision by circling either the RPD or CRDL for each element.

MATRIX: Soil

Element	CRDL		Sample = <u>NSD-7Ramp</u>	Duplicate* <u>NSB-7R</u>	RPD	Action
	water ug/L	soil mg/kg				
Aluminum	200					
Antimony	60					
Arsenic	10					
Barium	200					
Beryllium	5					
Cadmium	5		0.77	0.51	41	T+
Calcium	5000					
Chromium	10		103.2	53.8	63	J+
Cobalt	50					
Copper	25					
Iron	100					
Lead	5					
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	40					
Potassium	5000					
Selenium	5					
Silver	10		0.8	1.7	73	J+
Sodium	5000					
Thallium	10					
Vanadium	50					
Zinc	20		406.1	1574.4	54	J+
Cyanide	10					

Field Duplicate Actions should be applied to all other samples of the same matrix type.

ACTIONS:

1. Estimate (J) positive results for elements which have an RPD >30% for waters and >50% for soils.
2. If sample results are less than six the CRDL, estimate (J) positive results and (NC) nondetected results for elements whose absolute difference is >2xCRDL (4xCRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

REGION I
Data Review Worksheets

Estimate
(J) results for Cd, Nickel
Silver + Zinc.

VIII. LABORATORY DUPLICATES

List the concentrations of all analytes in the field duplicate pair. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate the precision by circling either the RPD or CRDL for each element.

MATRIX: soil

Element	CRDL		Sample # MCL-8 R _{dup}	Duplicates MCL-8 R	RPD	Action
	water ug/L	soil mg/kg				
Aluminum	200					
Antimony	60					
Arsenic	10					
Barium	200					
Beryllium	5					
Cadmium	5		0.19	0.36	62	(J)
Calcium	5000					
Chromium	10					
Cobalt	50					
Copper	25					
Iron	100					
Lead	5					
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	40		12.0	23.3	64	(J)
Potassium	5000					
Selenium	5					
Silver	10		0.5	0.3	57	(J)
Sodium	5000					
Thallium	10					
Vanadium	50					
Zinc	20		252	23.7	100	(J)
Cyanide	10					

Field Duplicate Actions should be applied to all other samples of the same matrix type.

ACTIONS:

1. Estimate (J) positive results for elements which have an RPD >30% for waters and >50% for soils.
2. If sample results are less than 5x the CRDL, estimate (J) positive results and (UJ) nondetected results for elements whose absolute difference is >2xCRDL, (4xCRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

REGION I
Data Review Worksheets

NSB-2R + NSB-2RFD
taken 10 days apart

VII. Field DUPLICATES

List the concentrations of any analyte not meeting the criteria for duplicate precision. For soil duplicates, calculate the CRDL in mg/kg using the sample weight, volume and percent solids data for the sample. Indicate what criteria was used to evaluate precision by circling either the RPD or CRDL for each element.

MATRIX: _____

Element	CRDL		Sample #	Duplicate#	RPD	Action
	water ug/L	soil mg/kg				
Aluminum	200					
Antimony	60					
Arsenic	10					
Barium	200					
Beryllium	5					
Cadmium	5					
Calcium	5000					
Chromium	10					
Cobalt	50					
Copper	25					
Iron	100					
Lead	5					
Magnesium	5000					
Manganese	15					
Mercury	0.2					
Nickel	40					
Potassium	5000					
Selenium	5					
Silver	10					
Sodium	5000					
Thallium	10					
Vanadium	50					
Zinc	20					
Cyanide	10					

Field samples NOT used
due to one sample
being taken 10 days
apart
the other
the 1st one is
to be used instead
of split
samples

Laboratory Duplicate Actions should be applied to all other samples of the same matrix type.

ACTIONS:

1. Estimate (E) positive results for elements which have an RPD >20% for waters and >35% for soils.
2. If sample results are less than 5x the CRDL, estimate (E) positive results for elements whose absolute difference is >CRDL (2xCRDL for soils). If both samples are non-detected, the RPD is not calculated (NC).

REGION I
Data Review Worksheets

Internal Check standards

IX. ~~LABORATORY CONTROL SAMPLE~~

1. Aqueous LCS

List any LCS recoveries not within the 80-120% criteria and the samples affected.

DATE	ELEMENT	%R	ACTION	SAMPLES AFFECTED
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

2. Solid LCS

List any analytes that were not within the control windows set by the EPA for the solid LCS sample. The 80-120% criteria is not used to evaluate solid LCS results.

ELEMENT	LCS CONC.	CONTROL WINDOWS	ACTION	SAMPLES AFFECTED
Chromium	1.3	0 - 0.8		Batch 2 ??
Nickel	12.2	15.0 - 25.0		Batch 2
Nickel	11.1	15.0 - 25.0		Batch 3
Nickel	13.1	15.0 - 25.0		Batch 5
_____	_____	_____	_____	_____

already qualified for poor lab duplicate results.

ACTIONS:

AQUEOUS LCS	Percent Recovery		
	<50%	51-79%	>120%

Positive Results	R	J	J
Non-detected Results	R	UJ	A

SOLID LCS	<EPA Control Windows	>EPA Control Windows
-----------	----------------------	----------------------

Positive Results	J	J
Non-detected Results	UJ	A

3. Frequency Criteria

- A. Was an LCS analyzed for every matrix, every digestion batch, and every 20 samples? Yes or No

APPENDIX C-3

**ANALYTICAL RESULTS FROM SAMPLES
COLLECTED FROM THE SOUTHERN SEEP AREA**

CTO# 197
 McALLISTER POINT LANDFILL SOUTHERN SEEP AREA
 CEIMIC CORPORATION

SOIL VOLATILE ORGANICS (UG/KG)

STATION ID:

LABORATORY ID:

MP-SS-S-C1-0006
 960996-01

MP-SS-S-C1-1218
 960996-02

MP-SS-S-E2-0006
 960996-03

MP-SS-S-DUP1
 960996-04

ANALYTE

CRQL MDL/IDL

C6-C10 (Gasoline Range)

Bromofluorobenzene

10

1

260

13

600

15

720

7.2

1100

10

DILUTION FACTOR

% SOLIDS

1

85

1

86

1

91

1

90

CTO# 197
 McALLISTER POINT LANDFILL SOUTHERN SEEP AREA
 CEIMIC CORPORATION

SOIL VOLATILE ORGANICS (UG/KG)
 STATION ID:
 LABORATORY ID:

MP-SS-S-E2-1218
 960996-05

MP-SS-S-A1-0006
 960996-06

MP-SS-S-G1-0006
 960996-07

MP-SS-S-F3-0006
 960996-08

ANALYTE	CRQL	MDL/IDL				
C6-C10 (Gasoline Range)			740	130	U	180
Bromofluorobenzene	10	1	17	16		13
DILUTION FACTOR			1	1		1
% SOLIDS			83	77		83

CTO# 197
 McALLISTER POINT LANDFILL SOUTHERN SEEP AREA
 CEIMIC CORPORATION

SOIL VOLATILE ORGANICS (UG/KG)
 STATION ID:
 LABORATORY ID:

MP-SS-S-B3-0006
 960996-09

MP-SS-S-D0-0006
 960996-10

MP-SS-S-D3-0006
 960996-11

ANALYTE	CRQL	MDL/IDL			
C6-C10 (Gasoline Range)			270	230	150
Bromofluorobenzene	10	1	17	11	14
DILUTION FACTOR			1	1	1
% SOLIDS			85	85	84

TOTAL PETROLEUM HYDROCARBONS (TPH)
 (Extractables)
 by Modified Method 8015B

Client: Brown & Root Environmental
 Client Sample ID: MP-SS-S-C1-1218
 Date Sampled: 11/22/96
 Date Sample Received: 11/23/96
 Matrix: Soil
 Percent Solids: 86

Laboratory ID: 960996-02
 Date Sample Extracted: 12/03/96
 Date Sample Analyzed: 12/11/96
 Associated Method Blank: F1203-B2
 Final Extract Volume (mL): 5.0
 Dilution Factor: 1
 Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	57
JP-4	ND	57
Kerosene	ND	57
Jet Fuel A	ND	57
JP-5	ND	57
JP-8	ND	57
Mineral Oil	ND	57
Naphtha	ND	57
Diesel Fuel	ND	57
Fuel Oil #2	ND	57
Fuel Oil #4	ND	57
Fuel Oil #5	ND	57
Fuel Oil #6	ND	57
Bunker Oil	ND	57
Motor Oil	ND	57
Hydraulic Jack Oil	ND	57
Transmission Fluid	ND	57
Lubricating Oil	PM	57
Compressor Oil	ND	57
Creosote	ND	57
Diesel Range Organics	31J	57

PM = Pattern matches target analyte
 ND = Not detected
 + Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	107	19 - 101

* These limits are provided for advisory purposes.

Reported by: _____ *[Signature]*

Approved by: _____ *[Signature]*

TOTAL PETROLEUM HYDROCARBONS (TPH)
 (Extractables)
 by Modified Method 8015B

Client: Brown & Root Environmental
 Client Sample ID: MP-SS-S-E2-0006
 Date Sampled: 11/22/96
 Date Sample Received: 11/23/96
 Matrix: Soil
 Percent Solids: 91

Laboratory ID: 960996-03
 Date Sample Extracted: 12/03/96
 Date Sample Analyzed: 12/11/96
 Associated Method Blank: F1203-B2
 Final Extract Volume (mL): 5.0
 Dilution Factor: 10
 Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	540
JP-4	ND	540
Kerosene	ND	540
Jet Fuel A	ND	540
JP-5	ND	540
JP-8	ND	540
Mineral Oil	ND	540
Naphtha	ND	540
Diesel Fuel	ND	540
Fuel Oil #2	ND	540
Fuel Oil #4	ND	540
Fuel Oil #5	ND	540
Fuel Oil #6	ND	540
Bunker Oil	ND	540
Motor Oil	ND	540
Hydraulic Jack Oil	ND	540
Transmission Fluid	PM	540
Lubricating Oil	ND	540
Compressor Oil	ND	540
Creosote	ND	540
Diesel Range Organics	7800	540

PM = Pattern matches target analyte
 ND = Not detected
 - Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	CO	19 - 101

CO = Co-elutes with TPH in the sample
 * These limits are provided for advisory purposes.

Reported by: _____

Approved by: _____

TOTAL PETROLEUM HYDROCARBONS (TPH)
(Extractables)
 by Modified Method 8015B

Client: Brown & Root Environmental
 Client Sample ID: MP-SS-S-E2-1218
 Date Sampled: 11/22/96
 Date Sample Received: 11/23/96
 Matrix: Soil
 Percent Solids: 83

Laboratory ID: 960996-05
 Date Sample Extracted: 12/03/96
 Date Sample Analyzed: 12/11/96
 Associated Method Blank: F1203-B2
 Final Extract Volume (mL): 5.0
 Dilution Factor: 1
 Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	60
JP-4	ND	60
Kerosene	ND	60
Jet Fuel A	ND	60
JP-5	ND	60
JP-8	ND	60
Mineral Oil	ND	60
Naphtha	ND	60
Diesel Fuel	ND	60
Fuel Oil #2	ND	60
Fuel Oil #4	ND	60
Fuel Oil #5	ND	60
Fuel Oil #6	ND	60
Bunker Oil	ND	60
Motor Oil	ND	60
Hydraulic Jack Oil	ND	60
Transmission Fluid	PM	60
Lubricating Oil	ND	60
Compressor Oil	ND	60
Creosote	ND	60
Diesel Range Organics	180	60

PM = Pattern matches target analyte
 ND = Not detected
 + Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	87	19 - 101

* These limits are provided for advisory purposes.

Reported by: _____

Approved by: _____

TOTAL PETROLEUM HYDROCARBONS (TPH)
(Extractables)
 by Modified Method 8015B

Client: Brown & Root Environmental
 Client Sample ID: MP-SS-S-F3-0006
 Date Sampled: 11/22/96
 Date Sample Received: 11/23/96
 Matrix: Soil
 Percent Solids: 83

Laboratory ID: 960996-08
 Date Sample Extracted: 12/03/96
 Date Sample Analyzed: 12/11/96
 Associated Method Blank: F1203-B2
 Final Extract Volume (mL): 5.0
 Dilution Factor: 5
 Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	300
JP-4	ND	300
Kerosene	ND	300
Jet Fuel A	ND	300
JP-5	ND	300
JP-8	ND	300
Mineral Oil	ND	300
Naphtha	ND	300
Diesel Fuel	ND	300
Fuel Oil #2	ND	300
Fuel Oil #4	ND	300
Fuel Oil #5	ND	300
Fuel Oil #6	ND	300
Bunker Oil	ND	300
Motor Oil	ND	300
Hydraulic Jack Oil	ND	300
Transmission Fluid	PM	300
Lubricating Oil	ND	300
Compressor Oil	ND	300
Creosote	ND	300
Diesel Range Organics	1100	300

PM = Pattern matches target analyte
 ND = Not detected
 + Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	112	19 - 101

* These limits are provided for advisory purposes.

Reported by: _____

Approved by: _____

TOTAL PETROLEUM HYDROCARBONS (TPH)
(Extractables)
 by Modified Method 8015B

Client: Brown & Root Environmental
 Client Sample ID: MP-SS-S-B3-0006
 Date Sampled: 11/22/96
 Date Sample Received: 11/23/96
 Matrix: Soil
 Percent Solids: 85

Laboratory ID: 960996-09
 Date Sample Extracted: 12/03/96
 Date Sample Analyzed: 12/11/96
 Associated Method Blank: F1203-B2
 Final Extract Volume (mL): 5.0
 Dilution Factor: 1
 Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	60
JP-4	ND	60
Kerosene	ND	60
Jet Fuel A	ND	60
JP-5	ND	60
JP-8	ND	60
Mineral Oil	ND	60
Naphtha	ND	60
Diesel Fuel	ND	60
Fuel Oil #2	ND	60
Fuel Oil #4	ND	60
Fuel Oil #5	ND	60
Fuel Oil #6	ND	60
Bunker Oil	ND	60
Motor Oil	ND	60
Hydraulic Jack Oil	ND	60
Transmission Fluid	PM	60
Lubricating Oil	ND	60
Compressor Oil	ND	60
Creosote	ND	60
Diesel Range Organics	140	60

PM = Pattern matches target analyte
 ND = Not detected
 + Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	77	19 - 101

* These limits are provided for advisory purposes.

Reported by: _____

Approved by: _____ HL

TOTAL PETROLEUM HYDROCARBONS (TPH)
(Extractables)
by Modified Method 8015B

Client: Brown & Root Environmental
Client Sample ID: MP-SS-S-D0-0006
Date Sampled: 11/22/96
Date Sample Received: 11/23/96
Matrix: Soil
Percent Solids: 85

Laboratory ID: 960996-10
Date Sample Extracted: 12/03/96
Date Sample Analyzed: 12/11/96
Associated Method Blank: F1203-B2
Final Extract Volume (mL): 5.0
Dilution Factor: 5
Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	290
JP-4	ND	290
Kerosene	ND	290
Jet Fuel A	ND	290
JP-5	ND	290
JP-8	ND	290
Mineral Oil	ND	290
Naphtha	ND	290
Diesel Fuel	ND	290
Fuel Oil #2	ND	290
Fuel Oil #4	ND	290
Fuel Oil #5	ND	290
Fuel Oil #6	ND	290
Bunker Oil	ND	290
Motor Oil	ND	290
Hydraulic Jack Oil	ND	290
Transmission Fluid	ND	290
Lubricating Oil	PM	290
Compressor Oil	ND	290
Creosote	ND	290
Diesel Range Organics	280J	290

PM = Pattern matches target analyte
ND = Not detected
+ Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	114	19 - 101

* These limits are provided for advisory purposes.

Reported by: _____ *JS*

Approved by: _____ *HL*

TOTAL PETROLEUM HYDROCARBONS (TPH)
(Extractables)
 by Modified Method 8015B

Client: Brown & Root Environmental
 Client Sample ID: MP-SS-S-D3-0006
 Date Sampled: 11/22/96
 Date Sample Received: 11/23/96
 Matrix: Soil
 Percent Solids: 84

Laboratory ID: 960996-11
 Date Sample Extracted: 12/03/96
 Date Sample Analyzed: 12/11/96
 Associated Method Blank: F1203-B2
 Final Extract Volume (mL): 5.0
 Dilution Factor: 5
 Concentration in: mg/Kg (ppm) +

Target Analyte	Sample Concentration	Quantitation Limit
Mineral Spirits	ND	300
JP-4	ND	300
Kerosene	ND	300
Jet Fuel A	ND	300
JP-5	ND	300
JP-8	ND	300
Mineral Oil	ND	300
Naphtha	ND	300
Diesel Fuel	ND	300
Fuel Oil #2	ND	300
Fuel Oil #4	ND	300
Fuel Oil #5	ND	300
Fuel Oil #6	ND	300
Bunker Oil	ND	300
Motor Oil	ND	300
Hydraulic Jack Oil	ND	300
Transmission Fluid	PM	300
Lubricating Oil	ND	300
Compressor Oil	ND	300
Creosote	ND	300
Diesel Range Organics	1200	300

PM = Pattern matches target analyte
 ND = Not detected
 + Dry weight basis.

Surrogate Spike Recovery

Surrogate Compound	Recovery(%)	QC Limits(%)*
n-Eicosane	76	19 - 101

* These limits are provided for advisory purposes.

Reported by: _____

Approved by: _____

CTO# 197
 McALLISTER POINT LANDFILL SOUTHERN SEEP AREA
 CEIMIC CORPORATION

SOIL POLYCHLORINATED BIPHENYLS (PCB) (UG/KG)

STATION ID: MP-SS-S-C1-0006 MP-SS-S-E2-0006 MP-SS-S-DUP1
 LABORATORY ID: 960996-01 960996-03 960996-04

ANALYTE	CRQL	MDL/IDL			
Aroclor-1016	1	0.33	39	U	36 U
Aroclor-1221	2	0.67	78	U	72 U
Aroclor-1232	1	0.33	39	U	36 U
Aroclor-1242	1	0.33	39	U	36 U
Aroclor-1248	1	0.33	39	U	36 U
Aroclor-1254	1	0.33	60		170
Aroclor-1260	1	0.33	39	U	36 U
Decachlorobiphenyl		0.05	7		12
Tetrachloro-m-xylene		0.01	5.9		9.4
DILUTION FACTOR			1		1
% SOLIDS			85		91

APPENDIX D
DATA FROM TOXICITY ANALYSIS

APPENDIX D-1

**AMPHIPOD TOXICITY TESTS,
NEAR SHORE AND OFF SHORE SAMPLE STATIONS**

**10-Day Amphipod Solid-Phase
Toxicity Tests Results**

**McAllister Point Resampling
Newport, Rhode Island**

1 November 1996

Submitted to:

Science Applications International Corporation
Applied Aquatic Science Division
165 Dean Knauss Drive
Narragansett, RI 02882

Submitted by:

Science Applications International Corporation
Environmental Testing Center
165 Dean Knauss Drive
Narragansett, RI 02882

SAIC Project Number
01-0440-04-3930-055

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Appendix A. ETC Standard Operating Procedures.

Appendix B. Amphipod (*Ampelisca abdita*) 10-Day Solid-Phase Toxicity Test Results for Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Appendix C. Water Quality Parameters Measured during the *Ampelisca abdita* 10-Day Solid-Phase Testing of Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Appendix D. Total and Un-Ionized Ammonia Measured Twice in Overlying Water of Test Chambers During the 10-Day Solid-Phase Tests for McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Appendix E. ToxCalc LC₅₀ Output for *Ampelisca abdita* SDS Reference Toxicant Tests.

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Appendix G. Chain of Custody Forms.

Introduction

The acute toxicity of sediments collected from McAllister, Newport, RI, was assessed as a measure of the biological effects of sediment contaminants and to evaluate the bioavailability of contaminants in bulk sediments. These data will be used in the Ecological Effects component of the Ecological Risk Assessment being conducted for McAllister Point. Sediment samples were evaluated for toxicity using the 10-day amphipod test at Science Applications International Corporation's (SAIC) Environmental Testing Center (ETC) following the Standard Operating Procedure (SOP), Conducting the 10-Day Solid-Phase Test Using the Four Marine Amphipods *Ampelisca abdita*, *Eohaustorius estuarius*, *Leptocheirus plumulosus*, and *Rhepoxynius abronius* (Appendix A). The euryhaline benthic amphipod *Ampelisca abdita*, which ranges from Newfoundland to Florida and the Gulf of Mexico, was used. This tube-dwelling amphipod constructs a soft, upright, membranous tube 3 to 4 cm long from fine-grained sediments in the intertidal zone to a depth of 60 m. *Ampelisca* ingest either surface-deposited particles or particles in suspension, and respire in both overlying and interstitial waters.

The 10-day amphipod test has been used extensively to assess the toxicity of laboratory-spiked and field collected sediments to *Ampelisca abdita* (DiToro *et al.* 1992, Scott and Redmond 1989, Long *et al.* 1990). In addition, *Ampelisca abdita* has been used routinely for sediment toxicity tests conducted by SAIC in support of numerous EPA programs (SAIC 1990a, SAIC 1991, SAIC 1992a, and SAIC 1993a). It was the most sensitive species tested in the U.S.EPA/U.S.ACE Field Verification Program, and has formed the toxicological basis for EPA research on the availability of metals in relation to acid volatile sulfides in marine sediments (Gentile *et al.* 1987 and DiToro *et al.* 1992). It has been used to characterize the toxicity of sediments from the Calcasieu River, LA, covering a broad range of salinity and grain size (SAIC 1990b). *Ampelisca abdita* was the first species used to demonstrate the toxicity of sediments from New Bedford Harbor, MA, and subsequently was used to assess the effectiveness of capping procedures as part of a Pilot Dredging Project on site remediation techniques (USACE 1989). Tests of sediments from New York Harbor have been conducted recently for EPA Region II (SAIC 1992b, SAIC 1994a, and SAIC 1995a) and for the U.S. Navy (SAIC 1994b, SAIC 1995b, SAIC 1995c). In addition, SAIC has recently completed a series of tests for NOAA to characterize toxicity of sediments from the Hudson-Raritan Estuary, Long Island Sound, Boston Harbor, Tampa Bay, the southeast U.S, and Biscayne Bay (SAIC 1992c, SAIC 1992d, SAIC 1993b, SAIC 1994c, SAIC 1994d, SAIC 1995d).

Methods

Sample Collection, Log-In, and Holding

Sediments from 16 stations were collected and delivered to the ETC for testing between 10 September and 20 September 1996 (see Table 1). Standard chain-of-custody

procedures were followed. Samples were transported from the site in 4-liter high-density polyethylene jars which had been washed, acid-stripped, and DI rinsed. Samples were delivered to the ETC in insulated coolers with blue ice. Upon arrival at the laboratory, sample containers were inspected and were found to be full with less than 1 - 2" of head space remaining. These samples were received and logged into the ETC sample tracking system. Chain-of custody tracking forms were signed and xeroxed. The originals were placed in the ETC's sample log books and copies were retained with test data in experiment binders and project files. After inspection, the sample containers were placed in zip-lock bags and stored at $4 \pm 2^{\circ}\text{C}$ in the dark until testing.

Organism Collection and Holding

Ampelisca abdita were collected locally, according to the procedures outlined in the SOP in Appendix A from tidal flats in the Pettaquamscutt (Narrow) River, a small estuary flowing into Narragansett Bay, Rhode Island. The ETC has used *Ampelisca* from the Narrow River to conduct more than 100 test series with over 1000 sediments. Surface sediments (8 to 10 cm) from this site were collected, sieved through a 0.5-mm-mesh screen and tubes containing amphipods were transported to the laboratory in buckets. At the laboratory, amphipods were sieved from their tubes and then collected from the air/water interface with an aquarium dip net as described in the SOP (Appendix A). Amphipods were held in the laboratory in pre-sieved, uncontaminated sediment from the collection site under static conditions. Fifty percent of the water in the holding containers was replaced every day when the amphipods were fed, *ad libitum*, the laboratory-cultured diatom, *Phaeodactylum tricornutum* (see SOP in Appendix A).

Animals collected for each test series were evaluated during concurrent (2, 19, and 26 October 1995) reference toxicant 96-hour water-only tests with sodium dodecyl sulfate (SDS). The trimmed Spearman-Kärber method of regression analysis, available on ToxCalc (version 4.0.8) from TidePool Scientific Software, was used to calculate the SDS LC_{50} . The LC_{50} values were evaluated against a control chart, a running plot of LC_{50} s obtained from 20 of the most recent reference toxicant tests performed at the ETC with *Ampelisca abdita*.

Sample Preparation

Each test sediment sample was press-sieved through a 2.0-mm mesh stainless-steel screen. During press-sieving, the entire contents of a sample container were scooped into a 12" diameter sieve and pushed through the sieve into a collection pan (without adding water) using a Plexiglas paddle according to procedures described in the SOP in Appendix A. Sediments were press-sieved no more than seven days before sediments were added to test chambers. Press-sieved sediments were stored prior to testing at 4°C in the dark. For testing, sediments were mixed with a stainless steel paddle using an electric drill and then added to test chambers. Chambers were then filled with overlying filtered ($0.45 \mu\text{m}$)

seawater from Narragansett Bay, RI (see the SOP Appendix A). Tests were conducted "blind" to eliminate investigator bias. All test chambers were numbered and individual replicate numbers were randomly assigned. Test chambers were arranged in a 20°C water bath in ascending order by number. This ensured that replicates for each treatment were randomly placed within the water bath.

Test Apparatus and Conditions

Amphipods were exposed to test sediments for 10 days under static conditions, following ETC SOPs (see Appendix A) developed according to ASTM and EPA procedures (ASTM 1990 and U.S.EPA 1994). The test chambers were quart-sized glass canning jars with an inverted glass dish as a cover. Two hundred milliliters of homogenized sediment sample was placed in the bottom of each of five replicate chambers and covered with approximately 600 ml of seawater. A plastic disk was used to cover sediments when adding the seawater to minimize disturbance of the sediment. Air was delivered by oil-free air pumps into the water column through a 1-ml pipette inserted through the cover opening. The aeration provided acceptable dissolved oxygen concentrations (>60% saturation). Ambient laboratory lighting was continuous during the 10-day test to inhibit swimming behavior of the organisms. The addition of sediment occurred the day before the start of the test, assuring that surface sediments were well oxygenated.

At the beginning of a test, amphipods were sieved from holding containers through a 0.5-mm mesh stainless-steel screen and collected from the water's surface with an aquarium dip net as described in the SOP in Appendix A. Twenty (20) sub-adult amphipods (passing through a 1.0 mm, but retained on a 0.71 mm screen) were distributed randomly into 100-ml plastic cups containing 20°C filtered seawater (see Appendix A). After sorting, the cups were examined for dead or outsized animals, which were replaced with others from the same sieved population. The cups were randomized, air delivery to the test chambers stopped, and the amphipods were added to the test chambers. After one hour, the chambers were examined for any amphipods that had not burrowed into the sediment. Non-burrowing animals were replaced, and air delivery was restarted, initiating the test. The animals were not fed during testing.

Test chambers were monitored daily and the number of individuals found on the sediment surface, trapped in the water column or on the water surface were recorded according to procedures outlined in the SOP in Appendix A. Dead, emerged individuals were removed and examined microscopically. Live, emerged individuals trapped on the water surface were prodded with the large end of a disposable plastic pipette and allowed to reburrow.

Water quality parameters were monitored throughout the test. Temperature was recorded daily using a partial immersion, spirit-filled Celsius thermometer contained in sediment/overlying water test chamber set in the waterbath. Waterbath temperature was

monitored continuously with a Dickson 7-day recording thermometer. Salinity, dissolved oxygen (DO), and pH were measured in two replicates selected through a computerized random and blind sampling process, twice during each test. Salinity was measured with a hand-held Reichert-Jung refractometer. DO was measured with an Orion DO meter (model 820) and DO electrode (Orion model 97-08), and pH was measured with an Orion pH meter (model 250A) and Orion Triode pH probe (model 91-57BN). All instruments and equipment were calibrated, maintained and operated according to the manufacturer's specifications. Manufacturer's instructions and calibration logs are maintained in the laboratory in binders designated "Equipment Manuals" and "Equipment Maintenance and Calibration".

Samples were analyzed for ammonia to address the continuing concern and debate over the potential toxic effects of ammonia in static sediment toxicity tests (Whiteman et al. 1996). Sub-samples of sediments were collected for porewater analyses after sediments were press-sieved and homogenized before placement into test chamber. Approximately 50 grams of sediment were centrifuged and pore water was collected for each analysis. Overlying water samples were collected twice (i.e. day 2 and day 8) during each test from two replicate test chambers for analyses. Total ammonia was measured spectrophotometrically using the salicylate-hypochlorite method described by Bower and Holm-Hansen (1980). Dilute porewater samples and overlying water samples (1:20 and 1:10, respectively) were prepared with deionized water. The dilutions ensured that ammonia concentrations were always within the measurable range of up to 2 mg ammonia nitrogen per liter and that sample and ammonia standard salinities were within the required 5 ppt of one another. Un-ionized ammonia was calculated using measured total ammonia values, concurrent measurements of pH and salinity, and mean test temperature. The calculations were based on information provided in Hampton (1977) and Whitfield (1978).

At the end of a test, each test chamber was individually sieved through a 0.5-mm mesh stainless-steel screen using tap water as described in the SOP in Appendix A. All material remaining on the screen was rinsed into a small dish using seawater. The contents of each dish were sorted under a stereomicroscope (see SOP in Appendix A). The number of live animals were recorded. All samples for which greater than 10% (e.g. 2 out of 20) of the original organisms were unaccounted for were reexamined. For animals not found, it was assumed that they had died and decomposed in the sediment during the test. Sorted sediment was covered with seawater and left to stand in the dark overnight. Dishes were examined for additional emerged amphipods every 24 hours for 72 hours. The numbers of surviving amphipods, recorded on laboratory data sheets, were entered into a computer spreadsheet for statistical analyses.

Performance Control

Performance control sediments were collected during May 1995 from the U.S. Army Corps of Engineers New England Division central Long Island Sound (LIS) reference

station. Sediments from this reference station have been used for the COE Disposal Areas Monitoring System, the Field Verification Program, and EPA's EMAP Virginian Province in 1990 - 1993. The sediments from this site are fine-grained (>90% silt-clay) and have an organic carbon content of about 2%. An extensive database has demonstrated its non-toxic nature in solid-phase tests with *A. abdita*.

Data Analysis

Stations with a mean survival less than that of the LIS performance control were compared statistically to the control. Microsoft Excel was used to perform a two-sample student's t-test (assuming unequal variances). This test assumes that the variances of both ranges of data are unequal, and determines whether two sample means are equal. A one-tailed distribution was specified, since it is of interest to identify only those treatments which exhibit statistically significant responses less than the control (i.e., not greater than the control). Data were not transformed since an examination of a large historical data set from the ETC has shown that *A. abdita* percentage survival data meet the requirement of normality. Survival was expressed as a percent of the mean control survival in order to facilitate comparison between sampling batches. Significant toxicity for *A. abdita* has been defined as survival statistically less than the performance control and $\leq 80\%$ of the mean control survival (U.S.EPA 1994). Statistical power curves created from SAIC's extensive testing database with *A. abdita* show that the power to detect a 20% difference from the control is approximately 90%. Sites meeting both requirements (statistically different than the performance control and survival $\leq 80\%$ of the control) were flagged.

Results

A total of 16 sediment samples were evaluated for toxicity in the 10-day amphipod test in two test series. The 14-day holding requirements (time elapsed between sampling and test initiation) were met for all samples (see Table 1). Raw survival data are presented Appendix B (mean performance control survival ranged from 91 to 95%). Summary survival data are presented in Table 2. Mean sample survival, normalized to performance controls, ranged from 15 to 98%. Mean survival at Stations NSB-2, NSB-4, NSB-5, and NSB-7 (i.e. 15, 24, 37, and 63%, respectively), was both statistically different than the performance control and $<80\%$ of the mean control survival.

Water quality parameters for temperature, salinity, and dissolved oxygen measured in the overlying water of chambers during the test are presented in Appendix C. Temperature and salinity parameters were within acceptable limits. The DO in the water overlying the sediment was maintained above the acceptance criteria of 60% saturation. Salinities measured were 30 to 32 parts per thousand (ppt) and pH measurements ranged from 7.80 to 8.49.

Ammonia measurements are presented in Appendix D. Overlying ammonia analyses were performed in each of two replicates on Day 3 and Day 6 or 7 of testing. Raw data for total and un-ionized ammonia values in overlying waters ranged between <MDL (method detection limit) to 6.43 mg/L and <MDL to 0.006 mg/L, respectively. Mean values from both replicate measurements on Day 3 and Day 6 or 7 are presented in Table 3. The total ammonia No Observed Effect Concentration (NOEC) of 30.0 mg/L at pH 7.7 (U.S.EPA 1994) was not exceeded. The un-ionized ammonia NOEC of 0.40 mg/L at pH 7.7 (U.S.EPA 1994) was exceeded on one occasion (S2B-R-FD). However, significant reductions in survival (i.e. <80% of performance control) were not observed.

Total and un-ionized ammonia measured in sediment porewaters are presented in Table 4 as an additional indicator of possible source of toxicity to amphipods. Porewaters could not be obtained from sediments from six stations due to the coarse-grained nature of the samples. Total and un-ionized ammonia values in sediment porewaters ranged between 9.1 to 17.9 mg/L and 0.3 to 0.7 mg/L, respectively. Total ammonia was not elevated above the NOEC at any of the stations tested. The un-ionized ammonia NOEC of 0.40 mg/L at pH 7.7 (U.S.EPA 1994) was exceeded for nine samples. However, none of these samples were associated with any significant reduction in survival (i.e. <80%).

Quality Assurance Results

Reference Toxicant Tests

The ToxCalc output of EC₅₀ data obtained during the SDS reference toxicant tests performed for this study are presented in Appendix E. EC₅₀ values for reference toxicant tests 960909 and 960914 were 6.88 and 9.69 mg/L, respectively. A control chart which includes data from 20 of the most recent tests performed at the ETC is presented in Figure 1. Reference toxicant tests 960909 and 960914 were conducted in conjunction with 10-day solid-phase test numbers 960908 and 960913 for this project, and were within the control limits (± 2 SD above and below the mean).

Performance Controls

Performance control survival data for the 43 of the most recent solid-phase tests performed at the ETC, not including data associated with the present study, is presented in Appendix F and summarized graphically in Figure 2. The survival of *A. abdita* exposed to this collection of LIS sediment was consistent with all previous LIS collections used at the ETC (November 1989, May 1991, and August 1993).

References

- ASTM. 1990. Standard Guide for Conducting 10-day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods. *Annual Book of ASTM Standards*. Volume 11.04:1052-1067.
- Bower, C.E. and T. Holm-Hansen. 1980. A salicylate-hypochlorite method for determining ammonia in seawater. *Can. J. Fish. Aquat. Sci.* 37:794-798.
- DiToro, D.M., J.D. Mahoney, D.J. Hansen, K.J. Scott, A.R. Carlson and G.T. Ankley. 1992. Acid Volatile Sulfide Predicts the Acute Toxicity of Cadmium and Nickel in Sediments. *Environmental Science and Technology*, 26:96-101.
- Gentile, J.H., Scott, K.J., Lussier, S.M., and Redmond, M.S., "The Assessment of Black Rock Harbor Dredged Material Impacts on Laboratory Population Responses," Technical Report D-87-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, 1987.
- Hampton, B.L. 1977. Relationship Between Total Ammonia and Free Ammonia in Terrestrial and Ocean Waters. *J. Cons. Int. Explor. Mer.* 37(2):117-122.
- Long, E.R., M.F. Buchman, S.M. Bay, R.J. Bretler, R.S. Carr, P.M. Chapman, J.E. Hose, A.L. Lissner, J. Scott and D.A. Wolfe. 1990. Comparative evaluation of five toxicity tests with sediments from San Francisco Bay and Tomales Bay, California. *Environmental Toxicology and Chemistry*. 9:1193-1214.
- SAIC. 1990a. Results of Sediment Toxicity Tests with *Ampelisca*, EMAP, Summer 1990. SAIC Contribution No. 1006. U.S. EPA Environmental Research Laboratory, Narragansett, RI.
- SAIC. 1990b. Data Report on Sediment Toxicity Tests Conducted on Calcasieu River Samples. SAIC Contribution No. 1001. U.S. EPA Environmental Research Laboratory, Narragansett, RI.
- SAIC. 1991. EMAP Virginian Province: 1991 Sediment Toxicity. SAIC Contribution No. 1013. U.S. EPA Environmental Research Laboratory, Narragansett, RI.
- SAIC. 1992a. EMAP Virginian Province: 1992 Sediment Toxicity Test Results. SAIC Contribution No. 1014. U.S. EPA Environmental Research Laboratory, Narragansett, RI.

- SAIC. 1992b. Survey of Sediment Toxicity in the Hudson/Raritan Bay Estuary. SAIC Contribution No. 1011. U.S. EPA Office of Water Enforcement and Permits, Washington, DC.
- SAIC. 1992c. Survey of Sediment Toxicity in Tampa Bay, Florida: Final Report. SAIC Contribution No. 1039. National Oceanic and Atmospheric Administration, Seattle, WA.
- SAIC. 1992d. Survey of Sediment Toxicity in Long Island Sound Final Report. SAIC Contribution No. 1012. National Oceanic and Atmospheric Administration, Rockville, MD.
- SAIC. 1993a. EMAP Virginian Province: 1992 Sediment Toxicity Test Results. SAIC Contribution No. 1069. U.S. EPA Environmental Research Laboratory, Narragansett, RI.
- SAIC. 1993b. Sediment Toxicity in the Hudson Estuary Final Toxicity Report. SAIC Contribution No. 1016. National Oceanic and Atmospheric Administration, Seattle, WA.
- SAIC. 1994a. Assessment of Sediment Quality of the New York/New Jersey Harbor System (REMAP 1993) Toxicity Test Results. SAIC Contribution No. 1049. Hudson River Foundation, New York, NY.
- SAIC. 1994b. Toxicity Test Results McAllister Point Newport, RI. SAIC Contribution No. 1023. University of Rhode Island, Narragansett, RI.
- SAIC. 1994c. Sediment Toxicity in Boston Harbor Final Report. SAIC Contribution No. 1020. National Oceanic and Atmospheric Administration, Seattle, WA.
- SAIC. 1994d. Survey of Sediment Toxicity in Coastal South Carolina, Georgia, and Western Florida Final Report: Option I. SAIC Contribution No. 1098. National Oceanic and Atmospheric Administration, Seattle, WA.
- SAIC. 1995a. Assessment of Sediment Quality of the New York/New Jersey Harbor System (REMAP 1994) Toxicity Test Results. SAIC Contribution No. 1049. Hudson River Foundation, New York, NY.
- SAIC. 1995b. Toxicity Test Results Allen Harbor, RI. SAIC Contribution No. 1143. EA Engineering, Sharon, MA.
- SAIC. 1995c. Toxicity Test Results Newport, RI. SAIC Contribution No. 1149. University of Rhode Island, Narragansett, RI.

- SAIC. 1995d. Survey of Sediment Toxicity in Biscayne Bay, Florida Final Report: Option II. SAIC Contribution No. 1164. National Oceanic and Atmospheric Administration, Seattle, WA.
- Scott, K.J. and M.S. Redmond. 1989. "The Effects of a Contaminated Dredged Material on Laboratory Populations of the Tubicolous Amphipod *Ampelisca abdita*." *Aquatic Toxicology and Hazard Assessment: 12th Volume, ASTM STP 1027*. U.M. Cowgill and L.R. Williams, Eds., American Society for Testing and Materials, Philadelphia, pp 289-303.
- U.S.ACE. 1989. New Bedford Harbor Superfund Pilot Study: Evaluation of dredging and dredged materials disposal. New England Division, Interim Report.
- U.S.EPA. 1994. Methods for Assessing the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods. EPA 600/R-94/025.
- Whiteman, F.W., G.T. Ankley, M.D. Kahl, D.M. Rau, and M.D. Balcer. 1996. Evaluation of Interstitial Water as a Route of Exposure for Ammonia in Sediment Tests with Benthic Macroinvertebrates. *Environmental Toxicology and Chemistry*, 15:794-801.
- Whitfield, M. 1978. The Hydrolysis of Ammonium Ions in Sea Water--Experimental Confirmation of Predicted Constants at One Atmosphere Pressure. *J. Mar. Assoc. U.K.* 58:781-787.

Table 1. Collection, Receiving, and Test Dates for Solid-Phase Tests for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Sample ID	Date Collected ¹	Date Received ¹	Date Tested	ETC Exp. No. ²
M1-R	9/10/96	9/10/96	9/19/96	960908
MCL-10-R	9/12/96	9/12/96	9/19/96	960908
MCL-11-R	9/12/96	9/12/96	9/19/96	960908
MCL-12-R	9/10/96	9/10/96	9/19/96	960908
MCL-13-R	9/12/96	9/12/96	9/19/96	960908
MCL-14-R	9/10/96	9/10/96	9/19/96	960908
MCL-8-R	9/12/96	9/12/96	9/19/96	960908
MCL-9-R	9/12/96	9/12/96	9/19/96	960908
NSB-1	9/20/96	9/20/96	9/26/96	960913
NSB-2	9/20/96	9/20/96	10/2/95	951001
NSB-3 ³	9/20/96	9/20/96	10/2/95	951001
NSB-4	9/18/96	9/18/96	10/2/95	951001
NSB-5	9/18/96	9/18/96	10/19/95	951011
NSB-6	9/20/96	9/20/96	10/19/95	951011
NSB-7	9/18/96	9/18/96	10/19/95	951011
S2B-R	9/10/96	9/10/96	9/19/96	960908
S2B-R-FD	9/10/96	9/10/96	9/19/96	960908

FOOTNOTES

1 - Samples were stored at 4°C in the dark until received and tested.

2 - ETC Exp. No. = Laboratory identification number

3 - Although sample was collected, insufficient material was available for analysis.

Table 2. Summary 10-Day Solid-Phase Test Results for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

ETC Test No. ¹	Sample ID	Mean Control Survival (%)	SD ²	Mean Survival (%)	SD ²	Mean Survival as % of Control	Comment
960908	M1-R	91.0	7.4	85.0	7.9	93.4	
960908	MCL-10-R	91.0	7.4	84.0	7.4	92.3	
960908	MCL-11-R	91.0	7.4	89.0	4.2	97.8	
960908	MCL-12-R	91.0	7.4	86.3	4.8	94.8	
960908	MCL-13-R	91.0	7.4	85.0	7.1	93.4	
960908	MCL-14-R	91.0	7.4	82.0	6.7	90.1	
960908	MCL-8-R	91.0	7.4	89.0	5.5	97.8	
960908	MCL-9-R	91.0	7.4	85.0	11.7	93.4	
960913	NSB-1	95.0	5.0	86.0	12.4	90.5	
960913	NSB-2	95.0	5.0	14.0	18.2	14.7	**
960913	NSB-4	95.0	5.0	23.0	24.6	24.2	**
960913	NSB-5	95.0	5.0	35.0	7.1	36.8	**
960913	NSB-6	95.0	5.0	86.0	12.9	90.5	
960913	NSB-7	95.0	5.0	60.0	17.0	63.2	**
960908	S2B-R	91.0	7.4	89.0	4.2	97.8	
960908	S2B-R-FD	91.0	7.4	84.0	11.4	92.3	

FOOTNOTES

** Sample survival was both statistically lower and less than 80% of control survival.

1 - ETC Exp. No. = Laboratory identification number

2 - SD = Standard deviation

Table 3. Ammonia in Test Chambers¹, McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Sample ID	Total Ammonia (mg/L ⁽²⁾)	Salinity (ppt ⁽³⁾)	pH	Un-ionized Ammonia (mg/L ⁽²⁾)
M1-R	3.39	30.00	8.29	0.22
MCL-10-R	4.32	30.00	8.40	0.35
MCL-11-R	1.83	30.00	8.18	0.09
MCL-12-R	4.24	30.00	8.36	0.32
MCL-13-R	2.29	30.00	8.30	0.15
MCL-14-R	0.74	30.00	8.25	0.04
MCL-8-R	4.87	30.00	8.33	0.32
MCL-9-R	4.75	30.00	8.35	0.35
NSB-1	0.01	30.75	8.10	0.00
NSB-2	0.66	31.25	8.08	0.02
NSB-4	0.00	30.50	8.08	0.00
NSB-5	0.54	31.00	8.11	0.02
NSB-6	1.06	30.83	8.16	0.06
NSB-7	0.89	30.00	8.07	0.03
S2B-R	4.66	30.00	8.22	0.28
S2B-R-FD	6.88	30.00	8.39	0.54

FOOTNOTES

1 - Mean Day 3 and Day 6 or 7 ammonia measured in overlying water of each of two replicate test chambers during the 10-day solid-phase test.

2 - mg = milligram, L = Liter

3 - ppt = parts per thousand

Table 4. Ammonia in Porewaters of Sediments, McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Sample ID	Total Ammonia (mg/L ⁽²⁾)	Salinity (ppt ⁽³⁾)	pH	Un-ionized Ammonia (mg/L ⁽²⁾)
M1-R	12.55	32	8.07	0.598
MCL-10-R	13.40	32	8.12	0.718
MCL-11-R	11.05	32	8.09	0.547
MCL-12-R	15.53	32	8.01	0.649
MCL-13-R	12.12	32	8.11	0.618
MCL-14-R	9.12	32	8.03	0.398
MCL-8-R	13.64	32	7.98	0.534
MCL-9-R	11.29	32	7.82	0.309
NSB-1	*	32	8.11	0.704
NSB-2	*	*	*	*
NSB-4	*	*	*	*
NSB-5	*	*	*	*
NSB-6	*	*	*	*
NSB-7	*	*	*	*
S2B-R	13.52	32	8.11	0.704
S2B-R-FD	17.88	31	8	0.731

FOOTNOTES

* Porewater sample could not be obtained due to the physical nature of this sample.

1 - Total and un-ionized ammonia measured in porewaters of sediments used during 10-day solid-phase tests.

2 - mg = milligram, L = Liter

3 - ppt = parts per thousand

SDS Control Chart

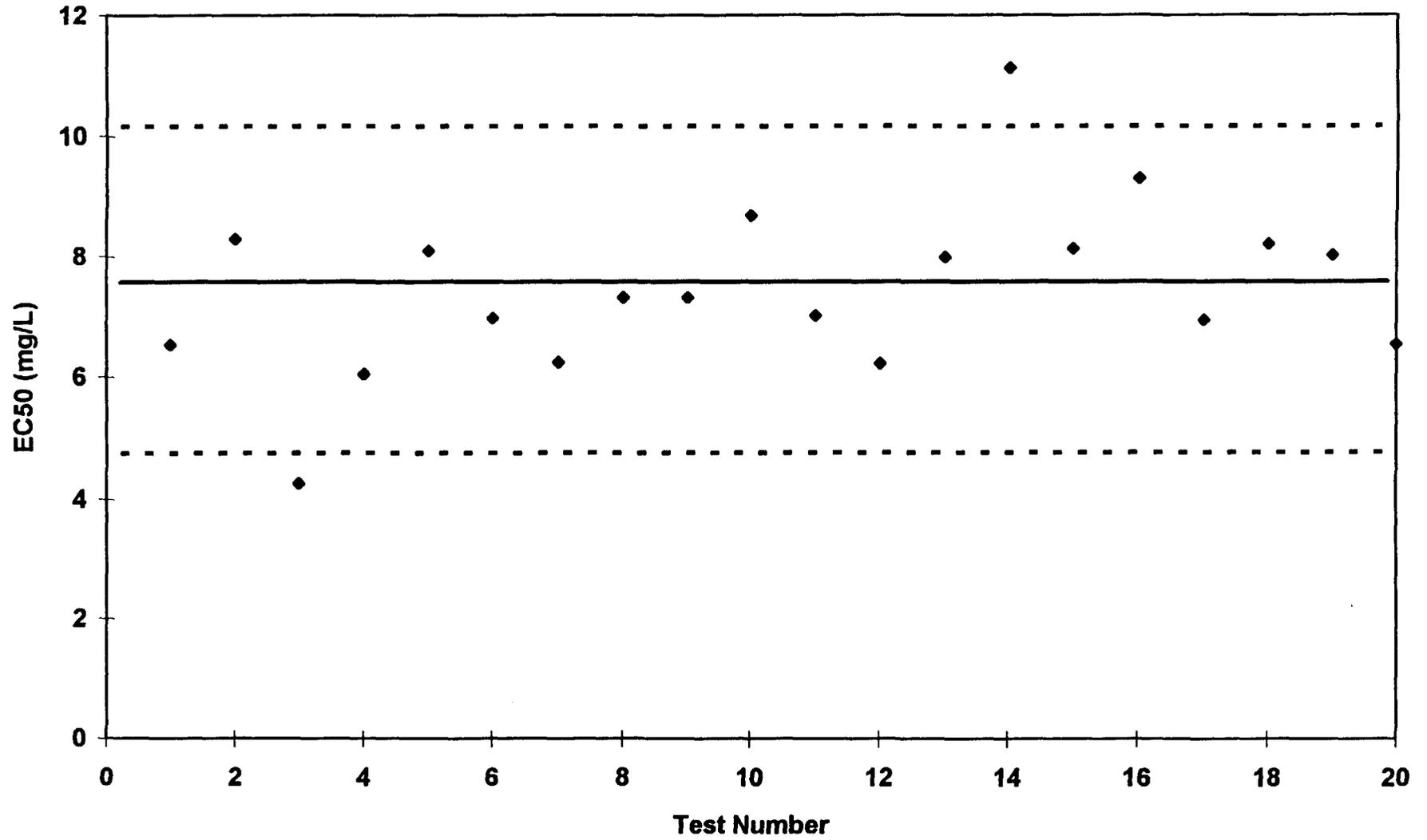


Figure 1. SDS Control Chart. The solid line represents the mean of 20 previous reference toxicant tests. The dotted lines represent the upper and lower control limits or 2 SD above and below the mean.

Performance Control Survival

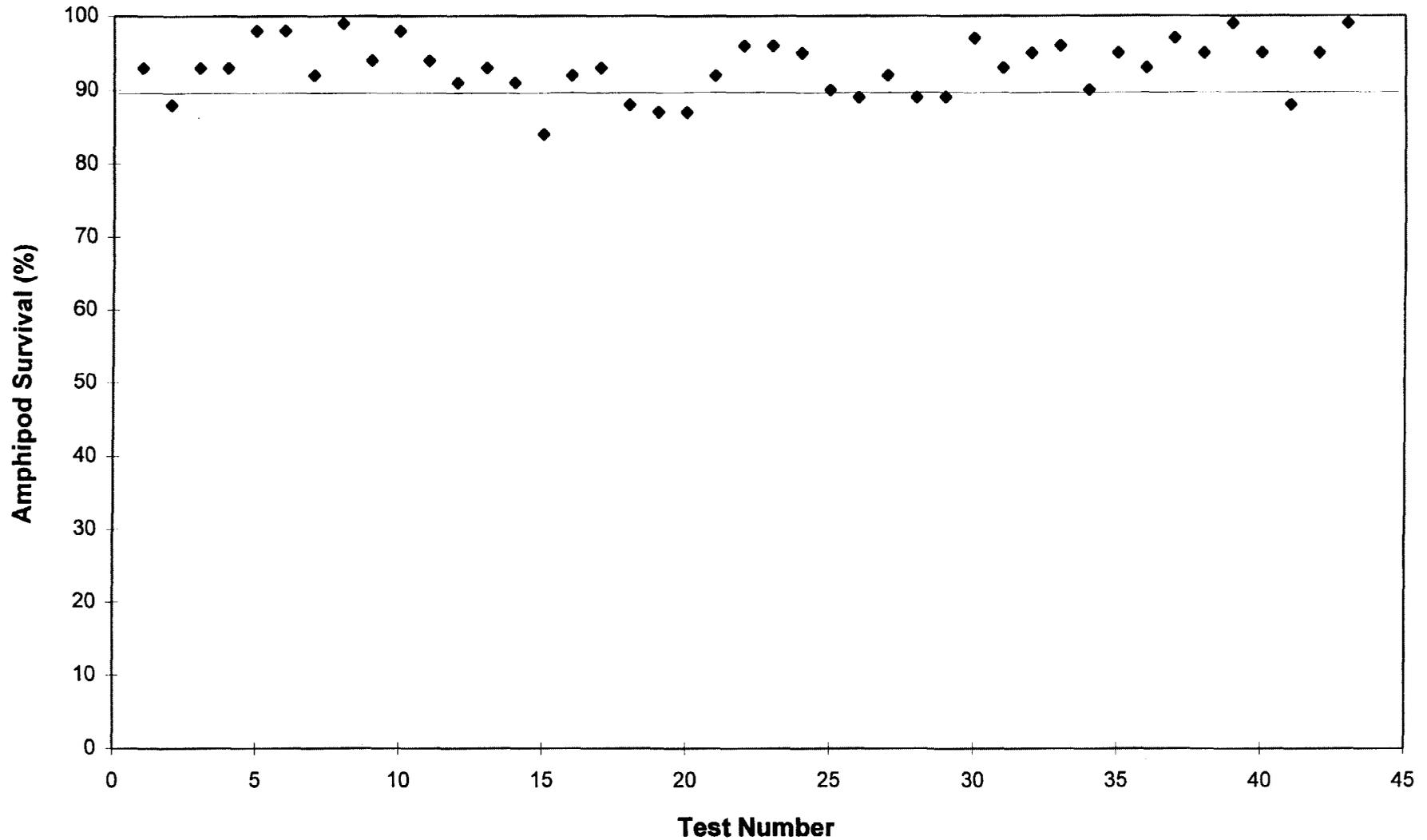


Figure 2. Amphipod survival in performance control sediment from 43 recent tests performed at the ETC. The solid line at 90% indicates the criteria for test acceptability.

Appendix A. ETC's Standard Operating Procedures

The ETC's Standard Operating Procedures for:

10-day solid-phase test with *Ampelisca abdita*

Conducting the 10-day Solid-Phase Test Using Four Marine Amphipods, *Ampelisca abdita*, *Eohaustorius estuarius*, *Leptocheirus plumulosus*, and *Rhepoxynius abronius*

**CONDUCTING THE 10-DAY SOLID-PHASE TEST
USING FOUR MARINE AMPHIPODS
*AMPELISCA ABDITA, EOHAUSTORIUS ESTUARIUS,
LEPTOCHEIRUS PLUMULOSUS, AND RHEPOXYNIUS ABRONIUS***

1.0 OBJECTIVE

- 1.1 This document describes the methods used to set-up, monitor, and breakdown the 10 Day Solid Phase test using four marine amphipods: *Ampelisca abdita*, *Eohaustorius estuarius*, *Leptocheirus plumulosus*, and *Rhepoxynius abronius*.
- 1.2 An appendix at the end of this document describes specific procedures involving collection, culture, and laboratory holding of the individual species can be found in the appendix.

2.0 SAFETY

- 2.1 Sediment samples may contain hazardous biological or chemical constituents. Always wear protective gear (i.e. poly laminated aprons/labcoats, faceshield, latex gloves, and glasses) to prevent exposure.
- 2.2 Hazardous constituents can become airborne when spilled/splattered sediment is allowed to dry. All spills must be wiped immediately with a damp paper towel.
- 2.3 Clean and disinfect the work area as soon as work is completed, particularly areas where spills have occurred.
- 2.4 Make sure that the work station is comfortable whether at the computer or at the hood. Chairs should be positioned ergonomically. Try not to spend too much time in one position, particularly working at the hood. **Never** work with your head in the hood. Use the microscopes at eye level to relieve tension in the neck. If at any time you feel pain, discomfort, or fatigue, let somebody know immediately.

3.0 MATERIALS

- 3.1 10% buffered formalin solution with rose bengal
- 3.2 12" Diameter, 1.0mm standard test sieve
- 3.3 12" Diameter, 2.0mm standard test sieve
- 3.4 12" Diameter, 500µm standard test sieve
- 3.5 Acetone

- 3.6 Amphipods that have been acclimated to test conditions
- 3.7 Black pen
- 3.8 Bowl for rinsing
- 3.9 Control sediment
- 3.10 Data sheets (attached)
- 3.11 Disposable pipette with cut tip
- 3.12 Dissecting tools: probes, forceps
- 3.13 Drill with stainless steel homogenizer attachments
- 3.14 ETC computer, networked to the ETC Library computer
- 3.15 Formalin contaminated blue bin
- 3.16 Formalin contaminated disposable pipette with cut tip
- 3.17 Formalin contaminated large rinsing bowl
- 3.18 Formalin contaminated plastic bowl
- 3.19 Formalin contaminated plastic petri dishes, various sizes
- 3.20 Formalin contaminated plastic spoon, bent and straight probes, and forceps
- 3.21 Formalin contaminated settling bucket
- 3.22 Formalin contaminated sieve, 500µm
- 3.23 Formalin contaminated squeeze bottle filled with test water
- 3.24 Formalin waste container with waste log
- 3.25 Gray bins
- 3.26 Large carolina dish
- 3.27 Modified funnel

- 3.28 Modified transfer pipette
- 3.29 Paper towels
- 3.30 Pipet and bulb
- 3.31 Plastic bowls/picking dishes
- 3.32 Plastic petri dishes, various sizes
- 3.33 Plastic spoon, bent and straight probes, and forceps
- 3.34 Plastic spoon and spatula
- 3.35 Plexiglas paddles
- 3.36 Preserving jars
- 3.37 Red plastic trays
- 3.38 Round Plastic Bins
- 3.39 Sample jars preserved with formalin
- 3.40 Screen cup (specimen cup, bottomless, with Nitex screen)
- 3.41 Sediment samples
- 3.42 Settling bucket with liners
- 3.43 Specimen cups
- 3.44 Squeeze bottle filled with test water
- 3.45 Stereo Microscope
- 3.46 Test chamber lids (small crystallization dish with hole drilled in the bottom)
- 3.47 Test chambers (1 quart mason jar)
- 3.48 Test water at appropriate salinity
- 3.49 The experiment number assigned to the test



3.50 Thermometers

3.51 Turbulence reducers

3.52 Waterproof colored labels

3.53 Waterproof markers

4.0 METHODS

4.1 Preparing Data sheets for Sample Preparation and Test Monitoring

4.2 Preparing Test Chambers

4.3 Sample Preparation for Test Initiation

4.4 Adding Sediment to Test Chambers

4.5 Counting Amphipods into the Test Chambers--Initiating the Test

4.6 Daily Observations of Amphipod Toxicity Test

4.7 Sieving out Test Chambers at End of Test

4.8 Picking Samples at End of Test

4.9 Picking Preserved Samples at End of Test

4.1 PREPARING DATASHEETS FOR SAMPLE PREPARATION AND TEST MONITORING

4.1.1 OBJECTIVE

4.1.1.1 This section describes the methods used to set-up the datasheet for the solid-phase amphipod test.

4.1.1.2 Datasheets are generated from comuter files stored on the ETC library computer under the file name:

4.1.2 SAFETY

4.1.2.1 Make sure that the work station is comfortable (ie. a wrist support, the mouse isn't too far away, the monitor isn't too high) and that the chair positioned ergonomically. To avoid eye strain, try to look away from the computer screen for 15 seconds every 15 minutes.

4.1.3 MATERIALS

4.1.3.1 ETC computer, networked to the ETC Library computer

4.1.3.2 The experiment number assigned to the test

4.1.4 METHODS

4.1.4.1 Access the amphipod datasheets from the library computer.

4.1.4.1.1 Acces the 'C' drive on the library computer.

4.1.4.1.2 Open the EXCEL®spreadsheet program and access the directory: \Share.

4.1.4.1.3 Select the Directory: \Datasheets\Solidpha.

4.1.4.2.4 Open the file: amp01ds.xls.

4.1.4.2.5 Save the file amp01ds.xls as the experiment number (ie. 950101.xls).

4.1.4.2 Fill in the information on the Method Summary.

4.1.4.2.1 Select the file tab labelled 'Method Summary'.

4.1.4.2.2 Enter the project name, test number, experiment number, test start date, and accompanying reference test experiment number in the spaces provided.



NOTE: This information will automatically transfer to all pages of the datasheet.

4.1.4.3 Create the Randomization Sheet.

4.1.4.3.1 Select the file tab labelled 'Randomization Sheet'.

4.1.4.3.2 In the space designated 'organism' type in the genus and species of the test organism being used.

4.1.4.3.3 Select 'Data Analysis' from the Tools menu.

4.1.4.3.4 Generate random numbers in column A.

1. Choose 'Random Number Generation'.
2. Leave the 'Number of Variables' box blank.
3. Select the 'Number of Random Numbers' box and enter the number that corresponds to the number of jars in the test.
4. Select 'Distribution', choose 'Uniform'.
5. Set Parameters, choose any numbers.
6. Select the 'Output Options' box, choose output range then use the mouse to highlight the desired range on the randomization sheet in column A only.

4.1.4.4 Sort the jar numbers.

4.1.4.4.1 Highlight columns A and B.

4.1.4.4.2 Choose 'Sort' from the Data menu.

4.1.4.4.3 Select 'Sort by column A, Ascending', choose OK.

4.1.4.4.4 Delete column A.

4.1.4.5 Sort the circles and stars.

4.1.4.5.1 Scroll over to column Z.

4.1.4.5.2 Highlight the numbers under the heading 'Circles'.

4.1.4.5.3 Select 'Copy' from the Edit menu.

4.1.4.5.4 Select 'Paste Special' from the Edit menu, choose 'Values', then click on OK.

4.1.4.5.5 Scroll down to row 51 in column Z and repeat this process for the numbers under the heading 'Stars'.

4.1.4.6 Save the file under the project directory.

4.1.4.6.1 Access the Directory: \\Share\Projects on the hard drive of the library computer.

4.1.4.6.2 Create a directory for the project if there isn't one already.

4.1.4.6.3 Save the file to the new directory.

NOTE: If more than one project is covered by the experiment number, save the file to all project directories involved.

4.1.4.6.4 Print the entire file.



4.2 PREPARING TEST CHAMBERS FOR AMPHIPOD TOXICITY TESTS

4.2.1 OBJECTIVE

4.2.1.1 This section describes the methods used to label and soak test chambers prior to test initiation.

4.2.1.2 Test chambers are labeled and soaked with test water at least 24 hours prior to the addition of sediment samples.

4.2.2 SAFETY

4.2.2.1 Test chambers are made of glass. Always check for cracks and chips before handling.

4.2.3 MATERIALS

4.2.3.1 Seawater

4.2.3.2 Data sheets (attached)

4.2.3.3 Waterproof colored label tape

4.2.3.4 Waterproof marker

4.2.3.5 Test chambers (1 quart mason jar)

4.2.3.6 Test chamber lids (small crystallization dish with hole drilled in the bottom)

4.2.4 METHODS

4.2.4.1 **Obtain the randomization sheet.**

4.2.4.2 **Label glassware.**

4.2.4.2.1 Select enough test chambers for the test as determined by the randomization sheet.

4.2.4.2.2 Attach waterproof colored label tape to each jar, just above the word "Ball".
NOTE: Turn under one side of the tape so that it can be easily removed later.

4.2.4.2.3 Arrange the jars in groups of five on a cart or a table.

4.2.4.2.4 Label each group of five jars with a group of five numbers from the randomization sheet, using the waterproof marker.

- 4.2.4.2.5 Circle the numbers that correspond to the first two replicates of each group.
- 4.2.4.2.6 Put a star next to the number that corresponds to the third replicate of each group.
- 4.2.4.2.7 Sign the randomization sheet in the spaced designated, 'randomized by: '.
- 4.2.4.2.8 Label the lids in the same manner.
- 4.2.4.3 QA the randomization.**
 - 4.2.4.3.1 Ask a second person to check the number assignments on the jars and lids against the randomization sheet to insure that they are labeled correctly and that no numbers are duplicated.
 - 4.2.4.3.2 The second person must also sign the randomization sheet.
- 4.2.4.4 Soak the test chambers.**

NOTE: The chambers do not need to be totally emersed in water. Only the inside needs exposure to the soak.

 - 4.2.4.4.1 Fill test chambers with test water (usually seawater at 30ppt).
 - 4.2.4.4.2 Cover the test chambers with black plastic to avoid dust.
 - 4.2.4.4.3 Let chambers stand for at least 24 hours.

4.3 SAMPLE PREPARATION FOR TEST INITIATION

4.3.1 OBJECTIVE

- 4.3.1.1 This section describes the methods used to press sieve sediment samples prior to test initiation.
- 4.3.1.2 Sediment samples are press sieved through a 2.0mm sieve to remove large debris or predators. If a sample already contains amphipods, it must be press sieved through a 1.0mm sieve to remove the resident amphipods.

4.3.2 SAFETY

- 4.3.2.1 Sediment samples may contain hazardous biological or chemical constituents. Poly laminated (waterproof) coveralls, poly laminated apron, faceshield, latex gloves, silvershield gloves, nitrile gloves, and dielectric boots are to be worn.
- 4.3.2.2 Hazardous constituents can become airborne when spilled/splattered sediment is allowed to dry. All spills must be wiped immediately with a damp paper towel.
- 4.3.2.3 Excess sediment is double bagged and disposed of in the dumpster when work is completed. Check with ECH&S Officer first.
- 4.3.2.4 Press sieving must be performed in a hood.

4.3.3 MATERIALS

- 4.3.3.1 12" Diameter, 2.0mm standard test sieve (one per person)
- 4.3.3.2 12" Diameter, 1.0mm standard test sieve (one per person)
- 4.3.3.3 Round Plastic Bin (one per sample)
- 4.3.3.4 Plexiglas paddle (one per sample)
- 4.3.3.5 Plastic spoon, spatula, and funnel (one per sample)
- 4.3.3.6 Drill with stainless steel homogenizer attachments
- 4.3.3.7 Acetone
- 4.3.3.8 Seawater

- 4.3.3.9 Sediment samples
- 4.3.3.10 Data sheets (attached)
- 4.3.3.11 Paper towels
- 4.3.3.12 Settling bucket with liners.
- 4.3.3.13 Red plastic tray (one per person)
- 4.3.3.14 Sediment samples
- 4.3.4 **METHODS**
- 4.3.4.1 **Obtain samples from storage.**
- 4.3.4.2 **Select a sample container.**
- 4.3.4.2.1 Remove a sample from its plastic ziploc bag.
- 4.3.4.2.2 Observe sample number and initial the appropriate space on the randomization sheet.
- 4.3.4.2.3 Place sample container in the hood.
- 4.3.4.4 **Set-up sieving station**
- 4.3.4.4.1 Select a sieve
 1. Remove the lid of the sample jar and look for any resident amphipods floating on the surface.
 2. Choose the 2.0mm sieve if no amphipods are present.
 3. Choose the 1.0mm sieve if amphipods are present.
- 4.3.4.4.2 Obtain a round plastic bin, a plastic spoon, a plastic funnel, a red plastic tray, and a Plexiglas® paddle.
- 4.3.4.4.3 Place the sieve inside the bin, and place the bin on the tray.
- 4.3.4.5 **Press sieve the sample.**

NOTE: Do not add any water to the samples.
- 4.3.4.5.1 Homogenize the sample by shaking vigorously or by using the drill and the stainless steel homogenizer.
- 4.3.4.5.2 Pour or spoon the entire contents of the sample container onto the sieve.



- 4.3.4.5.3 Push the sediment through the sieve using the Plexiglas paddle until only the material larger than the sieve opening remains.
NOTE: If tubes are present in the sample it must be press sieved through a 1.0mm sieve.
- 4.3.4.5.4 Rinse out the sample container with seawater, discard rinse into a settling bucket.
- 4.3.4.5.5 Discard the material remaining on the sieve into a garbage can with a double liner.
- 4.3.4.5.6 Wipe excess material from the paddle and use it to scrape sediment off the bottom of the sieve into the garbage can.
- 4.3.4.6 Return the sample to its original container.**
- 4.3.4.6.1 Homogenize the sediment in the bin using the plastic spoon.
- 4.3.4.6.2 Place the funnel in the mouth of the sample container.
- 4.3.4.6.3 Pour or spoon the sample slowly back into the container and secure the lid.
- 4.3.4.6.4 Wipe any excess sediment from the outside of the container using a damp paper towel.
Discard the towel.
- 4.3.4.6.5 Place an elastic band with a green clip around the neck of the sample container to indicate that the sample has been press sieved.
- 4.3.4.6.6 Return the sample to the plastic ziploc bag and seal.
- 4.3.4.6.7 Fill out the randomization sheet.
1. Record sediment type, odor, color, and components under sample description on the randomization sheet.
 2. Have a second person verify the sample number and countersign the appropriate space on the randomization sheet.
- 4.3.4.7 Clean equipment between samples.**
- 4.3.4.7.1 Rinse all excess sediment from sieve(s), bin, spoon, funnel, tray, and paddle into a settling bucket using tap water.
- 4.3.4.7.2 Place the bin, spoon, funnel, and paddle into a dishbin.
- 4.3.4.7.3 Rinse the sieve with acetone over an acetone waste container and cap the container.



- 4.3.4.7.4 Rinse the sieve thoroughly first with deionized water and then with seawater so that it can be used again.
- 4.3.4.8 Return all samples to storage.**
- 4.3.4.9 Clean the work area.**
 - 4.3.4.9.1 Return any un-used /clean equipment to its storage area.
 - 4.3.4.9.2 Wipe any splattered sediment from the hood and surrounding area (including the floor) using damp paper towels.
 - 4.3.4.9.3 Wash the hood and surrounding area (walls, floor mats, cabinets, faucets, counter-tops, etc.) with a solution ofalconox/dissinfectant. Rinse thoroughly.
 - 4.3.4.9.4 Remove the floor mat from in front of the hood and spray it down outside.
 - 4.3.4.9.5 Wash the floor withalconox dissolved in hot water. Rinse.
 - 4.3.4.9.6 Discard apron and coveralls if grossly dirty.
NOTE: Coveralls can be used again if they are free of sediment; store them on the labcoat rack.
 - 4.3.4.9.7 Clean faceshield and hang on wall; rinse silvershield and nitrile gloves and hang on glove rack.
- 4.3.4.10 Discard the sediment in the settling bucket.**
 - 4.3.4.10.1 Allow the bucket to sit overnight in the hood.
 - 4.3.4.10.2 Decant the overlying water down the drain after 24 hours.
 - 4.3.4.10.3 Remove the liner from the settling bucket and discard in the dumpster.

4.4 ADDING SEDIMENT SAMPLES TO TEST CHAMBERS

4.4.1 OBJECTIVE

4.4.1.1 This section describes the methods used to add sediments to test chambers for solid-phase testing.

4.4.1.2 To insure oxidation of the sediment surface, sediments and seawater are added to the test chambers 24 hours prior to test initiation.

4.4.2 SAFETY

4.4.2.1 Sediment samples may contain hazardous biological or chemical constituents. Poly laminated (waterproof) coveralls, poly laminated apron, faceshield, latex gloves, silvershield gloves, nitrile gloves, and dielectric boots are to be worn.

4.4.2.2 Hazardous constituents can become airborne when spilled/splattered sediment is allowed to dry. All spills must be wiped immediately with a damp paper towel.

4.3.2.3 Excess sediment is double bagged and disposed of in the dumpster when work is completed. Check with ECH&S Officer first.

4.4.2.4 Press seiving must be performed in a hood.

4.4.3 MATERIALS

4.4.3.1 Plastic spoon, spatula, and funnel (one per sample)

4.4.3.2 Drill with stainless steel homogenizer attachments

4.4.3.3 Seawater at appropriate test salinity

4.4.3.4 Sediment samples

4.4.3.5 Data sheets (attached)

4.4.3.6 Control sediment

4.4.3.7 Turbulence reducer

4.4.3.8 Squeeze bottle filled with test water

4.4.3.9 Paper towels

4.4.3.10 Settling bucket with liners

4.4.3.11 Red plastic trays (one per person)

4.4.4 METHODS

4.4.4.1 Obtain samples from storage.

4.4.4.2 Select a sample container.

4.4.4.2.1 Remove a sample from its plastic ziploc bag.

4.4.4.2.2 Observe sample number and initial the 'Seds in' space on the randomization sheet.

4.4.4.2.3 Place sample container in hood.

4.4.4.4 Set-up station in hood.

4.4.4.4.1 Place the red tray in the hood.

4.4.4.4.2 Select the appropriately numbered jars for the sample that was chosen, discard the soak water and place them on the red tray.

4.4.4.4.3 Obtain a plastic spoon and a plastic funnel.

4.4.4.4.4 Fill a squeeze bottle with test water and place it in the hood. (Refill as necessary).

4.4.4.5 Fill the test chambers with sediment.

NOTE: To avoid cross-contamination, fill the control replicates first.

4.4.4.5.1 Homogenize the sample by shaking vigorously and/or by using the drill and the stainless steel homogenizer.

4.4.4.5.2 Place the funnel in the mouth of the first test chamber.

4.4.4.5.3 Pour or spoon ~ 200mls of homogenized sample through the funnel into the test chamber using the metric markings on the side of the jar as the measure. Repeat this for all five replicates.

4.4.4.5.4 Eliminate air pockets and surface irregularities by gently tapping the test chamber and by smoothing the sediment surface with a spatula.

- 4.4.4.5.5 Rinse all mud from the sides (inside and out) of the test chamber using the squeeze bottle filled with test water.
- 4.4.4.5.6 Wipe excess sediment from the outside of the chamber using a paper towel.
- 4.4.4.5.7 Ask a second person to verify that the appropriate sediment was placed into the appropriate jars.
- 4.4.4.5.8 The second person must countersign the randomization sheet.
- 4.4.4.5.9 Place the five replicate jars on the cart.
- 4.4.4.6 Put the completed sample aside.**
- 4.4.4.6.1 Secure the lid of the sample container.
- 4.4.4.6.2 Wipe any excess sediment from the outside of the container using a damp paper towel.
- 4.4.4.6.3 Return the sample to the plastic ziploc bag and seal.
- 4.4.4.6.4 Set the sample aside.
- 4.4.4.7 Clean equipment between samples.**
- 4.4.4.7.1 Rinse all excess sediment from the spoon, funnel, and tray into a settling bucket using tap water.
- 4.4.4.7.2 Place the spoon and funnel into a dishbin.
- 4.4.4.7.3 Wipe any excess sediment from the hood using tap water and paper towels.
- 4.4.4.7.4 Discard excess water from the hood into the sink using the squeegee.
- 4.4.4.7.5 Place the red tray back into the hood.
- 4.4.4.8 Fill the test chambers with test water.**
- 4.4.4.8.1 Hold a turbulence reducer in the first test chamber just above the sediment surface.
- 4.4.4.8.2 Pour test water slowly from a pitcher onto the turbulence reducer in the test chamber until the water level is between the 750 and the 800ml mark on the jar.
NOTE: For best results, keep the turbulence reducer above the water surface by slowly raising it while pouring.

- 4.4.4.8.3 Rinse the turbulence reducer between test treatments but not between treatment replicates.
- 4.4.4.8.4 Record the number of the carboy used to fill the test chambers on the randomization sheet.
- 4.4.4.9 Transfer the test chambers to the test table.**
 - 4.4.4.9.1 Set-up the test table.
 - 1. Add tap water to the table to just below the labels.
 - 2. Turn on the circulating pump.
 - 3. Set the temperature control on the chiller unit to the appropriate test temperature.
 - 4. Set the upper limit temperature control inside the chiller unit for 2°C higher than the desired test temperature.
 - 5. Set-up a temperature recorder and a thermometer at the table.
 - 4.4.4.9.2 Place the test chambers into the test table in numerical order, in groups of five.
 - 4.4.4.9.3 Place the corresponding lid onto each test chamber.
 - 4.4.4.9.4 Place pipettes in test chambers so that the tip of the pipette is approximately half-way down the water column (between the 400 and 600ml mark on the jar).
 - 4.4.4.9.5 Attach the air lines to the pipettes and turn on the air pump.
 - 4.4.4.9.6 Check to make sure air is flowing to all test chambers and adjust the 'gang' valves for gentle aeration.
 - 4.4.4.9.7 Fill out the "Method Summary Datasheet".
 - 1. Check the appropriate spaces describing the test methods used.
 - 2. Record the Carboy #'s, the Lot # for the control sediment, the sieve size used, the table #, the air pump #, the thermometer #, the temperature recorder #.
 - 3. Obtain physical data information from the Assistant Manager and fill in the appropriate spaces.
 - 4.4.4.10 Clean the work area.**
 - 4.4.4.10.1 Return any un-used /clean equipment back to its storage area.
 - 4.4.4.10.2 Wipe any splattered sediment from the hood and surrounding area (including the floor) using damp paper towels.
 - 4.4.4.10.3 Wash the hood and surrounding area (walls, floor mats, cabinets, faucets, counter-tops, etc) with a solution of alconox/dissinfectant. Rinse thoroughly.
 - 4.4.4.10.4 Remove the floor mat from in front of the hood and spray it down outside.

4.4.4.10.5 Wash the floor withalconox dissolved in hot water. Rinse.

4.4.4.10.6 Discard apron and coveralls if grossly dirty.

NOTE: Coveralls can be used again if they are free of sediment; store them on the labcoat rack.

4.4.4.10.7 Clean faceshield and hang on wall; rinse silvershield and nitrile gloves and hang on the glove rack.

4.4.4.11 Discard the sediment in the settling bucket.

4.4.4.11.1 Allow the bucket to sit overnight in the hood.

4.4.4.11.2 Decant the overlying water down the drain after 24 hours.

4.4.4.11.3 Remove the liner from the settling bucket and discard in the dumpster.

4.5 INITIATING THE TEST-Counting Amphipods into the Test Chambers

4.5.1 OBJECTIVE

4.5.1.1 This section describes the methods used to count amphipods into the test chambers.

4.5.1.2 Amphipods are randomly distributed into specimen cups containing test water before being transferred to test chambers. Twenty amphipods are added to each test chamber.

4.5.2 SAFETY

4.5.2.1 A labcoat and latex gloves(rinsed) are to be worn when adding animals to the test chambers.

4.5.3 MATERIALS

4.5.3.1 Amphipods that have been acclimated to test conditions

4.5.3.2 Specimen cups (one for each test replicate)

4.5.3.3 Specimen cup (for representative sample of animals to be preserved)

4.5.3.4 Test water at appropriate salinity

4.5.3.5 Modified transfer pipette (end cut off)

4.5.3.6 Screen cup (specimen cup, bottomless, with Nitex screen)

4.5.3.7 Squeeze bottle filled with test water

4.5.3.8 Datasheets

4.5.4 METHODS

4.5.4.1 Set-up the work area.

4.5.4.1.1 Cover the work space with white absorbant paper.

4.5.4.1.3 Count out the number of specimen cups needed (include the extra cup for preserving).

4.5.4.1.4 Fill each cup approximately one third to half full with test water.

4.5.4.2 Determine amphipod mortality in the holding jars.

- 4.5.4.2.1 Remove all animals that look dead, from each holding jar.
- 4.5.4.2.2 Examine the amphipod's condition under a stereo microscope.
- 4.5.4.2.3 Record the number of dead amphipods for each holding jar on the "Field Collection and Laboratory Holding Datasheet".
- 4.5.4.2.4 Determine the acceptability of the percent mortality.
 - 1. Divide the number of dead animals by the total number of animals added to the jar initially.
 - 2. Use the animals from the dish if percent mortality is less than or equal to 5% (ie. 18 dead out of 350, or 15 dead out of 300).
- 4.5.4.4 Add the animals to the specimen cups.**
 - 4.5.4.4.1 Determine the number of animals that can be used from each holding jar by dividing the desired number of animals per test chamber (20) by the number of acceptable dishes containing animals.
 - 4.5.4.4.2 Select a dish containing animals (keep track of the number of the dish you choose).
 - 4.5.4.4.3 Select healthy looking, non-gravid, amphipods from the dish using a pipette.
 - 1. Determine healthy animals using the following criteria:
animals should have good color, full guts, and be active.
 - 2. Determine non-gravid animals by looking for the absence of eggs in the oviduct or brood chamber.
 - 4.5.4.4.4 Place the pre-determined number of amphipods from each numbered dish (usually 2-3) into each specimen cup until all of the cups contain 20 animals.
NOTE: If there are not enough animals to fill all of the cups with 20; the laboratory manager must be consulted to determine a course of action.
 - 4.5.4.4.5 Examine each cup and replace any weak or gravid looking animals.
- 4.5.4.5 Count animals into the test chambers.**
NOTE: Take notice of the time.
 - 4.5.4.5.1 Place the specimen cups on a cart and bring them to the test table.
NOTE: To help prevent double dosing or skipping a test chamber, it is suggested that the cups be placed on the cart in rows of five.
 - 4.5.4.5.2 Turn off the air pump that supplies the test chambers.
 - 4.5.4.5.3 Remove the lid and pipette from the first test chamber.

- 4.5.4.5.4 Pour the content of one specimen cup through the screen cup.
NOTE: Work over a bucket on the floor.
- 4.5.4.5.5 Verify that the number of animals in the cup equals 20.
NOTE: Avoid exposing animals to the air for extended periods by nesting the screen cup in a specimen cup containing test water.
- 4.5.4.5.6 Replace any gravid or weak animals in the screen cup.
- 4.5.4.5.7 Verify the count again.
- 4.5.4.5.8 Add the animals to the test chamber.
1. Rinse the contents of the screen cup into the test chamber using the squeeze bottle containing test water.
 2. Examine the cup inside and out for the presence of any amphipods.
 3. Rinse any remaining amphipods into the test chamber.
- 4.5.4.5.9 Examine the test chamber for animals stuck on the sides or floating in the surface.
- 4.5.4.5.10 Spray down the inside rim of the test chamber using the squeeze bottle. Bring the volume up to the 800 ml mark.
- 4.5.4.5.11 Prod the floating animals toward the sediment using the aeration pipette or the bulb end of a transfer pipette.
- 4.5.4.5.12 Replace the lid and the aeration pipette and move on to the next test chamber. Continue until all amphipods have been added to all test chambers.
- 4.5.4.6 Initiate the test (one hour after the addition of animals to the first chambers).**
- 4.5.4.6.1 Examine all test chambers one at a time.
1. Look for animals that have not burrowed into the sediment.
 2. Replace animals that have not burrowed with animals from the holding dishes.
 3. Record any replacements on the datasheet for day zero.
- 4.5.4.6.2 Record your initials, the time, the table temperature, and the thermometer number, in the appropriate space on the "Daily Datasheet" for day 0.
- 4.5.4.6.3 Turn on the air pump that supplies the test chambers.
- 4.5.4.6.4 Check to make sure that air is flowing to all the test chambers and adjust the 'gang' valves for gentle aeration.

- 4.5.4.6.7 Complete the "Method Summary Datasheet" using the information from the "Field Collection Datasheet", the "Randomization Datasheet", and the "10-Day Daily Datasheet" for Day 0.
- 4.5.4.6.8 Make sure that **all** datasheets have been filled out completely and correctly.
- 4.5.4.7 Preserve the extra cup of 20 animals.**
 - 4.5.4.7.1 Transfer the animals from the extra cup to a 20ml scintillation vial using a small amount of test water.
 - 4.5.4.7.2 Verify the count as twenty.
 - 4.5.4.7.3 Add a volume 10% formalin equal to the volume in the vial and cap the vial tightly.
 - 4.5.4.7.4 Mark the vial with the experiment number and the name of the test species.
 - 4.5.4.7.5 Place the labelled vial in the scintillation vial tray designated for animal storage.
- 4.5.4.8 Clean the equipment and the work area.**
 - 4.5.4.8.1 Return any un-used /clean equipment back to its storage area.
 - 4.5.4.8.2 Rinse all specimen cups, screen cups, and holding dishes with deionized water. Let drip dry.
 - 4.5.4.8.3 Replace the absorbant paper if it is grossly dirty.
 - 4.5.4.8.4 Return all materials to their appropriate storage area.

4.6 DAILY OBSERVATIONS OF THE AMPHIPOD TOXICITY TEST

4.6.1 OBJECTIVE

4.6.1.1 This section describes the methods used to make and record daily observations of test chambers during the 10 day exposure.

4.6.1.2 Each test chamber is checked daily to identify any emerged or dead amphipods and observe the presence of molts.

4.6.1.3 Physical parameters are measured twice during the exposure, they include: pH, salinity, dissolved oxygen, and sometimes ammonia.

4.6.2 SAFETY

4.6.2.1 A labcoat, latex gloves (rinsed), and safety glasses are to be worn when performing the daily test check and measuring physical parameters.

4.6.3 MATERIALS

4.6.3.1 Pipet and bulb

4.6.3.2 Stereo Microscope

4.6.3.3 Dissecting tools: probes, forceps

4.6.3.4 Plastic petri dish

4.6.3.5 Bowl for rinsing

4.6.3.6 Data sheets (attached)

4.6.3.7 Seawater at appropriate test salinity

4.6.3.8 Squeeze bottle filled with test water

4.6.4 METHODS

4.6.4.1 **Record the time and your initials on the 'Daily Data Sheet'.**

4.6.4.2 **Check test temperature.**

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- 4.6.4.2.1 Observe the temperature recorder and note any irregularities on the daily data sheet and the general comment sheet.
NOTE: Unusual temperatures should be brought to the attention of the assistant laboratory manager immediately.
- 4.6.4.2.2 Record the thermometer number on the data sheet.
- 4.6.4.2.3 Read the thermometer and record the temperature on the data sheet, taking into account the calibration adjustment on the label.
- 4.6.4.3 Check each test chamber (Day 1 - 9).**
- 4.6.4.3.1 Remove aeration pipette and lid from the test chamber.
- 4.6.4.3.2 Rinse the inside edge of the test chamber with test water from a squeeze bottle. Use only enough water to dislodge any emerged animals that may have been caught in an air bubble.
- 4.6.4.3.3 Look into the test chamber to find amphipods that are not burrowed into the sediment and remove them to a petri dish using a clean pipette.
- 4.6.4.3.4 Examine the animals under the stereo microscope.
- 4.6.4.3.5 Record observations on the "10-Day Daily Datasheet", based on the following classifications:
Emerged (E)--any live amphipod not burrowed in the sediment, i.e. floating swimming, or lying on the sediment surface.
Molt (M)--discarded exo-skeleton the usually exhibits the following: it is transparent, has no eyes or gut, it appears hollow and is usually split at the neck.
Neuromuscular twitch (NMT)--a live amphipod that appears dead, when gently probed near the legs or the midsection, one or two legs may kick spasmodically (this may take some time to observe).
Dead (D)--a dead amphipod usually exhibits the following: there is *no* neuromuscular twitch; the body is soft and extended, it may be disintegrating; and the gut is usually empty.
- 4.6.4.3.6 Return all live animals (include NMT) and molts to the test chamber.
- 4.6.4.3.7 Discard all dead animals by rinsing them into the rinse bowl.
NOTE: An experienced technician **must** verify any animals that you have designated dead until he/she has determined that you can work on your own.
- 4.6.4.3.8 Replace the lid and the aeration pipette to the test chamber.
- 4.6.4.3.9 Rinse the pipette, inside and out, with test water between test chambers.

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- 4.6.4.3.10 After all chambers have been checked, rinse probes and dishes with deionized water. Clean the microscope and cover.
- 4.6.4.3.11 Walk back along both sides of the test table and insure that all lids and pipettes have been replaced and that all chamber are aerating properly.
- 4.6.4.4 Check each test chamber (Day 10).**
- 4.6.4.4.1 Repeat steps 4.6.4.3.1 through 4.6.4.3.5.
- 4.6.4.4.2 Place emerged animals (include NMT) in a labeled vial corresponding to the test chamber.
- 4.6.4.4.3 Record the number emerged (include NMT) on the 'Test Breakdown Sheet' as well as the 'Daily Data Sheet'.
- 4.6.4.4.4 Repeat steps 4.6.4.2.7 through 4.6.4.2.11.
- 4.4.4.5 Complete the Daily Data Sheet (Day 1-10).**
- 4.6.4.5.1 QA the cumulative number dead from yesterday.
NOTE: This does not apply for Day's 0 and 1.
1. For each jar, re-tabulate the cumulative number dead from yesterday by adding the number of dead found yesterday to the cumulative total from the day before.
 2. Record your initials on today's datasheet in the space labeled 'Previous day's Cumulative number dead, QA'd by: _____'.
- 4.6.4.5.2 Calculate today's cumulative number dead by adding today's observed dead to yesterday's QA'd total. Record data in the columns labeled: 'Cum # Dead'.
- 4.6.4.5.3 Make photocopies of today's data sheet and any previous sheet that needed corrections and place them into the test folder in the file cabinet.
NOTE: Do not wear protective clothing outside the laboratory.
- 4.6.4.5.4 Return the original data to the clipboard; place completed data sheets at the bottom of the stack.
- 4.6.4.6 Take physical measurements twice during test.**
- 4.6.4.6.1 Calibrate the equipment needed to measure dissolve oxygen, pH, and salinity. See individual SOP's for specific instructions.
- 4.6.4.6.2 Record calibrations in the *EQUIPMENT-Calibration Logs for Measurement of Dissolved Oxygen, pH, Salinity, and Temperature on Experiments Performed in (Year)*.

- 4.6.4.6.3 Obtain physical data measurements from test chambers designated by the presence of a circle.
- 4.6.4.6.4 Record data on the 'Physical Data Sheet' for the appropriate day.
- 4.6.4.6.5 Record your initials and the date in the appropriate space on the 'Physical Data Sheet'
- 4.6.4.6.6 Walk back along both sides of the test table and insure that all lids and pipettes have been replaced and that all chamber are aerating properly.
- 4.6.4.6.7 Make photocopies of today's data sheet and any previous sheet that needed corrections and place them into the test folder in the file cabinet.
- 4.6.4.6.8 Return the original data to the clipboard; place completed data sheets at the bottom of the stack.

4.7 SIEVING TEST CHAMBERS FOR TEST BREAKDOWN

4.7.1 OBJECTIVE

- 4.7.1.1 This section describes the methods used to sieve amphipods from test sediments at the end of the 10 day exposure.
- 4.7.1.2 Sediment from each test chamber must be sieved so that the remaining material can be picked through to find the surviving amphipods.
- 4.7.1.3 All replicates must be sieved, if all replicates can not be picked immediately, it is possible to preserve the last two replicates. This is determined by the Laboratory Manager.

4.7.2 SAFETY

- 4.7.2.1 Sediment samples may contain hazardous biological or chemical constituents. Polylaminated (waterproof) coveralls, polylaminated apron, faceshield, latex gloves, silvershield gloves, nitrile gloves, and dielectric boots are to be worn.
- 4.7.2.2 Hazardous constituents can become airborne when spilled/splattered sediment is allowed to dry. All spills must be wiped immediately with a damp paper towel.

4.7.3 MATERIALS

- 4.7.3.1 Settling bucket with liners (one per person)
- 4.7.3.2 500µm sieve (one per person)
- 4.7.3.3 Modified transfer pipette (cut tip) and forceps (one per person)
- 4.7.3.4 Gray bins (one per person)
- 4.7.3.5 Large carolina dish (one per person)
- 4.7.3.6 Plastic bowls/picking dishes (one per sample)
- 4.7.3.7 Seawater at appropriate test salinity
- 4.7.3.8 Squeeze bottle filled with test water
- 4.7.3.9 Thermometer
- 4.7.3.10 Test chambers

4.7.3.11 Preserving jars (one for each sample)

4.7.3.12 Modified funnel

4.7.3.13 10% buffered formalin solution with rose bengal

4.7.3.14 Datasheets (attached)

4.7.4 **METHODS**

4.7.4.1 **Set-up the sieving station.**

4.7.4.1.1 Place a settling bucket in the sink.

4.7.4.1.2 Place a 500µm sieve over the bucket.

4.7.4.1.3 Place a gray bin labeled 'test breakdown' to the left or right of the sink.

4.7.4.1.4 Fill the gray bin at least half full with test water.

4.7.4.1.5 Place the squeeze bottle containing test water, the large glass dish, the forceps, and the pipette on the opposite side of the sink as the bin.

4.7.4.2 **Sieve out the samples.**

NOTE: This must be done **after** daily observations have been recorded for Day 10.

4.7.4.2.1 Obtain the first three replicates for each treatment, indicated by a circle or a star, and bring them to the sieving station.

4.7.4.2.2 Determine who will sieve the odd numbered chambers and who will sieve the even numbered chambers. Record this on the data sheet.

4.7.4.2.3 Select a test chamber and a medium dish.

4.7.4.2.4 Transfer the label from the chamber to the medium dish and place the labeled medium dish inside the large dish next to the sink.

4.7.4.2.5 Rinse the content of the test chamber into the sieve using a moderate force tap water spray. Rinse jar thoroughly then place it in a dish bin.

4.7.4.2.6 Rinse the sediment through the sieve using a gentle to moderate force tap water spray, until no more material will pass through the sieve.

NOTE: Do not expose amphipods to this fresh water spray for more than 10 minutes.

- 4.7.4.2.7 Carefully rinse the material retained on the sieve to one end, while holding the sieve at a slight angle.
- 4.7.4.2.8 Rinse the material remaining on the sieve generously with test water, using the squeeze bottle and let the water drain through the sieve.
- 4.7.4.3 Transfer the material on the sieve to the picking dish.**
 - 4.7.4.3.1 Dip the end of the sieve carefully into the gray bin, do not let any material flow out of the sieve.
 - 4.7.4.3.2 Rinse the material again with test water to one end of the sieve, using the squeeze bottle.
 - 4.7.4.3.3 Place the sieve over the medium dish (inside the large dish) and tip it slightly toward you.
 - 4.7.4.3.4 Carefully rinse the material from the sieve into the medium dish, using the squeeze bottle containing test water.
 - 4.7.4.3.5 Check the large dish for any spillage and pipette or pour it into the medium dish.
- 4.7.4.4 Check the sieve for amphipods that are remaining on the sieve.**
 - 4.7.4.4.1 Dislodge amphipods clinging to the sieve by slapping the sieve forcefully against the surface of the water in the gray bin.
 - 4.7.4.4.2 Submerge the sieve gently using water tension to trap any remaining amphipods on the surface.
 - 4.7.4.4.3 Remove remaining amphipods to the labeled medium dish using the pipette.
 - 4.7.4.4.4 Notice any material caught in the mesh of the sieve, use forceps to remove it to the labeled medium dish.
 - 4.7.4.4.5 Repeat this process twice before moving on to the next sample.
 - 4.7.4.4.6 Transfer the medium dish containing sample (picking dish) to the designated 'To Be Picked' Area.
- 4.7.4.5 Repeat the sieving process for the last two treatment replicates.**

NOTE: These replicates can be preserved if time does not allow for them to be picked immediately.
- 4.7.4.6 Preserving the last two treatment replicates.**

NOTE: The decision to preserve is made by the laboratory manager. Samples are preserved with formalin, always work in the hood.

4.7.4.6.1 Determine the number of preserving jars required.

NOTE: If samples contain a lot of material two jars may be required per replicate.

4.7.4.6.2 Select a labeled medium dish containing sample and an empty preserving jar. Check the space on the data sheet 'Check if Preserved' for the corresponding jar number.

4.7.4.6.3 Transfer the label from the dish to the preserving jar. If two jars are needed, make sure that both are labeled.

4.7.4.6.4 Place a modified funnel into the labeled jar and place the jar inside a large dish.

4.7.4.6.5 Pour the sample carefully from the medium dish through the funnel into the preserving jar.

4.7.4.6.6 Rinse material remaining in the dish and on the funnel into the jar using a squeeze bottle containing test water.

NOTE: Use minimal amounts of test water for this procedure.

4.7.4.6.7 Note the volume of water in the jar and add an equal amount of 10% buffered formalin containing rose bengal.

4.7.4.6.8 Cap the jar tightly and swirl vigorously so that all material is exposed to the formalin.

4.7.4.6.9 Place the jar into a storage box. Label the box(es) with the project name and experiment number.

NOTE: Do not store in a box that already contains preserved samples.

4.7.4.6.10 Place a photocopy of the incomplete 'Test Breakdown Sheet' in the box.

4.7.4.7 Clean-up the work area.

4.7.4.7.1 Fill the dish bin with hot tap water, make sure that all jars are soaking.

4.7.4.7.2 Remove labels from the lids and carefully stack and soak the lids in a gray dishroom bin.

4.7.4.7.3 Wipe an splattered sediment from the work area (walls, cabinets, faucets, counter-tops, etc.) using damp paper towels.

4.7.4.7.4 Wash the work area (including the floor and floor mats) with an alconox solution and then a disinfectant solution. Rinse.

- 4.7.4.7.5 Clean faceshield and hang it on the wall. Clean gloves and hang on the glove rack. Wipe splattered mud from apron and coveralls and hang on the coat rack. Disposable protective wear may be discarded if grossly dirty.
- 4.7.4.8 **Clean the test table.**
 - 4.7.4.8.1 Make sure that no aeration tubing is dangling in the water table.
 - 4.7.4.8.2 Remove any stray petri dishes, bowls, or dissecting tools to a dish bin.
NOTE: Dissecting tools should be cleaned and put away immediately.
 - 4.7.4.8.3 Discard any stray pipettes.
 - 4.7.4.8.4 Drain the water from the table and wipe it down with clean hot water to remove any scum.
NOTE: If the table is very dirty a mild bleach solution can be used. Always check with a manager before using bleach in the lab.

4.8 PICKING SAMPLES AT THE END OF THE TEST

4.8.1 OBJECTIVE

4.8.1.1 This section describes the methods used to sort through the remaining material after the samples have been sieved out.

4.8.1.2 If all replicates can not be picked immediately it is possible to preserve the last two replicates.

4.8.2 SAFETY

4.8.2.1 Sediment samples may contain hazardous biological or chemical constituents. Polylaminated apron, labcoat, and latex gloves, are to be worn.

4.8.2.2 Hazardous constituents can become airborne when spilled/splattered sediment is allowed to dry. All spills must be wiped immediately with a damp paper towel.

4.8.3 MATERIALS

4.8.3.1 Disposable pipette with cut tip (one per person)

4.8.3.2 Stereo Microscope (one per person)

4.8.3.3 Plastic spoon, bent and straight probes, and forceps (one per person)

4.8.3.4 Plastic petri dishes, various sizes (several per person)

4.8.3.5 Plastic bowl (one per person)

4.8.3.6 Squeeze bottle filled with test water (one per person)

4.8.3.7 Black pen (one per person)

4.8.3.8 Data sheets (attached)

4.8.3.7 Testwater at appropriate test salinity

4.8.4 METHODS

4.8.4.1 **Set-up the picking table.**

4.8.4.1.1 Cover the table with absorbent paper.

- 4.8.4.1.2 Arrange the microscopes on the table so that each person will have plenty of work space (this includes leg space).
- 4.8.4.1.3 Place a plastic bowl, picking tools, petri dishes, black pen, and a squeeze bottle at each microscope station.
- 4.8.4.1.4 Place a bowl labeled 'PODS' at each end of the table.
- 4.8.4.1.5 Make sure there is a suitable chair at each microscope station.
- 4.8.4.2 Select a sample.**
NOTE: Select only one sample at a time.
 - 4.8.4.2.1 Obtain a sample from the area designated: 'To Be Picked'
NOTE: The first three replicates for each treatment, indicated by a circle or a star, must be picked first.
 - 4.8.4.2.2 Observe the sample number and record your initials and the time in the spaces provided for that sample on the breakdown datasheet.
 - 4.8.4.2.3 Determine the number of emerged animals found during the daily test check on your sample from the 'Day 10 Emerged' column on the breakdown data sheet.
 - 4.8.4.2.4 Obtain the vial containing the emerged animals corresponding to that sample (if any).
 - 4.8.4.2.5 Return to the microscope station with the sample.
 - 4.8.4.2.6 Once you have started picking a sample, do not leave the work station until the sample is completed.
- 4.8.4.3 Look for amphipods.**
 - 4.8.4.3.1 Remove amphipods floating on the surface to a small petri dish (counting dish).
 - 4.8.4.3.2 Agitate the sample using a spoon or probe to encourage any submerged amphipods to the surface and remove them to the counting dish.
- 4.8.4.4 Pick through the material remaining in the sample bowl.**
NOTE: Material must be picked even if all 20 animals have been found.
 - 4.8.4.4.1 Pour most of the surface water in the sample dish/picking dish into the empty plastic bowl.
 - 4.8.4.4.2 If picking *Ampelisca*, look for tubes and arrange them on a larger petri dish.
 1. Place the petri dish under the stereo microscope.

2. Using the forceps and a probe, carefully tear apart the tubes trying not to destroy any animals that might be present.
 3. Carefully transfer any amphipods you find to the counting dish.
 4. Transfer the tube material to the bowl containing the sample water.
- 4.8.4.4.3 Use the spoon to transfer a small portion of the sample material onto a large petri dish.
- 4.8.4.4.4 Pick through the material under a stereo microscope using the probes and forceps.
- 4.8.4.4.5 Rinse the material into the plastic bowl containing your sample water (and tubes, if any) using a squeeze bottle containing test water.
- 4.8.4.4.6 Repeat this process until the entire sample has been picked.
- 4.8.4.5 Return the sample to its original labeled dish.**
NOTE: This sometimes helps to loosen any remaining amphipods from the sediment.
- 4.8.4.5.1 Carefully pour the sample from your plastic bowl into its original dish.
- 4.8.4.5.2 Rinse any leftover material into the original dish using a squeeze bottle containing test water.
- 4.8.4.5.3 Remove any additional animals to the counting dish.
- 4.8.4.6 Observe the condition of the animals in your amphipod dish and fill in the datasheet.**
- 4.8.4.6.1 Count the number of live and dead amphipods in the counting dish.
NOTE: Animals that are determined to be dead must be verified by a senior technician.
- 4.8.4.6.2 Have an experienced technician verify your count by recounting the animals in the counting dish and by counting the animals in the emerged vial (if any).
NOTE: If the counts disagree both parties must recount.
- 4.8.4.6.3 Record *your own* count under "First Pick" in the '# Live' and '# Dead' columns that correspond to your sample number.
- 4.8.4.6.4 Have the experienced technician verify your sample number and record *his/her own* initials and the number live counted under the "First Pick-Recount" column corresponding to your sample number.
NOTE: The number live recorded in the recount column includes any animals that were emerged on Day 10.
- 4.8.4.6.5 Rinse the amphipods from your counting dish into any of the dishes labeled 'PODS' located at each end of the picking table.

- 4.8.4.6.6 Observe the counting dish to insure that no animals remain.
- 4.8.4.7 Determine whether or not the sample must be re-picked.**
NOTE: This is usually done by the person performing the recount.
- 4.8.4.7.1 Determine the number of animals missing by adding the total number live from the recount to the number dead and subtracting this number from 20.
1. If more than 10% of the animals are missing (i.e. 3 out of 20) the sample dish must be placed in the area designated: 'To Be Re-picked'.
 2. If the number of animals missing is less than or equal to 10%, then the sample does not need to be repicked. The sample can be placed in the area designated 'No Re-pick'.
- 4.8.4.7.2 Place the sample in the appropriate area make sure that all material is covered with water, cover the sample with a lid. The sample is now completed.
- 4.8.4.8 Repeat this process for all samples.**
- 4.8.4.9 Re-pick all samples that have more than 10% missing.**
NOTE: Repicks should be performed within 24 hours, but no more than 72 hours.
- 4.8.4.9.1 Have an experienced technician QA the breakdown data sheet.
1. Verify the number live recorded in the recount section of the data sheet.
 2. Verify the number missing recorded in the recount section of the data sheet.
 3. Verify that all samples requiring a repick are located in the area designated: 'To Be Repicked'.
- 4.8.4.9.2 Select a sample that you did not pick originally.
- 4.8.4.9.3 Record your initials in the "QA-Repick" column.
- 4.8.4.9.4 Pick the sample using the techniques described above.
- 4.8.4.9.5 Count the number of live and dead amphipods in the counting dish. Record the number live found during the repick in the "QA-Repick" '# Live' column.
- 4.8.4.9.6 Have an experienced technician verify your count by recounting the animals in the counting dish. He/she will verify your sample number and record *his/her own* initials and the number live counted under the "QA Repick-Recount" column corresponding to your sample number.
- 4.8.4.9.7 Rinse the amphipods from your counting dish into any of the dishes labeled 'PODS' located at each end of the picking table.
- 4.8.4.9.8 Observe the counting dish to insure that no animals remain.

- 4.8.4.9.9 When all samples have been picked and repicked, transfer them to a safe place and cover them with dark plastic.
- 4.8.4.10 Determine the Final Count and QA the Breakdown Data Sheet**
- 4.8.4.10.1 Have the an experience technician calculate the final number live by adding the number live from the "First Pick-Recount" column to the number live from the "QA-Repick-Recount" column.
- 4.8.4.10.2 Have the Assistant Manager verify all of the tallies and transcribe the 'Final Number Live' to the "72-Hour Extended QA" Datasheet.
- 4.8.4.10.3 The assistant manager will have someone QA the transcription of the data.
- 4.8.4.11 Clean the work table.**
- 4.8.4.11.1 Clean all microscopes with deionized water (remove the glass plate and clean under it), then with alcohol, paying special attention to the eyepieces.
- 4.8.4.11.2 Cover the microscopes and put them away unless they are needed tomorrow.
- 4.8.4.11.3 Collect all of the picking tools, petri dishes, and bowls.
1. Rinse with deionized water.
 2. Let the picking tools dry overnight on a paper towel.
 3. Discard the pipette.
 4. Place the bowls and the petri dishes in a dishbin to be washed unless they are needed tomorrow.
- 4.8.4.11.4 Discard the absorbent paper and replace it with fresh paper.
- 4.8.4.12 Perform the 72-Hour Extended QA.**
- 4.8.4.12.1 After 24 hours, uncover the sample dishes and look for floating or emerged amphipods in all sample dishes.
- 4.8.4.12.2 Note the sample number and remove the animals using a modified pipette and observe them under a stereo microscope.
1. If the animals are live, record the number in the '24 hr' column on the "72-Hour Extended QA" datasheet.
 2. If the animals are dead. nothing needs to be recorded. You can record the number followed by a 'd' for dead.
 3. If nothing is found, record a dash (-) in the space.

- 4.8.4.12.3 Cover the dishes with dark plastic.
- 4.8.4.12.4 Repeat this process at 48 and 72 hours. The samples can be discarded.
- 4.8.4.12.5 Have an experienced technician tally the 'Final # Live Animals' by adding the number recorded in the 'Final # Live from Brkdwn' column to the numbers recorded in the '24 hr', '48 hr', and '72 hr' columns.
- 4.8.4.12.6 Have the Assistant Manager QA the datasheet.

4.9 PICKING PRESERVED SAMPLES AT THE END OF THE TEST

4.9.1 OBJECTIVE

4.9.1.1 This section describes the methods used to sort through the remaining material after the samples have been sieved out and preserved.

4.9.2 SAFETY

4.9.2.1 Sediment samples may contain hazardous biological or chemical constituents. Polylaminated apron, labcoat, and latex gloves, are to be worn.

4.9.2.2 Hazardous constituents can become airborne when spilled/splattered sediment is allowed to dry. All spills must be wiped immediately with a damp paper towel.

4.9.2.3 All work with formalin must be conducted under the hood or a fume adsorber.

4.9.3 MATERIALS

4.9.3.1 Formalin contaminated disposable pipette with cut tip (one per person)

4.9.3.2 Stereo Microscope (one per person)

4.9.3.3 Formalin contaminated plastic spoon, bent and straight probes, and forceps (one per person)

4.9.3.4 Formalin contaminated plastic petri dishes, various sizes (several per person)

4.9.3.5 Formalin contaminated plastic bowl (one per person)

4.9.3.6 Formalin contaminated squeeze bottle filled with test water (one per person)

4.9.3.7 Black pen (one per person)

4.9.3.8 Data sheets (attached)

4.9.3.7 Testwater at appropriate test salinity

4.9.3.7 Formalin contaminated sieve, 500µm

4.9.3.7 Formalin contaminated blue bin

4.9.3.8 Formalin contaminated large rinsing bowl



4.9.3.9 Formalin contaminated settling bucket

4.9.3.10 Formalin waste container with waste log

4.9.3.11 Sample jars preserved with formalin

4.9.4 METHODS

4.9.4.1 Set-up the picking stations under the fume adsorbers.

NOTE: A table can be set-up outside without a fume adsorber, weather and wind direction permitting.

4.9.4.1.1 Cover the table with absorbent paper.

4.9.4.1.2 Arrange the microscopes so that they are under the fume adsorber and so that each person has plenty of work space.

4.9.4.1.3 Place a formalin contaminated plastic bowl, picking tools, petri dishes, black pen, and a squeeze bottle at each microscope station.

4.9.4.1.4 Make sure there is a suitable chair at each microscope station.

4.9.4.2 Obtain the preserved samples.

4.9.4.2.1 Find the storage box containing the test that needs to be finished.

4.9.4.2.2 Obtain the original 'Breakdown Datasheet' for that test.

NOTE: This can be found in the original data notebooks located in the ETC library.

4.9.4.3 Set-up a sieving station in the hood sink.

4.9.4.3.1 Place the formalin contaminated settling bucket in the sink.

4.9.4.3.2 Place the formalin contaminated 500µm sieve over the bucket.

4.9.4.3.3 Place the formalin contaminated blue bin to the left or right of the sink.

4.9.4.3.4 Place the formalin contaminated, white plastic grid over the blue bin.

4.9.4.3.5 Place the formalin contaminated squeeze bottle containing test water, the large glass dish, the forceps, and the pipette on the opposite side of the sink as the bin.

4.9.4.4 Sieve out a preserved sample.

NOTE: Several may be sieved ahead, but only sieve as many as can be picked in one day.

- 4.9.4.4.1 Obtain a jar from the box containing preserved samples.
- 4.9.4.4.2 Select a jar containing preserved sample and a formalin contaminated medium dish (picking dish).
- 4.9.4.4.3 Transfer the label from the jar to the medium dish and place the labeled medium dish inside the large dish next to the sink.
- 4.9.4.4.4 Swirl the contents of the jar and pour it into the sieve over the blue bin.
- 4.9.4.4.5 Rinse any remaining material from the jar into the sieve using a small amount tap water.
- 4.9.4.4.6 Place the sieve over the settling bucket. Rinse the jar thoroughly, over the settling bucket, then place it back into a storage box.
- 4.9.4.4.7 Rinse the material in the sieve by flushing it with copious quantities of tapwater until the formalin has been rinsed from the sample.
NOTE: Do not allow any material/animals to bounce out of the sieve.
- 4.9.4.4.8 Carefully rinse the material retained on the sieve to one end, while holding the sieve at a slight angle.
- 4.9.4.4.9 Rinse the material remaining on the sieve generously with test water, using the squeeze bottle and let the water drain through the sieve.
- 4.9.4.5 Transfer the material on the sieve to the picking dish.**
- 4.9.4.5.1 Place the sieve over the medium dish (inside the large dish) and tip it slightly toward you.
- 4.9.4.5.2 Carefully rinse the material from the sieve into the medium dish, using the squeeze bottle containing test water.
- 4.9.4.5.3 Check the large dish for any spillage and pipette or pour it into the medium dish.
- 4.9.4.5.4 Check the sieve for amphipods that are remaining on the sieve.
- 4.9.4.6 Select a sample.**
- 4.9.4.6.1 Obtain a sample from the area designated: 'To Be Picked'
- 4.9.4.6.2 Observe the sample number and record your initials and the time in the spaces provided for that sample on the breakdown datasheet.

- 4.9.4.6.3 Determine the number of emerged animals found during the daily test check on your sample from the 'Day 10 Emerged' column on the breakdown data sheet.
- 4.9.4.6.4 Return to the microscope station with the sample.
- 4.9.4.6.5 Once you have started picking a sample, do not leave the work station until the sample is completed.
- 4.9.4.7 Pick the sample using the methods described in section 4.8-Picking Samples at End of Test.**
- 4.9.4.8 Return the sample to its original labeled dish.**
- 4.9.4.9 Determine whether or not the sample must be re-picked using the methods described in Section 4.8.**
NOTE: This is usually done by the person performing the recount.
If the sample needs to be re-picked, have someone do it right away.
- 4.9.4.10 Re-pick all samples that have more than 10% missing.**
- 4.9.4.11 Repeat this process for all samples until they are completed.**
- 4.9.4.12 Determine the Final Count and QA the Breakdown Data Sheet**
 - 4.9.4.12.1 Have the an experience technician calculate the final number live by adding the number live from the "First Pick-Recount" column to the number live from the "QA-Repick-Recount" column.
 - 4.9.4.12.2 Have the Assistant Manager verify all of the tallies and transcribe the 'Final Number Live' to the 72-Hour Extended QA Datasheet.
 - 4.9.4.12.3 The assistant manager will have someone QA the transcription of the data.
- 4.9.4.13 Clean the work area.**
 - 4.9.4.13.1 Place the formalin waste container in the hood.
NOTE: If a waste container is not available, contact the ECH&S Officer.
 - 4.9.4.13.2 Transfer the formalin waste to the waste container.
 1. Carefully pour the formalin from the blue bin into the waste container
 2. Rinse the blue bin several times with tap water and pour the **first** rinse into the waste container.
 3. Pour off most of the water in the settling bucket and rinse the material at the bottom into the waste container.

4. Record the date, your initials, the project, and the approximate volume of waste added to the container on the waste log for that container.
- 4.9.4.13.3 Discard the completed samples into the formalin waste container by pouring them through a funnel and rinsing the funnel with minimal water.
- 4.9.4.13.4 Rinse all formalin contaminated dishes and tools with tap water and place them in their storage area.
- 4.9.4.13.5 Clean the microscopes and put them away. Turn off the fume adsorber.
- 4.9.4.13.6 Replace the absorbent paper and wipe down the fume guard.
- 4.9.4.13.7 Clean all surfaces with a solution of alconox. Rinse.

10 Day Solid Phase Test—Randomization Sheet

Project: _____

Experiment #: _____

Species: _____

Jar #	Sort	Client #/Descriptor	Cardov #	Sample Description / Sample QA
	A1	LIS Control		Sign: CSign: /Sign: Csign:
	A2	LIS Control		Sed Type: sand mud clay
	A3	Jar #:		Odor/Color: fishy sulfur oily fecal / brown gray black
	A4	LIS Control		Other Notes: PODS
	A5	LIS Control		Press Sieved: 2mm 1mm
	B1			Sign: CSign: /Sign: Csign:
	B2			Sed Type: sand mud clay
	B3			Odor/Color: fishy sulfur oily fecal / brown gray black
	B4			Other Notes: PODS
	B5			Press Sieved: 2mm 1mm
	C1			Sign: CSign: /Sign: Csign:
	C2			Sed Type: sand mud clay
	C3			Odor/Color: fishy sulfur oily fecal / brown gray black
	C4			Other Notes: PODS
	C5			Press Sieved: 2mm 1mm
	D1			Sign: CSign: /Sign: Csign:
	D2			Sed Type: sand mud clay
	D3			Odor/Color: fishy sulfur oily fecal / brown gray black
	D4			Other Notes: PODS
	D5			Press Sieved: 2mm 1mm
	E1			Sign: CSign: /Sign: Csign:
	E2			Sed Type: sand mud clay
	E3			Odor/Color: fishy sulfur oily fecal / brown gray black
	E4			Other Notes: PODS
	E5			Press Sieved: 2mm 1mm
	F1			Sign: CSign: /Sign: Csign:
	F2			Sed Type: sand mud clay
	F3			Odor/Color: fishy sulfur oily fecal / brown gray black
	F4			Other Notes: PODS
	F5			Press Sieved: 2mm 1mm
	G1			Sign: CSign: /Sign: Csign:
	G2			Sed Type: sand mud clay
	G3			Odor/Color: fishy sulfur oily fecal / brown gray black
	G4			Other Notes: PODS
	G5			Press Sieved: 2mm 1mm
	H1			Sign: CSign: /Sign: Csign:
	H2			Sed Type: sand mud clay
	H3			Odor/Color: fishy sulfur oily fecal / brown gray black
	H4			Other Notes: PODS
	H5			Press Sieved: 2mm 1mm

Data Entry: _____ QA's: _____

10 Day Solid Phase Test--Daily Data Sheet

Project: _____

Experiment #: _____

Day: _____ Date: _____

Organism: _____

Time/Initials: _____

Jar #	Observations*				Cum # Dead	Jar #	Observations*				Cum # Dead	Jar #	Observations*				Cur De
	E	M	NMT	D			E	M	NMT	D			E	M	NMT	D	
1						31						61					
2						32						62					
3						33						63					
4						34						64					
5						35						65					
6						36						66					
7						37						67					
8						38						68					
9						39						69					
10						40						70					
11						41						71					
12						42						72					
13						43						73					
14						44						74					
15						45						75					
16						46						76					
17						47						77					
18						48						78					
19						49						79					
20						50						80					
21						51						81					
22						52						82					
23						53						83					
24						54						84					
25						55						85					
26						56											
27						57											
28						58											
29						59											
30						60											

Animals/rep: _____

Temp: _____

Thermometer #: _____

Previous day's Cumulative number dead. QA'd by: _____

*KEY: E = emerged, M = molt, NMT = neuromuscular twitch, D = dead

Comments:

10 Day Solid Phase Test--Breakdown Data Sheet

Project: _____
 Species: _____

Experiment #: _____
 Date: _____

First Pick								QA - RePick				Final Count				
Initials	Time	Jar #	Dead During Test	Day 10 Emerged	# Live	# Dead	Recount			QA - RePick		Recount		# Tubes Day 0	24 Hr. QA	Final # Live ***
							Initials	# Live	# Animals Missing **	Initials	# Live	Initials	# Live			
		1														
		2														
		3														
		4														
		5														
		6														
		7														
		8														
		9														
		10														
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		25														
		26														
		27														
		28														
		29														
		30														

- Comments:
- * # Live = the # live emerged on day 10 + the # live found by the picker
 - ** If > 10% of the animals are missing (ie. > 2 of 20), the sample must be QA'd
 - *** Final # Live = the # live from the 'first pick' recount + the # live from the QA recount

Appendix B. Amphipod (*Ampelisca abdita*) 10-Day Solid-Phase Toxicity Test Results for Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Raw *Ampelisca abdita* toxicity data for McAllister Point sediment samples. Data are for 10-day solid-phase tests. "Sample ID" are station numbers. LIS is the ETC performance control sediment from central Long Island Sound. "Jar No." refers to the replicate number assigned to each test chamber. The "No. Alive" refers to the number of live animals observed at the end of the 10-day solid-phase test. The "% Survival" refers to percentage of live animals observed at the end of the 10-day solid-phase test out of the initial 20 animals added to each replicate test chamber. The "Mean %" refers to the mean percent survival of all five replicates per sample. The "SD" refers to the SD of the "Mean %". The "% of the Control" is the ratio of the actual mean % survival to the mean % survival of the performance control. The "p value" refers to the probability that the observed differences in survival occurred strictly by chance. Low values infer highly significant differences. Mortality was considered statistically different when $p \leq 0.05$.

Appendix B. Amphipod (*Ampelisca abdita*) 10-Day Solid-Phase Toxicity Test Results for Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Jar No.	Sample ID	No. Alive	Survival (%)	Mean (%)	SD ¹	% of Control	p value ²	Comment
6	LIS	18	90	91.0	7.4			
41	LIS	19	95					
9	LIS	16	80					
55	LIS	18	90					
43	LIS	20	100					
52	S2B-R	19	95	89.0	4.2	97.8	0.309	
50	S2B-R	18	90					
18	S2B-R	17	85					
46	S2B-R	18	90					
53	S2B-R	17	85					
48	S2B-R-FD	18	90	84.0	11.4	92.3	0.144	
3	S2B-R-FD	19	95					
15	S2B-R-FD	13	65					
34	S2B-R-FD	17	85					
37	S2B-R-FD	17	85					
35	M1-R	15	75	85.0	7.9	93.4	0.126	
38	M1-R	19	95					
33	M1-R	17	85					
4	M1-R	18	90					
49	M1-R	16	80					
11	MCL-12-R	nd	nd	86.3	4.8	94.8	0.142	
40	MCL-12-R	18	90					
16	MCL-12-R	17	85					
32	MCL-12-R	16	80					
22	MCL-12-R	18	90					
23	MCL-14-R	18	90	82.0	6.7	90.1	0.040	
29	MCL-14-R	15	75					
20	MCL-14-R	17	85					
2	MCL-14-R	15	75					
30	MCL-14-R	17	85					
19	MCL-8-R	18	90	89.0	5.5	97.8	0.321	
44	MCL-8-R	18	90					
45	MCL-8-R	16	80					
10	MCL-8-R	19	95					
12	MCL-8-R	18	90					
13	MCL-9-R	17	85	85.0	11.7	93.4	0.183	
25	MCL-9-R	18	90					
28	MCL-9-R	13	65					
24	MCL-9-R	19	95					
31	MCL-9-R	18	90					

Appendix B. Amphipod (*Ampelisca abdita*) 10-Day Solid-Phase Toxicity Test Results for Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Jar No.	Sample ID	No. Alive	Survival (%)	Mean (%)	SD ¹	% of Control	p value ²	Comment
39	MCL-10-R	19	95	84.0	7.4	92.3	0.087	
1	MCL-10-R	15	75					
14	MCL-10-R	16	80					
21	MCL-10-R	17	85					
8	MCL-10-R	17	85					
42	MCL-11-R	17	85	89.0	4.2	97.8	0.309	
47	MCL-11-R	18	90					
54	MCL-11-R	19	95					
7	MCL-11-R	17	85					
5	MCL-11-R	18	90					
27	MCL-13-R	18	90	85.0	7.1	93.4	0.113	
17	MCL-13-R	18	90					
51	MCL-13-R	18	90					
26	MCL-13-R	15	75					
36	MCL-13-R	16	80					

Appendix B. Amphipod (*Ampelisca abdita*) 10-Day Solid-Phase Toxicity Test Results for Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Jar No.	Sample ID	No. Alive	Survival (%)	Mean (%)	SD ¹	% of Control	p value ²	Comment
19	LIS	21	100	95.0	5.0			
34	LIS	18	90					
4	LIS	20	100					
17	LIS	18	90					
25	LIS	19	95					
26	NSB-1	17	85	86.0	12.4	90.5	0.096	
27	NSB-1	18	90					
18	NSB-1	13	65					
22	NSB-1	19	95					
32	NSB-1	19	95					
35	NSB-2	9	45	14.0	18.2	14.7	0.000	**
7	NSB-2	3	15					
12	NSB-2	0	0					
29	NSB-2	1	5					
13	NSB-2	1	5					
28	NSB-4	4	20	23.0	24.6	24.2	0.001	**
8	NSB-4	4	20					
1	NSB-4	1	5					
24	NSB-4	13	65					
9	NSB-4	1	5					
14	NSB-5	6	30	35.0	7.1	36.8	0.000	**
5	NSB-5	6	30					
15	NSB-5	9	45					
16	NSB-5	8	40					
31	NSB-5	6	30					
30	NSB-6	15	75	86.0	12.9	90.5	0.102	
2	NSB-6	20	100					
10	NSB-6	18	90					
33	NSB-6	14	70					
3	NSB-6	19	95					
20	NSB-7	7	35	60.0	17.0	63.2	0.004	**
6	NSB-7	16	80					
21	NSB-7	14	70					
23	NSB-7	12	60					
11	NSB-7	11	55					

FOOTNOTES

* = Mean sample response was less than 80% of mean LIS response.

** = Mean sample response was both statistically different and less than 80% of mean LIS response.

nd = No data was available for this replicate.

1 - SD = Standard deviation

2 - p value = significance level of t test

3 - LIS = Long Island Sound performance control sediment

Appendix C. Water Quality Parameters Measured during the *Ampelisca abdita* 10-Day Solid-Phase Testing of Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Water quality parameters measured during 10-day solid-phase testing of McAllister Point sediment samples using *Ampelisca abdita*. "Sample ID" are station numbers. LIS is the ETC performance control sediment from central Long Island Sound. "DO" is mg/L of dissolved oxygen. "Saturation" is the mg/L of dissolved oxygen normalized to 7.6 mg/L, 100% saturation at 30 ppt salinity and 20°C. "Salinity" is parts per thousand (ppt). Water quality parameters were measured twice during each test, on days 3 and 6 or 7, in each of two replicates.

Appendix C. Water Quality Parameters Measured during the *Ampelisca abdita* 10-Day Solid-Phase Testing of Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Sample ID	pH		D.O. ⁽²⁾ (mg/L ⁽³⁾)		Saturation (%)		Salinity (ppt ⁽⁴⁾)	
	Day 3	Day 6/7	Day 3	Day 6/7	Day 3	Day 6/7	Day 3	Day 6/7
M1-R	8.23	8.37	7.2	7.2	94.7	94.7	30	30
M1-R	8.18	8.37	7.0	7.3	96.1	96.1	30	30
MCL-10-R	8.37	8.43	7.0	7.2	94.7	94.7	30	30
MCL-10-R	8.38	8.43	6.8	6.2	81.6	81.6	30	30
MCL-11-R	8.19	8.16	7.2	5.9	77.6	77.6	30	30
MCL-11-R	8.15	8.21	7.1	6.0	78.9	78.9	30	30
MCL-12-R	8.30	8.36	7.0	6.2	81.6	81.6	30	30
MCL-12-R	8.32	8.47	7.0	7.3	96.1	96.1	30	30
MCL-13-R	8.17	8.42	7.1	7.4	97.4	97.4	30	30
MCL-13-R	8.18	8.41	7.1	6.0	78.9	78.9	30	30
MCL-14-R	8.14	8.35	6.9	7.1	93.4	93.4	30	30
MCL-14-R	8.14	8.35	7.1	7.3	96.1	96.1	30	30
MCL-8-R	8.36	8.35	7.0	6.6	86.8	86.8	30	30
MCL-8-R	8.34	8.25	7.0	5.8	76.3	76.3	30	30
MCL-9-R	8.30	8.40	6.7	6.2	81.6	81.6	30	30
MCL-9-R	8.28	8.43	7.0	7.3	96.1	96.1	30	30
NSB-1	8.06	8.13	7.1	7.2	94.7	94.7	31	31
NSB-1	8.06	8.13	7.1	7.2	94.7	94.7	30	31
NSB-2	8.02	8.10	6.9	7.0	92.1	92.1	31	31
NSB-2	8.02	8.16	6.8	7.1	93.4	93.4	31	32
NSB-4	8.04	8.14	7.0	7.0	92.1	92.1	30	31
NSB-4	8.02	8.13	6.9	6.9	90.8	90.8	30	31
NSB-5	8.05	8.18	7.0	7.1	93.4	93.4	31	31
NSB-5	7.99	8.20	6.9	7.1	93.4	93.4	31	31
NSB-6	8.10	8.44	7.0	6.6	86.8	86.8	30	31
NSB-6	7.92	8.35	6.8	7.0	92.1	92.1	31	31
NSB-6	7.80	8.36	6.3	6.9	90.8	90.8	30	32

Appendix C. Water Quality Parameters Measured during the *Ampelisca abdita* 10-Day Solid-Phase Testing of Sediment Samples for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Sample ID	pH		D.O. ⁽²⁾ (mg/L ⁽³⁾)		Saturation (%)		Salinity (ppt ⁽⁴⁾)	
	Day 3	Day 6/7	Day 3	Day 6/7	Day 3	Day 6/7	Day 3	Day 6/7
NSB-7	8.02	8.07	6.9	6.9	90.8	90.8	30	30
NSB-7	8.00	8.17	6.9	7.0	92.1	92.1	30	30
S2B-R	8.09	8.31	7.0	5.9	77.6	77.6	30	30
S2B-R	8.14	8.34	7.1	5.6	73.7	73.7	30	30
S2B-R-FD	8.29	8.36	6.9	6.0	78.9	78.9	30	30
S2B-R-FD	8.40	8.49	6.9	7.1	93.4	93.4	30	30

FOOTNOTES

- 1 - Parameters were measured in 10-day solid-phase test chambers.
- 2 - D.O. = Dissolved oxygen
- 3 - mg = Milligram, L = Liter
- 4 - ppt = parts per thousand

Appendix D. Total and Un-ionized Ammonia Measured Twice in Overlying Water of Test Chambers During the 10-Day Solid-Phase Tests for McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Total and un-ionized ammonia values measured in overlying waters of test chambers on days 3 and 6 or 7 of testing McAllister Point sediment samples. Temperature, salinity, and pH are used to calculate the un-ionized ammonia values and are included.

Appendix D. Total and Un-ionized Ammonia Measured Twice in Overlying Water of Test Chambers during the 10-Day Solid-Phase Tests for McAllister Point Marine Ecological Risk Assessment Resampling Investigation

ETC Exp. No. ¹	Day	Sample ID	Total Ammonia (mg/L) ²	Salinity (ppt) ³	pH	Un-Ionized Ammonia (mg/L) ²
960908	Day 3	M1-R	2.36	30	8.23	0.12
960908	Day 3	M1-R	2.85	30	8.18	0.13
960908	Day 6	M1-R	3.74	30	8.37	0.28
960908	Day 6	M1-R	4.62	30	8.37	0.35
960908	PW	M1-R	12.55	32	8.07	0.60
960908	Day 3	MCL-10-R	3.73	30	8.38	0.27
960908	Day 3	MCL-10-R	3.48	30	8.37	0.25
960908	Day 6	MCL-10-R	5.01	30	8.43	0.43
960908	Day 6	MCL-10-R	5.05	30	8.43	0.44
960908	PW	MCL-10-R	13.40	32	8.12	0.72
960908	Day 3	MCL-11-R	2.20	30	8.19	0.11
960908	Day 3	MCL-11-R	2.04	30	8.15	0.09
960908	Day 6	MCL-11-R	1.53	30	8.16	0.07
960908	Day 6	MCL-11-R	1.53	30	8.21	0.08
960908	PW	MCL-11-R	11.05	32	8.09	0.55
960908	Day 3	MCL-12-R	3.47	30	8.3	0.21
960908	Day 3	MCL-12-R	3.50	30	8.32	0.22
960908	Day 6	MCL-12-R	4.76	30	8.36	0.35
960908	Day 6	MCL-12-R	5.23	30	8.47	0.49
960908	PW	MCL-12-R	15.53	32	8.01	0.65
960908	Day 3	MCL-13-R	2.11	30	8.18	0.10
960908	Day 3	MCL-13-R	2.26	30	8.17	0.10
960908	Day 6	MCL-13-R	2.17	30	8.41	0.18
960908	Day 6	MCL-13-R	2.60	30	8.42	0.22
960908	PW	MCL-13-R	12.12	32	8.11	0.62
960908	Day 3	MCL-14-R	1.23	30	8.14	0.05
960908	Day 3	MCL-14-R	1.22	30	8.14	0.05
960908	Day 6	MCL-14-R	0.33	30	8.35	0.02
960908	Day 6	MCL-14-R	0.17	30	8.35	0.01
960908	PW	MCL-14-R	9.12	32	8.03	0.40

Appendix D. Total and Un-ionized Ammonia Measured Twice in Overlying Water of Test Chambers during the 10-Day Solid-Phase Tests for McAllister Point Marine Ecological Risk Assessment Resampling Investigation

ETC Exp. No. ¹	Day	Sample ID	Total Ammonia (mg/L) ²	Salinity (ppt) ³	pH	Un-ionized Ammonia (mg/L) ²
960908	Day 3	MCL-8-R	3.59	30	8.36	0.25
960908	Day 3	MCL-8-R	4.65	30	8.34	0.31
960908	Day 6	MCL-8-R	4.80	30	8.35	0.35
960908	Day 6	MCL-8-R	6.43	30	8.25	0.38
960908	PW	MCL-8-R	13.64	32	7.98	0.53
960908	Day 3	MCL-9-R	3.71	30	8.3	0.23
960908	Day 3	MCL-9-R	3.71	30	8.28	0.22
960908	Day 6	MCL-9-R	5.76	30	8.4	0.47
960908	Day 6	MCL-9-R	5.83	30	8.43	0.50
960908	PW	MCL-9-R	11.29	32	7.82	0.31
960913	Day 3	NSB-1	0.16	31	8.06	0.01
960913	Day 3	NSB-1	0.01	30	8.06	0.00
960913	Day 7	NSB-1	0.00	31	8.13	0.00
960913	Day 7	NSB-1	0.00	31	8.13	0.00
960913	PW	NSB-1	*	*	*	*
960913	Day 3	NSB-2	1.18	31	8.02	0.04
960913	Day 3	NSB-2	1.07	31	8.02	0.04
960913	Day 7	NSB-2	0.17	32	8.16	0.01
960913	Day 7	NSB-2	0.22	31	8.1	0.01
960913	PW	NSB-2	*	*	*	*
960913	Day 3	NSB-4	0.00	30	8.02	0.00
960913	Day 3	NSB-4	0.00	30	8.04	0.00
960913	Day 7	NSB-4	0.00	31	8.13	0.00
960913	Day 7	NSB-4	0.00	31	8.14	0.00
960913	PW	NSB-4	*	*	*	*
960913	Day 3	NSB-5	0.67	31	7.99	0.02
960913	Day 3	NSB-5	0.73	31	8.05	0.03
960913	Day 7	NSB-5	0.40	31	8.2	0.02
960913	Day 7	NSB-5	0.37	31	8.18	0.02
960913	PW	NSB-5	*	*	*	*

Appendix D. Total and Un-ionized Ammonia Measured Twice in Overlying Water of Test Chambers during the 10-Day Solid-Phase Tests for McAllister Point Marine Ecological Risk Assessment Resampling Investigation

ETC Exp. No. ¹	Day	Sample ID	Total Ammonia (mg/L) ²	Salinity (ppt) ³	pH	Un-Ionized Ammonia (mg/L) ²
960913	Day 3	NSB-6	0.99	30	7.8	0.02
960913	Day 3	NSB-6	1.22	31	7.92	0.03
960913	Day 3	NSB-6	0.79	30	8.1	0.03
960913	Day 7	NSB-6	1.22	32	8.36	0.09
960913	Day 7	NSB-6	1.46	31	8.35	0.11
960913	Day 7	NSB-6	0.66	31	8.44	0.06
960913	PW	NSB-6	*	*	*	*
960913	Day 3	NSB-7	0.81	30	8	0.03
960913	Day 3	NSB-7	1.93	30	8.02	0.07
960913	Day 7	NSB-7	0.27	30	8.17	0.01
960913	Day 7	NSB-7	0.55	30	8.07	0.02
960913	PW	NSB-7	*	*	*	*
960908	Day 3	S2B-R	2.88	30	8.14	0.12
960908	Day 3	S2B-R	2.77	30	8.09	0.11
960908	Day 6	S2B-R	6.73	30	8.34	0.48
960908	Day 6	S2B-R	6.26	30	8.31	0.42
960908	PW	S2B-R	13.52	32	8.11	0.70
960908	Day 3	S2B-R-FD	5.10	30	8.4	0.39
960908	Day 3	S2B-R-FD	5.66	30	8.29	0.34
960908	Day 6	S2B-R-FD	7.54	30	8.49	0.74
960908	Day 6	S2B-R-FD	9.22	30	8.36	0.69
960908	PW	S2B-R-FD	17.88	31	8	0.73

FOOTNOTES

* Porewater could not be extracted due to the physical nature of this sample.

(1) ETC Exp. No. = Laboratory identification number

(2) mg = Milligram, L = Liter

(3) ppt = parts per thousand

PW = Porewater

Appendix E. ToxCalc LC₅₀ Output for *Ampelisca abdita* SDS Reference Toxicant Tests.

ToxCalc LC50 output of SDS reference toxicant tests conducted during 10-day solid-phase testing with *Ampelisca abdita* of McAllister sediment samples.

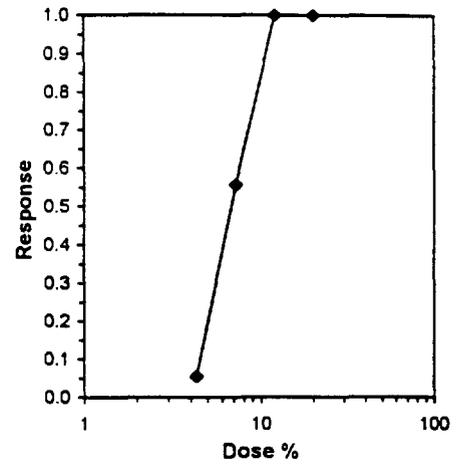
Acute Test-96 Hr Survival

Start Date: 9/20/96	Test ID: 960909	Sample ID: SDS
End Date:	Lab ID: ETC	Sample Type: Reference Toxicant
Sample Date:	Protocol:	Test Species: Ampelisca abdita
Comments:		

Conc-%	1	2
0	0.8000	1.0000
4.32	0.9000	0.8000
7.2	0.3000	0.5000
12	0.0000	0.0000
20	0.0000	0.0000

Trimmed Spearman-Kärber

Trim Level	EC50	95% CL	
0.0%			
5.0%			
10.0%	6.8674	5.6703	8.3173
20.0%	6.8461	5.3530	8.7557
Auto-5.6%	6.8770	5.7837	8.1770



Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Survival in performance control sediments of 43 of the most recent solid-phase tests performed at the ETC. "Rep No." refers to the replicate number assigned to each test chamber. The "% Survival" refers to percentage of live animals observed at the end of the 10-day solid-phase test out of the initial 20 animals added to each replicate test chamber. The "Mean" refers to the mean percent survival of all five replicates per sample. The "SD" refers to the SD of the "Mean %".

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Test No.	Rep No. ¹	% Survival	Mean	SD ²
1	1	95	93.0	4.5
	2	95		
	3	95		
	4	95		
	5	85		
2	1	80	88.0	4.5
	2	90		
	3	90		
	4	90		
	5	90		
3	1	100	93.0	4.5
	2	95		
	3	90		
	4	90		
	5	90		
4	1	85	93.0	6.7
	2	100		
	3	90		
	4	100		
	5	90		
5	1	100	98.0	2.7
	2	100		
	3	95		
	4	100		
	5	95		
6	1	95	98.0	2.7
	2	95		
	3	100		
	4	100		
	5	100		
7	1	100	92.0	9.7
	2	95		
	3	95		
	4	75		
	5	95		
8	1	95	99.0	2.2
	2	100		
	3	100		
	4	100		
	5	100		

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Test No.	Rep No. ¹	% Survival	Mean	SD ²
9	1	100	94.0	4.2
	2	95		
	3	90		
	4	95		
	5	90		
10	1	95	98.0	2.7
	2	95		
	3	100		
	4	100		
	5	100		
11	1	90	94.0	6.5
	2	95		
	3	100		
	4	100		
	5	85		
12	1	85	91.0	6.5
	2	90		
	3	95		
	4	85		
	5	100		
13	1	90	93.0	5.7
	2	95		
	3	85		
	4	95		
	5	100		
14	1	95	91.0	6.5
	2	85		
	3	85		
	4	90		
	5	100		
15	1	90	84.0	8.9
	2	90		
	3	70		
	4	80		
	5	90		
16	1	95	92.0	5.7
	2	100		
	3	90		
	4	90		
	5	85		

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Test No.	Rep No. ¹	% Survival	Mean	SD ²
17	1	90	93.0	4.5
	2	90		
	3	90		
	4	95		
	5	100		
18	1	100	88.0	7.6
	2	90		
	3	85		
	4	80		
	5	85		
19	1	90	87.0	5.7
	2	85		
	3	85		
	4	80		
	5	95		
20	1	90	87.0	4.5
	2	90		
	3	80		
	4	85		
	5	90		
21	1	95	92.0	2.7
	2	95		
	3	90		
	4	90		
	5	90		
22	1	100	96.0	5.5
	2	100		
	3	100		
	4	90		
	5	90		
23	1	90	96.0	4.2
	2	100		
	3	95		
	4	100		
	5	95		
24	1	90	95.0	5.0
	2	100		
	3	90		
	4	95		
	5	100		

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Test No.	Rep No. ¹	% Survival	Mean	SD ²
25	1	95	90.0	6.1
	2	90		
	3	80		
	4	90		
	5	95		
26	1	90	89.0	5.5
	2	95		
	3	90		
	4	80		
	5	90		
27	1	90	92.0	8.4
	2	100		
	3	100		
	4	80		
	5	90		
28	1	90	89.0	2.2
	2	90		
	3	90		
	4	90		
	5	85		
29	1	90	89.0	2.2
	2	90		
	3	90		
	4	90		
	5	85		
30	1	95	97.0	2.7
	2	100		
	3	100		
	4	95		
	5	95		
31	1	90	93.0	4.5
	2	90		
	3	100		
	4	95		
	5	90		
32	1	80	95.0	8.7
	2	100		
	3	100		
	4	100		
	5	95		

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Test No.	Rep No. ¹	% Survival	Mean	SD ²
33	1	95	96.0	4.2
	2	100		
	3	95		
	4	90		
	5	100		
34	1	100	90.0	7.9
	2	90		
	3	95		
	4	85		
	5	80		
35	1	95	95.0	0.0
	2	95		
	3	95		
	4	95		
	5	95		
36	1	90	93.0	2.7
	2	90		
	3	95		
	4	95		
	5	95		
37	1	95	97.0	2.7
	2	100		
	3	95		
	4	95		
	5	100		
38	1	95	95.0	0.0
	2	95		
	3	95		
	4	95		
	5	95		
39	1	95	99.0	2.2
	2	100		
	3	100		
	4	100		
	5	100		
40	1	100	95.0	6.1
	2	85		
	3	95		
	4	95		
	5	100		

Appendix F. Performance Control Survival for *Ampelisca abdita* for the McAllister Point Marine Ecological Risk Assessment Resampling Investigation.

Test No.	Rep No. ¹	% Survival	Mean	SD ²
41	1	95	88.0	5.7
	2	90		
	3	85		
	4	80		
	5	90		
42	1	95	95.0	5.0
	2	100		
	3	90		
	4	90		
	5	100		
43	1	100	99.0	2.2
	2	100		
	3	100		
	4	95		
	5	100		

1 - Rep. No. = Replicate Number

2 - SD = Standard Deviation

Appendix G. Chain of Custody Forms.

Chain-of-custody forms for McAllister Point sediment samples.



URI / GSO

Science Applications International Corporation

Chain of Custody Record

Environmental Testing Center / 165 Dean Knuss Dr. / Narragansett, RI 02882 / Tel. (401) 782-1900 / Fax (401) 782-2330

Site: McAlister Point Landfill Client Name and Contact: Brown & Root Environmental

Sample No.	Containers		Collection		Sample Description	Requested Parameters
	No.	Type	Date	Time		
NSB-1-R	1	plastic gal	9/20	0800	Sediment	Sed TOX
NSB-2-R	1	plastic gal	9/20	0755	Sediment	Sed TOX
NSB-3-R	1	plastic gal	9/20	0720	Sediment	Sed TOX
NSB-4-R	1	plastic gal	9/20	0805	Sediment	Sed TOX
Total: <u>4</u>						

Released By: Name: <u>[Signature]</u> Title: <u>URI</u>	Date Time: <u>9/20/90</u>	Received By: Signature: <u>[Signature]</u> Printed Name: <u>KJ McAfee ISAIC 1225</u>	Date Time: <u>9/20/90</u>	Remarks:
Collected By: Name: <u>[Signature]</u> Title: <u>URI</u>	Date Time: <u>9/20 1225</u>	Received By: Signature: Printed Name:	Date Time:	
Destination:	Contact Name and Phone Number:			
Sampling Method:	Page <u>1</u> of <u>1</u>			

Original Form Accompanies Shipment

APPENDIX D-2

**SEA URCHIN FERTILIZATION TESTS,
NEAR SHORE AND OFF SHORE SAMPLE STATIONS**

**Sea Urchin Fertilization
and Sea Urchin Larval Development
Toxicity Tests Results**

**Draft Marine Ecological Risk Assessment
McAllister ReSampling
Sediment Cores
Newport, Rhode Island**

26 November 1996

Submitted to:

Gregory Tracey
Science Applications International Corporation
165 Dean Knauss Drive
Narragansett, RI 02882

Submitted by:

Science Applications International Corporation
Environmental Testing Center
165 Dean Knauss Drive
Narragansett, RI 02882

SAIC Project Numbers
01-0440-04-3930-055

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Appendix G. Chain-of-Custody Forms

Section A

Elutriate Sea Urchin Fertilization Test

Introduction

The chronic toxicity of elutriates prepared from sediments collected from McAllister Point, Newport, RI, was assessed to evaluate the biological effects of sediment contaminants to water column organisms. Sediment elutriate toxicity was determined using the sea urchin (*Arbacia punctulata*) fertilization test at SAIC's ETC according to procedures outlined in the SOP, Fertilization Test Using the Sea Urchin *Arbacia punctulata*, in Appendix A. This assay is used routinely by the U.S.EPA and by National Pollutant Discharge Elimination System (NPDES) permittees to determine ambient and effluent water quality and to evaluate the effects of pollutants on aquatic life (U.S.EPA 1988). In addition, this assay has been used to evaluate sediment toxicity using porewaters for the U.S. Navy in McAllister Point, Allen Harbor, and Newport, Rhode Island (SAIC 1994, SAIC 1995a, SAIC 1995b). While the performance of this test was not specified in the Work Plan (URI and SAIC 1995), its inclusion in the Navy's previous Ecological Risk Assessment program's in Rhode Island and the widespread use of this species and endpoint by the U.S. EPA and others indicated its importance to this study at McAllister Point.

The purple sea urchin, *Arbacia punctulata*, occurs along the North American east coast from Cape Cod to Florida. They live in widely separated aggregations on rocky and shelly bottoms or adhere to rocks. Their life cycle includes a period of planktonic embryonic-larval development, followed by settlement and metamorphosis in the adult life stage. Sea urchin gametes have become widely used and popular subjects for toxicological studies (Bay et al. 1993).

The endpoint evaluated was fertilization. The response was measured in each of three concentrations per station/sample. The use of multiple concentration series provides information which can be applied to several techniques and integrated into the ecological risk assessment methodology. The concentration series responses can be used to develop an effect concentration (EC), a point estimate of the concentration that would cause a given percent reduction (e.g. EC₅₀) in development. In conjunction with the estimated environmental concentration (EEC), the EC value can be used as the toxicological benchmark concentration (TBC) in the risk assessment quotient method, used to quantitatively estimate ecological risk. If the quotient, EEC/TBC is >1, then a toxic effect is expected.

In addition, the concentration series could be used to develop exposure-response models. This technique, used previously to estimate ecological risk, utilizes whole-waste concentrations as independent variables determining the level of endpoint response for each test species (Munns et al. 1994). Using a joint probability method, probabilities of risk from sediment contaminants to water column and benthic organisms can be

calculated.

Methods

Sample Collection, Log-In, and Holding

Sediments from 7 sites were collected between 8 October and 5 November 1996 (see Table 5). Samples were delivered to the ETC for testing on 1 and 5 November 1996. Standard chain-of-custody procedures were followed. Upon arrival at the laboratory, sample containers were inspected. After inspection, the sample containers were placed in zip-lock bags and stored at $4 \pm 2^\circ\text{C}$ in the dark until testing. Chain-of-custody tracking forms were signed and duplicated. The originals were placed in the ETC's sample log books and copies were retained with test data in experiment binders and project files.

Organism Collection and Holding

Adult sea urchins were obtained from a commercial supplier. A 12 wH(v) transformer was used to electrically stimulate spawning. The urchins were segregated by sex into 20-liter aquaria each holding about 15 animals. The aquaria were aerated and biological filters were used to maintain water quality. The tanks were partially renewed with filtered seawater from lower Narragansett Bay, RI twice weekly. Temperature was maintained at $15 \pm 3^\circ\text{C}$. Salinity was between 28 and 32 ppt. The urchins were fed *Laminaria* collected locally from uncontaminated areas. Non-ingested food was removed weekly when new kelp was added.

Organisms used for testing are evaluated periodically during a reference toxicant test with sodium dodecyl sulfate (SDS). The linear interpolation method, available on ToxCalc (version 4.0.8) from TidePool Scientific Software, is used to calculate the SDS EC_{50} . The EC_{50} values were evaluated against a control chart, in this case, a running plot of EC_{50} s obtained from 20 previous reference toxicant tests performed at the ETC with *Arbacia punctulata*.

Elutriate Preparation and Dilutions

Elutriates were prepared according to procedures presented in SOPs of Appendix A. Preparation began by adding homogenized sediment to filtered ($0.45 \mu\text{m}$) natural seawater collected from Narragansett Bay, RI on an incoming tide in a 1:4 volumetric ratio. The mixture was stirred for 30 minutes by hand and then settled for one hour. The supernatant was siphoned off and was used to prepare dilutions. Dilutions were prepared by mixing the supernatant with filtered ($0.45 \mu\text{m}$) natural seawater (NSW) collected from lower Narragansett Bay on an incoming tide. Elutriate dilutions (10%, 50%, and 100%) as well as a NSW performance control (0%) were tested.

Test Apparatus and Conditions

The sea urchin fertilization test was conducted following the SOP, Fertilization Test Using the Sea Urchin *Arbacia punctulata*, in Appendix A, according to U.S.EPA procedures (U.S.EPA 1988). Four male urchins were placed in seawater in shallow bowls. Males were stimulated to release sperm by touching the shell for about 30 seconds with the steel electrodes of a 12 V transformer. Sperm were collected using a 1 ml disposable syringe fitted with an 18-gauge, blunt tipped needle. The sperm were held on ice and were used within 1 hr of release. Sperm were diluted with seawater to a concentration of 5×10^7 sperm/ml. One hundred microliters of sperm suspension were added to five ml of the elutriate preparation in glass scintillation vials. The vials were incubated at ambient temperature for one hour.

Four female urchins were placed in seawater in shallow bowls. Females were stimulated to release eggs by touching the shell as described above. Eggs were collected and held at room temperature for up to two hours with aeration. The eggs were washed three times with seawater by gentle centrifugation (500xg) for three minutes in a conical centrifuge tube. The eggs were diluted with seawater to a concentration of 2000 eggs/ml and were aerated until used. One ml of egg suspension was added to each vial containing elutriate and sperm. Eggs and exposed sperm were incubated for 20 minutes at ambient temperature. The test was terminated by adding 2 ml of 5% buffered formalin to each vial.

One ml of suspension from each of two replicates was transferred to a Sedgwick-Rafter counting chamber. Eggs were examined using a compound microscope (100X). One hundred eggs were examined for fertilization as indicated by the presence of a membrane surrounding the egg. A third replicate was examined when data varied by more than 10%. The number of fertilized eggs, recorded on laboratory data sheets, were entered into a computer spreadsheet for statistical analyses.

Performance Control

The performance control, natural seawater (NSW), is collected daily from lower Narragansett Bay, RI during an incoming tide after passage through a 0.45 μm filter.

Data Analysis

Stations with mean fertilization less than that of the NSW performance control were compared statistically to the control. Microsoft Excel's two-sample assuming unequal variances t-Test tool was used to perform a two-sample student's t-test. This test assumes that the variances of both ranges of data are unequal. A one-tailed distribution was specified. The t-test is used to determine whether two sample means are equal. Samples with an alpha or p value less than or equal to 0.05, indicating statistical significance, and samples with fertilization $\leq 70\%$ were flagged.

Treatments where no response was observed or where responses equal to or higher than the NSW (0%) control treatment were observed were not evaluated statistically since no adverse effects attributable to the sample was indicated (U.S.EPA/U.S.ACE 1991).

The linear interpolation method, available on ToxCalc (version 4.0.8) from TidePool Scientific Software, was used to calculate the IC₅₀s of samples where statistically significant responses were noted in one or more of the elutriate dilutions. The IC₅₀ is a point estimate of the concentration that would cause a 50% reduction in fertilization. The IC value can be used as a toxicological benchmark concentration (TBC) when using the risk quotient.

Results

A total of 7 elutriate samples were evaluated for toxicity in the sea urchin fertilization test in one test series. Three elutriate concentrations, 10, 50 and 100%, and a NSW performance control (i.e. 0%) were tested. Holding requirements were within acceptable limits for all samples (see Table 1). Data are presented Appendix A and are summarized in Table 2. Mean fertilization in the NSW performance control was 98.7%. Mean sample fertilization in 100% elutriates, ranged from 5.0 to 84.7%. Mean sample fertilization was statistically different than mean fertilization in the NSW performance control in all of the samples tested. Fertilization in all 100% elutriate samples but NSB6 were <70%, the criteria for a significant response.

IC values are presented in Appendix C and summarized in Table 3. IC₁₀s ranged from 13.319 to 36.223%. These data indicated that toxicity in MCL12 > NSB2 > NSB5 > NSB3 > MCL10 > NSB4 > NSB6.

Total ammonia was measured in elutriates of sediments used for the sea urchin fertilization test. These data are summarized in Table 4. Raw data are presented in Appendix D. Total and un-ionized ammonia values ranged from 0.02 to 4.70 mg/L and from 0.000 to 0.050 mg/L, respectively. The relationship between the concentration of ammonia and the response, sea urchin fertilization, are shown graphically in Figures 1 and 2. Total and un-ionized ammonia concentrations in the elutriates did not exceed the EC₅₀ thresholds of 20.00 mg/L and >0.60 mg/L, respectively (NOAA 1994 and Scott Carr, personal communication).

Quality Assurance Results

The control chart for this species includes data from 20 of the most recent tests performed at the ETC. It is presented in Figure 3. The most recent test was within the control limits (i.e. $\pm 2SD$).

Performance control fertilization data for 35 of the most recent sea urchin tests performed at the ETC are shown graphically in Figure 4. Fertilization in *Arbacia* exposed to NSW in this test was consistent with all previous NSW collections at the ETC since 1990.

Section B

Elutriate Sea Urchin Embryo/Larval Development Test

Introduction

Toxicity was determined using the sea urchin (*Arbacia punctulata*) larval development test at Science Applications International Corporation's (SAIC) Environmental Testing Center (ETC). This assay has been used in regulatory programs in California and Washington State to assess the suitability of sediments (as elutriates) for ocean disposal activities. Other regulatory applications include usage of the test to meet minimum data requirements for the derivation of the U.S.EPA's Marine Water Quality Criteria.

The endpoint evaluated was the abnormal or delayed development of the pluteus larva. The response was measured in each of three concentrations per station/sample. The use of multiple concentration series provides information which can be applied to several techniques and integrated into the ecological risk assessment methodology. The concentration series responses can be used to develop an effect concentration (EC), a point estimate of the concentration that would cause a given percent reduction (e.g. EC₅₀) in development. In conjunction with the estimated environmental concentration (EEC), the EC value can be used as the toxicological benchmark concentration (TBC) in the risk assessment quotient method, used to quantitatively estimate ecological risk. If the quotient, EEC/TBC is >1, then a toxic effect is expected.

In addition, the concentration series could be used to develop exposure-response models. This technique, used previously to estimate ecological risk, utilizes whole-waste concentrations as independent variables determining the level of endpoint response for each test species (Munns et al. 1994). Using a joint probability method, probabilities of risk from sediment contaminants to water column and benthic organisms can be calculated.

Methods

Sample Collection, Log-In, and Holding

Sediments from 7 sites were collected between 8 October and 5 November 1996 (see Table 5). Samples were delivered to the ETC for testing on 1 and 5 November 1996. Standard chain-of-custody procedures were followed. Upon arrival at the laboratory, sample containers were inspected. After inspection, the sample containers were placed in zip-lock bags and stored at $4 \pm 2^\circ\text{C}$ in the dark until testing. Chain-of-custody tracking forms were signed and duplicated. The originals were placed in the ETC's sample log books and copies were retained with test data in experiment binders and project files.

Organism Collection and Holding

Adult sea urchins were obtained from a commercial supplier. A 12 wH(v) transformer was used to electrically stimulate spawning. The urchins were segregated by sex into 20-liter aquaria each holding about 15 animals. The aquaria were aerated and biological filters were used to maintain water quality. The tanks were partially renewed with filtered seawater from lower Narragansett Bay, RI twice weekly. Temperature was maintained at $15 \pm 3^{\circ}\text{C}$. Salinity was between 28 and 32 ppt. The urchins were fed *Laminaria* collected locally from uncontaminated areas. Non-ingested food was removed weekly when new kelp was added.

Organisms used for testing are evaluated periodically during a reference toxicant test with sodium dodecyl sulfate (SDS). The linear interpolation method, available on ToxCalc (version 4.0.8) from TidePool Scientific Software, is used to calculate the SDS EC_{50} . The EC_{50} values were evaluated against a control chart, in this case, a running plot of EC_{50} s obtained from 20 previous reference toxicant tests performed at the ETC with *Arbacia punctulata*.

Elutriate Preparation and Dilutions

Elutriates were prepared according to procedures presented in SOPs of Appendix A. Preparation began by adding homogenized sediment to filtered ($0.45 \mu\text{m}$) natural seawater collected from Narragansett Bay, RI on an incoming tide in a 1:4 volumetric ratio. The mixture was stirred for 30 minutes by hand and then settled for one hour. The supernatant was siphoned off and was used to prepare dilutions. Dilutions were prepared by mixing the supernatant with filtered ($0.45 \mu\text{m}$) natural seawater (NSW) collected from lower Narragansett Bay on an incoming tide. Elutriate dilutions (10%, 50%, and 100%) as well as a NSW performance control (0%) were tested.

Test Apparatus and Conditions

Modified U.S.EPA procedures were used to perform the larval development test (Mueller et al. 1992). Briefly, four male urchins were placed in seawater in shallow bowls. Males were stimulated to release sperm by touching the shell for about 30 seconds with the steel electrodes of a 12 V transformer. Sperm were collected using a 1 ml disposable syringe fitted with an 18-gauge, blunt tipped needle. The sperm were held on ice and were used within 1 hr of release. Sperm were diluted with seawater to a concentration of 5×10^7 sperm/ml.

Four female urchins were placed in seawater in shallow bowls. Females were stimulated to release eggs by touching the shell as described above. Eggs were collected and held at room temperature for up to two hours with aeration. The eggs were washed three times with seawater by gentle centrifugation (500xg) for three minutes in a conical centrifuge tube. The eggs were diluted with seawater to a concentration of

2000 eggs/ml and were aerated until used. Sperm and egg suspensions were mixed to a final concentration of 1:2000 egg:sperm ratio. After 20 minutes, 1 ml of fertilized egg suspension was added to 200 ml of sample in each of three replicates and was incubated for 48 hours at $20 \pm 1^\circ\text{C}$. Following the 48 h incubation period, two 10 ml sample replicates were collected from each chamber and placed in scintillation vials. The test was terminated by adding 2 ml of 5% buffered formalin with rose bengal to each vial. Embryos were examined using a compound microscope (100X). The entire contents of each vial was examined for abnormal or delayed development of the pluteus larva.

Elutriate samples were analyzed for total and un-ionized ammonia. Each elutriate was diluted 1:20 with deionized water for analysis.

Data Analysis

Treatments where no response was observed or where responses equal to or higher than the NSW (0%) control treatment were observed were not evaluated statistically since no adverse effects attributable to the sample was indicated (U.S.EPA/U.S.ACE 1991).

Stations with mean abnormal larva less than that of the NSW performance control were compared statistically to the control. Microsoft Excel's two-sample assuming unequal variances t-Test tool was used to perform a two-sample student's t-test. This test assumes that the variances of both ranges of data are unequal. A one-tailed distribution was specified. The t-test is used to determine whether two sample means are equal. Samples with an alpha or p value less than or equal to 0.05, indicated statistical significance. Those treatments which were statistically different from the control were flagged.

The linear interpolation method, available on ToxCalc (version 4.0.8) from TidePool Scientific Software, was used to calculate the IC_{50} s of samples where statistically significant responses were noted in one or more of the elutriate dilutions. The IC_{50} is a point estimate of the concentration that would cause a 50% reduction in normal development. The IC value can be used as a toxicological benchmark concentration (TBC) when using the risk quotient.

Results

A total of 7 elutriate samples were evaluated for toxicity in the sea urchin larval development test in one test series. Three elutriate concentrations, 10, 50 and 100%, and a NSW performance control (i.e. 0%) were tested. Holding requirements were within acceptable limits for all samples (see Table 1). Data are presented Appendix E and are summarized in Table 5. Mean development in the NSW performance control was 92.32%. Mean sample development in 100% elutriates, ranged from 0.75 to 86.75%. Mean sample development was statistically different than mean development in the NSW

performance control in all of the samples tested. Development in all 100% elutriate samples but NSB3, NSB6, and MCL10 were <70%, the criteria for a significant response.

IC values are presented in Appendix F and summarized in Table 6. IC₁₀s ranged from 6.316 to >100%. These data indicated that toxicity in NSB2 > NSB5 > MCL12 > NSB4 > MCL10 > NSB3 > NSB6.

Total ammonia was measured in elutriates of sediments used for the sea urchin larval development test. These data are summarized in Table 7. Raw ammonia data are presented in Appendix D. Total and un-ionized ammonia values ranged from 0.02 to 4.70 mg/L and from 0.000 to 0.050 mg/L, respectively. The relationship between the concentration of ammonia and the response, sea urchin larval development, are shown graphically in Figures 5 and 6. The n-ionized ammonia concentrations in the elutriates did not exceed the NOEC and LOEC thresholds of 0.037 mg/L and 0.090 mg/L, respectively (NOAA 1994 and Scott Carr, personal communication).

References

- Ankley, G.T., M.K. Schurbauer-Berigan, and J.R. Dierkes. 1991. Predicting the Toxicity of Bulk Sediments to Aquatic Organisms with Aqueous Test Fractions: Porewater vs. Elutriate. *Environmental Toxicology and Chemistry*, Vol. 10, pp. 1359-1366.
- Bay, S., Burgess, R. and D. Nacci. 1993. Status and Applications of Echinoid (*Phylum Echinodermata*) Toxicity Test Methods. *ASTM*. Standard Technical Publication 1179-1993.
- Bower, C.E. and T. Holm-Hansen. 1980. A salicylate-hypochlorite method for determining ammonia in seawater. *Can. J. Fish. Aquat. Sci.* 37:794-798.
- Carr, R. Scott, D.C. Chapman, C.L. Howard, D.N. Biedenbach. In press. Sediment Quality Triad Assessment Survey on Galveston Bay, Texas System. *Ecotoxicology*.
- Harkey, G.A., P.F. Landrum, and S.J. Klaine. 1994. Comparison of Whole-Sediment, Elutriate, and Pore-Water Exposures for Use in Assessing Sediment-Associated Organic Contaminants in Bioassays. *Environmental Toxicology and Chemistry*, Vol. 13, No. 8, pp. 1315-1329.
- Munns. 1994.
- NOAA. 1994. Magnitude and Extent of Sediment Toxicity in Tampa Bay, Florida. NOAA Technical Memorandum NOS ORCA 78.
- SAIC. 1994. Toxicity Test Results McAllister Point Newport, RI. SAIC Contribution No.

1023. University of Rhode Island, Narragansett, RI.
- SAIC. 1995a. Toxicity Test Results Allen Harbor, RI. SAIC Contribution No. 1143. EA Engineering, Sharon, MA.
- SAIC. 1995b. Toxicity Test Results Newport, RI. SAIC Contribution No. 1149. University of Rhode Island, Narragansett, RI.
- U.S.EPA/U.S.ACE. 1991. Evaluation of Dredged Material Proposed for Ocean Dumping (Testing Manual). Prepared under U.S.EPA Contract No. 68-C8-0105.
- U.S.EPA. 1988. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA/600/4-87/028.
- URI and SAIC. 1995.
- Whiteman, F.W., G.T. Ankley, M.D. Kahl, D.M. Rau, and M.D. Balcer. 1996. Evaluation of Interstitial Water as a Route of Exposure for Ammonia in Sediment Tests with Benthic Macroinvertebrates. *Environmental Toxicology and Chemistry*, 15:794-801.
- Whitfield, M. 1978. The Hydrolysis of Ammonium Ions in Sea Water--Experimental Confirmation of Predicted Constants at One Atmosphere Pressure. *J. Mar. Assoc. U.K.* 58:781-787.
- Winger, P.V. and P.J. Lasier. 1991. A Vacuum-Operated Pore-Water Extractor for Estuarine and Freshwater Sediments. *Archives of Environmental Contamination and Toxicology*. 21:321-324.

Sea Urchin Fertilization vs. Total Ammonia

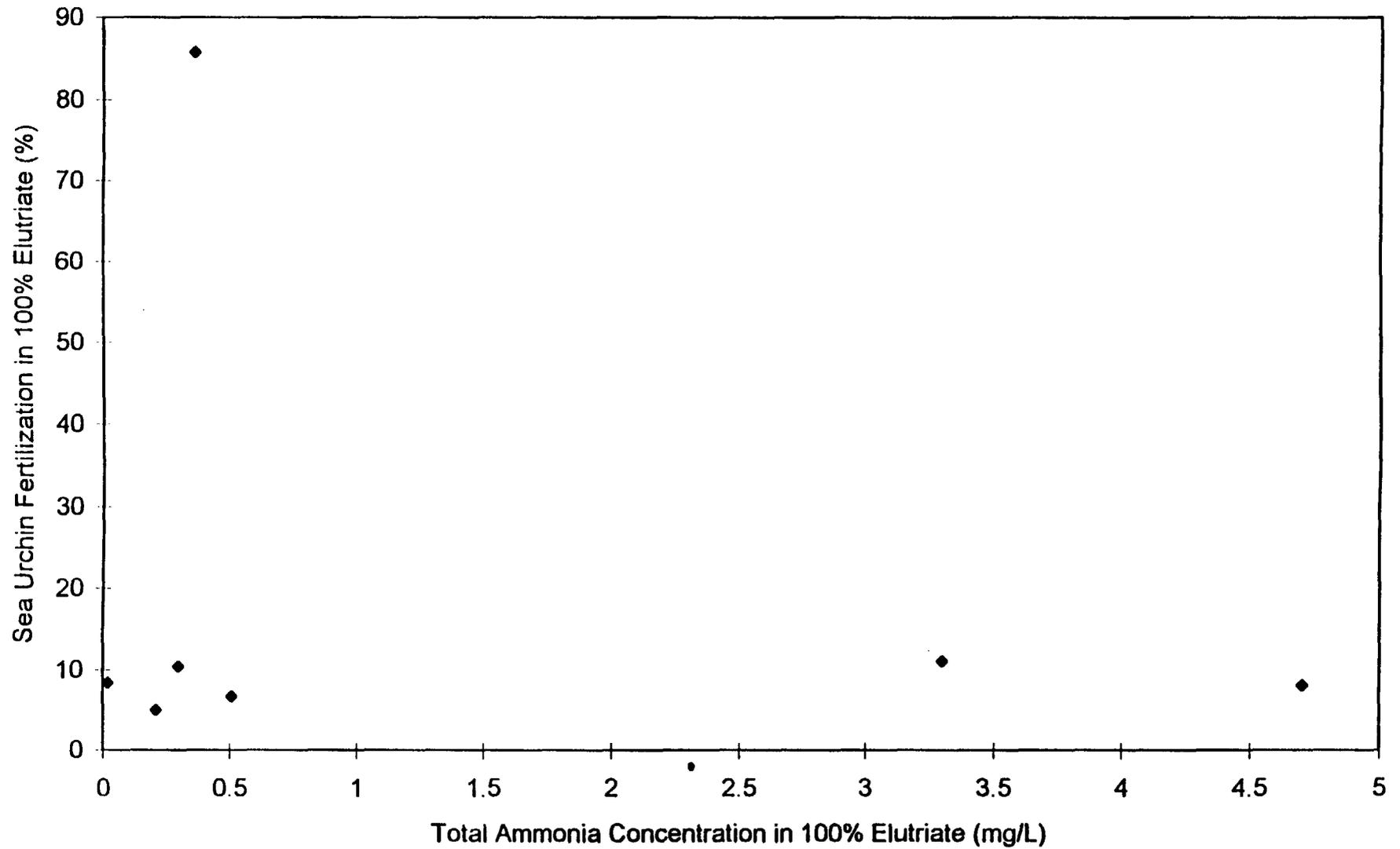


Figure 1. Scatter plot of sea urchin fertilization vs. total ammonia in 100% elutriate. The threshold for significant toxicity is below 70% fertilization. The EC_{50} for total ammonia is 20.00 mg/L.

Sea Urchin Fertilization vs. Un-Ionized Ammonia

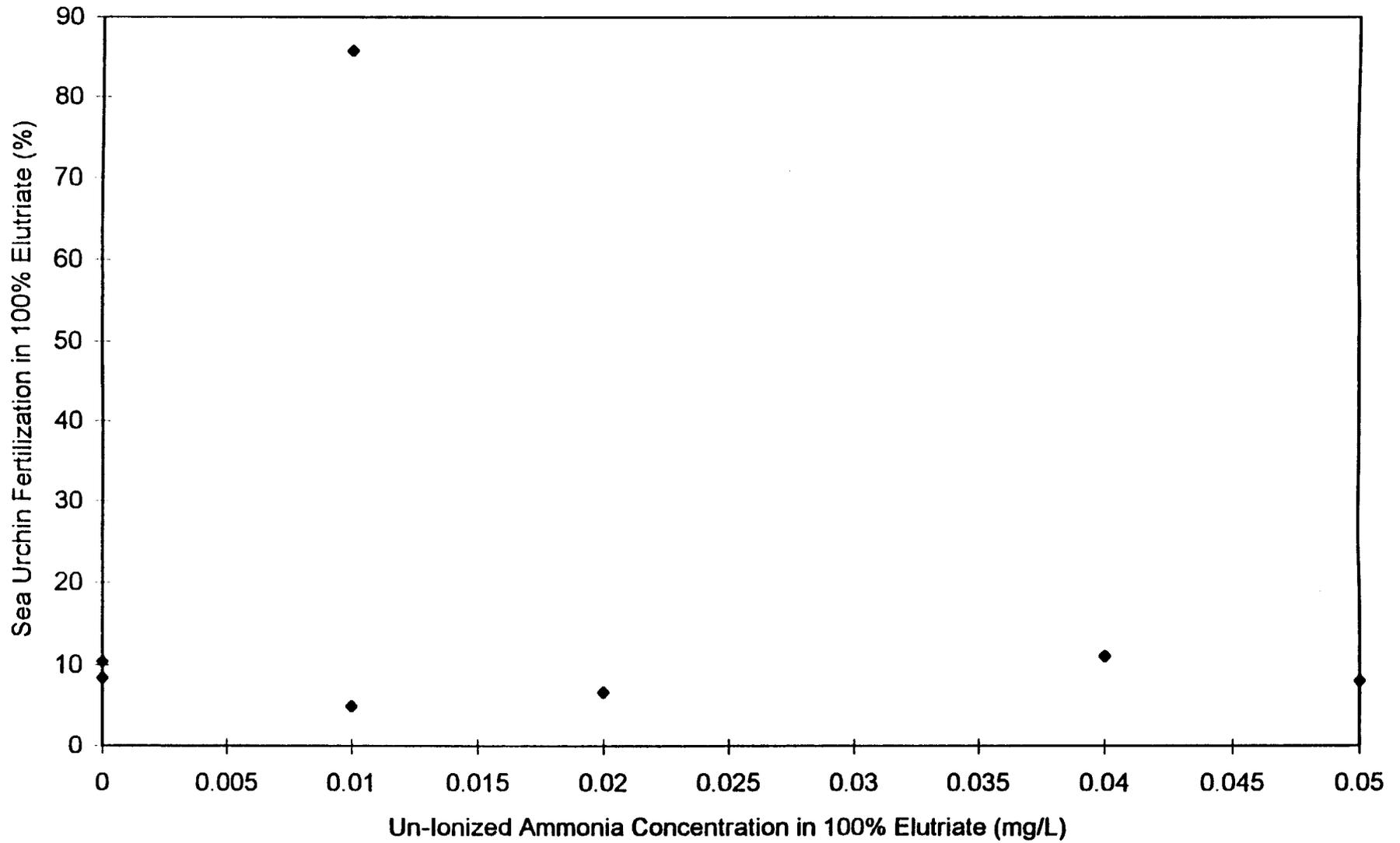


Figure 2. Scatter plot of sea urchin fertilization vs. un-ionized ammonia in 100% elutriate. The threshold for significant toxicity is below 70% fertilization. The EC_{50} for un-ionized ammonia is 0.60 mg/L.

SDS Control Chart

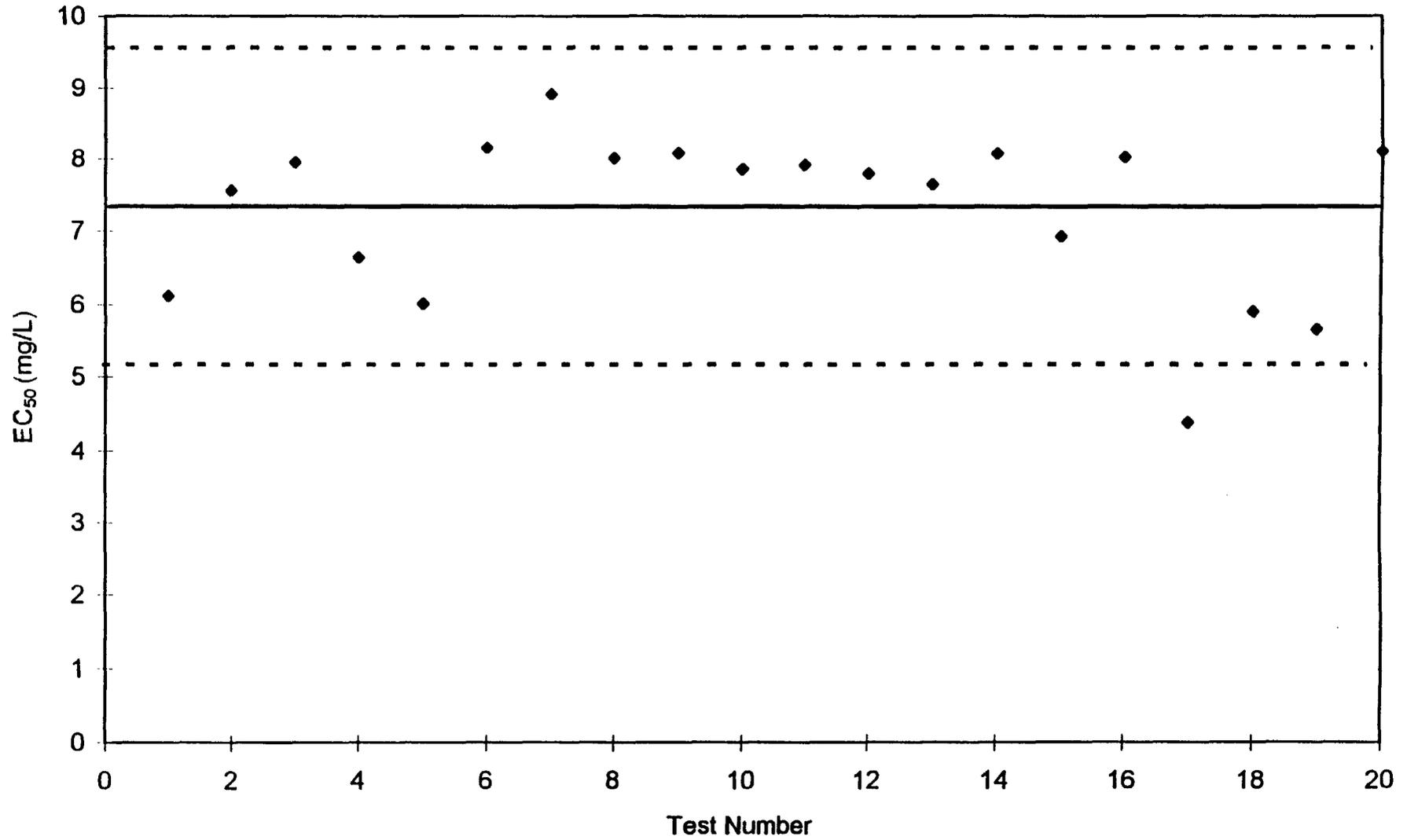


Figure 3. Scatter plot of fertilization EC₅₀ vs. test number. The solid line indicates the mean EC₅₀ of 20 previous tests. The dotted lines indicate the upper and lower control limits.

Performance Control Fertilization

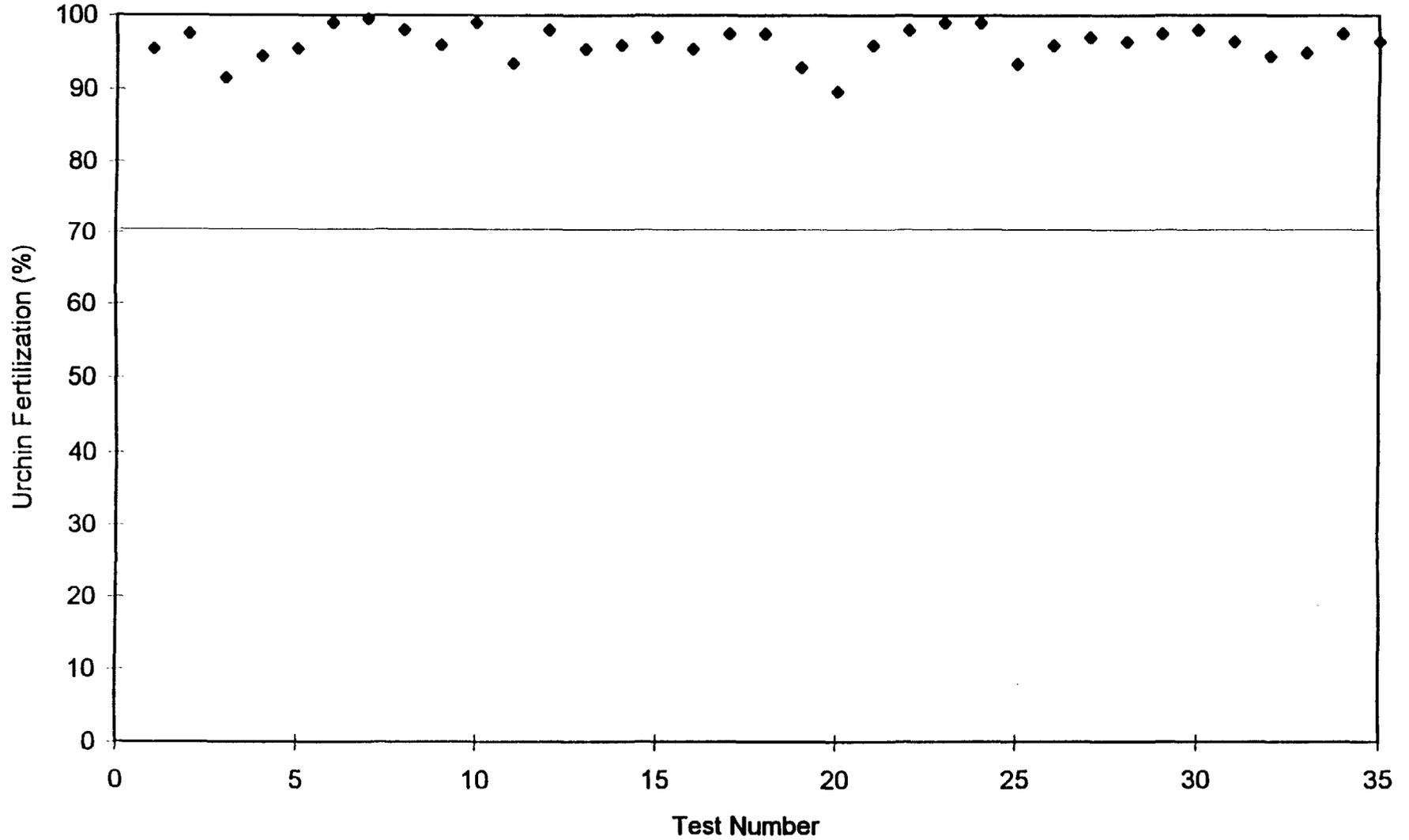


Figure 4. Scatter plot of sea urchin fertilization in performance control seawater vs. test number. The solid line at 70% indicates the threshold for significant toxicity.

Sea Urchin Development vs. Total Ammonia

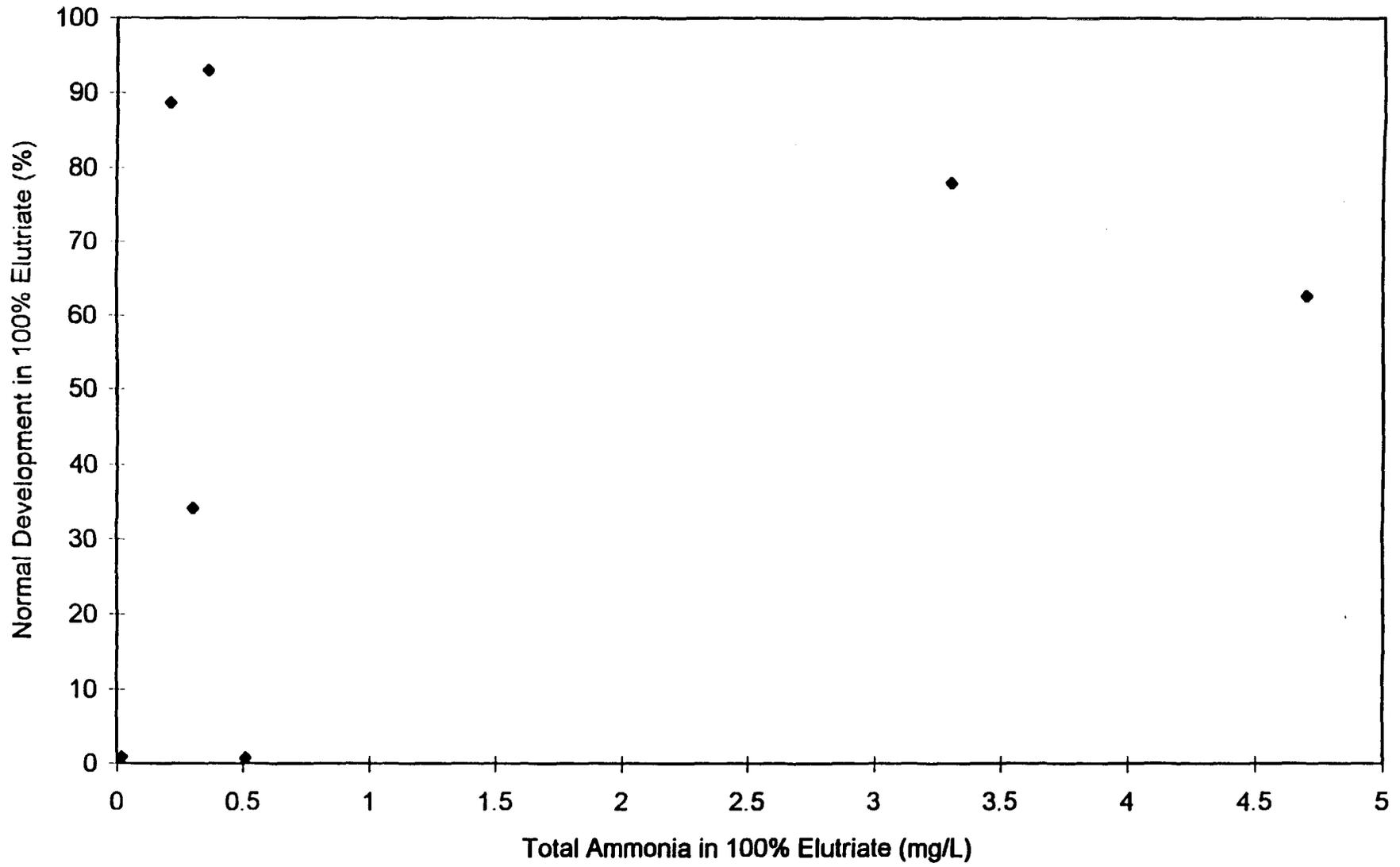


Figure 5. Scatter plot of sea urchin development vs. total ammonia in 100% elutriate.

Sea Urchin Development vs. Un-ionized Ammonia

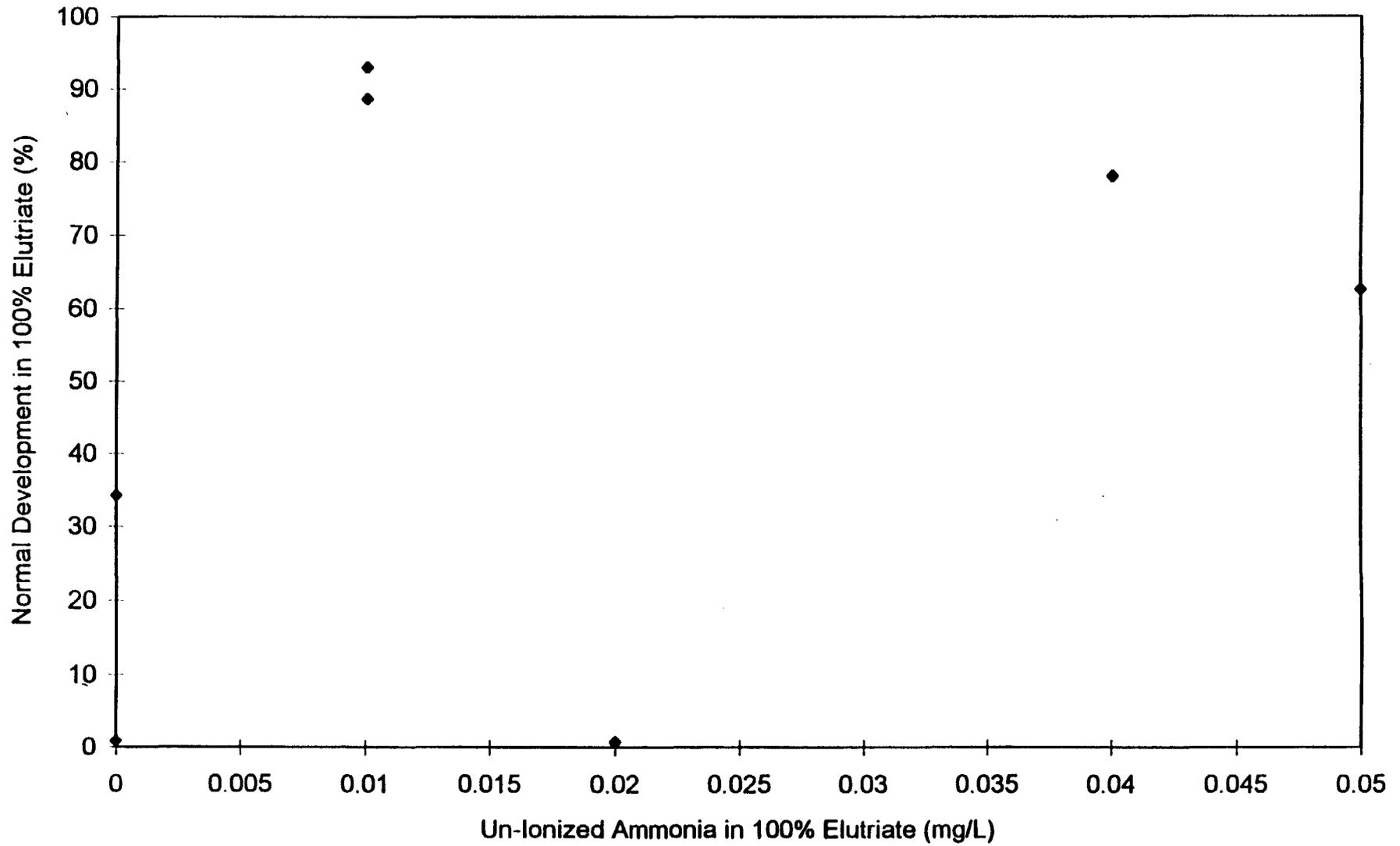


Figure 6. Scatter plot of sea urchin development vs. un-ionized ammonia in 100% elutriate. The NOEC and LOEC for un-ionized ammonia are 0.037 and 0.090 mg/L, respectively.

Table 1. Collection, receiving, and test dates for sediments used in sea urchin fertilization and development elutriate tests.

Sample ID	Date Collected ⁽¹⁾	Date Received	Elutriate Preparation	Date Tested	ETC Exp. No. ⁽²⁾	ETC Exp. No. ⁽³⁾
NSB2	11/5/96	11/5/96			961101	961102
NSB3	11/5/96	11/5/96			961101	961102
NSB4	10/29/96	11/1/96			961101	961102
NSB5	10/29/96	11/1/96			961101	961102
NSB6	10/29/96	11/1/96			961101	961102
MCL10	10/8/96	11/1/96			961101	961102
MCL12	10/8/96	11/1/96			961101	961102

FOOTNOTES

(1) Sediments were stored at *****.

(2) ETC Exp. No. = Laboratory identification number for the sea urchin fertilization test.

(3) ETC Exp. No. = Laboratory identification number for the sea urchin development test.

Table 2. Summary sediment elutriate sea urchin fertilization test results.

Sample ID	Elutriate Conc. (%)	Mean Fertilized (%)	SD ⁽¹⁾	Comment
Control ⁽²⁾	na	98.7	0.58	
NSB2	10	95.7	0.58	
NSB2	50	8.0	2.65	*
NSB2	100	6.7	2.08	*
NSB3	10	95.3	3.06	
NSB3	50	43.0	16.82	*
NSB3	100	5.0	1.00	*
NSB4	10	97.3	1.53	
NSB4	50	57.7	6.11	*
NSB4	100	10.3	0.58	*
NSB5	10	98.0	2.00	
NSB5	50	8.0	3.61	*
NSB5	100	8.3	1.53	*
NSB6	10	96.3	2.31	
NSB6	50	85.3	3.06	*
NSB6	100	84.7	2.31	*
MCL10	10	94.3	4.04	
MCL10	50	65.3	11.59	*
MCL10	100	11.0	4.58	*
MCL12	10	95.3	3.06	
MCL12	50	7.3	1.53	*
MCL12	100	8.0	2.65	*

FOOTNOTES

* = Mean response was statistically lower than the mean response observed in the control.

(1) SD = Standard deviation

(2) Control = NSW performance control collected from lower Narragansett Bay.

Table 3. Summary sea urchin fertilization IC₁₀ values.

Sample ID	IC10 ⁽¹⁾ (%)	SE ⁽²⁾	95% CL ⁽³⁾	
NSB2	13.608	0.214	12.809	14.345
NSB3	16.082	1.937	10.100	25.153
NSB4	21.425	1.675	15.836	28.619
NSB5	16.125	1.179	12.170	20.090
NSB6	36.223	3.798	22.491	49.380
MCL10	17.545	3.340	7.300	32.916
MCL12	13.319	1.064	10.302	17.557

FOOTNOTES

(1) IC10 = Estimate of concentration which would cause a 10% reduction in fertilization.

(2) SE = Standard error

(3) CL = Confidence limit

Table 4. Summary ammonia and IC₁₀ measurements for 100% elutriates used to determine toxicity in the sea urchin fertilization test.

Station	Total Ammonia (mg/L) ¹	Un-ionized Ammonia (mg/L) ¹	IC10 (%)	Comment
NSB-2	0.51	0.02	13.61	***
NSB-3	0.21	0.01	16.08	***
NSB-4	0.30	0.00	21.43	***
NSB-5	0.02	0.00	16.13	***
NSB-6	0.36	0.01	36.22	***
MCL-10	3.30	0.04	17.55	***
MCL-12	4.70	0.05	13.32	***

Arbacia successful fertilization: - = not toxic; * = one or more dilutions statistically < control;

*+ = <70% Elutriate concentration is toxic.

*** = <50% Elutriate concentration is toxic.

**** = <10% Elutriate concentration is toxic.

1 - Ammonia was measured in 100% elutriate.

Table 6. Summary sea urchin development IC₁₀ values.

Sample ID	IC10 ⁽¹⁾ (%)	SE ⁽²⁾	95% CL ⁽³⁾	
NSB2	6.316	1.635	2.537	14.367
NSB3	94.520	-	-	-
NSB4	21.290	5.625	8.806	49.730
NSB5	10.970	1.914	2.015	15.050
NSB6	>100	-	-	-
MCL10	51.271	11.130	0.000	76.337
MCL12	12.181	4.990	0.000	35.787

FOOTNOTES

(1) IC10 = Estimate of concentration which would cause a 10% reduction in normal development.

(2) SE = Standard error

(3) CL = Confidence limit

Table 7. Summary ammonia and IC₁₀ measurements for 100% elutriates used to determine toxicity in the sea urchin development test.

Station	Total Ammonia (mg/L) ¹	Un-ionized Ammonia (mg/L) ¹	IC10 (%)	Comment
NSB-2	0.51	0.02	6.32	*+++
NSB-3	0.21	0.01	94.52	*
NSB-4	0.30	0.00	21.29	*++
NSB-5	0.02	0.00	10.97	*++
NSB-6	0.36	0.01	>100	
MCL-10	3.30	0.04	51.27	*+
MCL-12	4.70	0.05	12.18	*++

Arbacia normal larval development: - = not toxic; * = one or more dilutions statistically < control;

*+ = <70% Elutriate concentration is toxic.

*++ = <50% Elutriate concentration is toxic.

*+++ = <10% Elutriate concentration is toxic.

1 - Ammonia was measured in 100% elutriate.

Table 5. Summary sediment elutriate sea urchin development test results.

Sample ID	Elutriate Conc. (%)	Mean Normal (%)	SD ⁽¹⁾	Comment
Control ⁽²⁾	na	92.32	2.12	
NSB2	10	80.36	4.02	*
NSB2	50	0.81	0.70	*
NSB2	100	0.75	1.30	*
NSB3	10	84.17	5.15	*
NSB3	50	88.93	4.28	
NSB3	100	82.75	14.08	*
NSB4	10	90.09	2.08	*
NSB4	50	70.50	13.61	*
NSB4	100	31.93	14.85	*
NSB5	10	86.50	7.94	
NSB5	50	4.95	2.50	*
NSB5	100	0.86	0.76	*
NSB6	10	91.72	0.95	
NSB6	50	89.79	3.54	
NSB6	100	86.77	5.53	*
MCL10	10	88.19	0.55	
MCL10	50	83.41	3.49	*
MCL10	100	72.85	4.27	*
MCL12	10	84.39	6.71	*
MCL12	50	70.64	4.68	*
MCL12	100	58.48	7.73	*

FOOTNOTES

* = Mean response was statistically lower than the mean response observed in the control.

(1) SD = Standard deviation

(2) Control = NSW performance control collected from lower Narragansett Bay.

Sea Urchin Larval Development
ETC No. 961102

Sample ID	Conc. (%)	Rep	Number Normal	Number Abnormal	Total	Normal (%)	Mean Normal (%)	SD
Control	na	A	90	6	96	93.8	92.32	2.120
		B	70	5	75	93.3		
		C	80	9	89	89.9		
NSB4	10	A	86	7	93	92.5	90.09	2.079
		B	82	10	92	89.1		
		C	86	11	97	88.7		
	50	A	74	21	95	77.9	70.50	13.613
		B	67	18	85	78.8		
		C	40	33	73	54.8		
	100	A	24	30	54	44.4	31.93	14.851
		B	18	98	116	15.5		
		C	24	43	67	35.8		
NSB2	10	A	50	14	64	78.1	80.36	4.023
		B	68	12	80	85.0		
		C	53	15	68	77.9		
	50	A	1	88	89	1.1	0.81	0.705
		B	1	76	77	1.3		
		C	0	92	92	0.0		
	100	A	0	91	91	0.0	0.75	1.297
		B	0	112	112	0.0		
		C	2	87	89	2.2		
NSB3	10	A	59	8	67	88.1	84.17	5.146
		B	47	13	60	78.3		
		C	62	10	72	86.1		
	50	A	54	10	64	84.4	88.93	4.275
		B	65	5	70	92.9		
		C	60	7	67	89.6		
	100	A	66	2	68	97.1	82.75	14.076
		B	51	23	74	68.9		
		C	65	14	79	82.3		
NSB5	10	A	71	7	78	91.0	86.50	7.938
		B	72	7	79	91.1		
		C	58	17	75	77.3		
	50	A	7	106	113	6.2	4.95	2.504
		B	5	71	76	6.6		
		C	2	95	97	2.1		
	100	A	1	68	69	1.4	0.86	0.760
		B	1	88	89	1.1		
		C	0	63	63	0.0		
NSB6	10	A	100	10	110	90.9	91.72	0.953
		B	77	6	83	92.8		
		C	86	8	94	91.5		

Sea Urchin Larval Development
ETC No. 961102

Sample ID	Conc. (%)	Rep	Number Normal	Number Abnormal	Total	Normal (%)	Mean Normal (%)	SD
MCL10	50	A	45	5	50	90.0	89.79	3.538
		B	56	9	65	86.2		
		C	55	4	59	93.2		
	100	A	60	5	65	92.3	86.77	5.529
		B	65	15	80	81.3		
		C	59	9	68	86.8		
	10	A	67	9	76	88.2	88.19	0.548
		B	71	10	81	87.7		
		C	71	9	80	88.8		
MCL12	50	A	72	15	87	82.8	83.41	3.494
		B	68	10	78	87.2		
		C	57	14	71	80.3		
	100	A	57	24	81	70.4	72.85	4.266
		B	69	29	98	70.4		
		C	70	20	90	77.8		
	10	A	80	7	87	92.0	84.39	6.707
		B	57	15	72	79.2		
		C	64	14	78	82.1		
50	A	59	22	81	72.8	70.64	4.679	
	B	62	33	95	65.3			
	C	62	22	84	73.8			
100	A	43	21	64	67.2	58.48	7.727	
	B	43	39	82	52.4			
	C	48	38	86	55.8			

Sea Urchin Fertilization
ETC No. 961101

Sample ID	Conc. (%)	Rep	Number Fertilized	Number nfertilize	Total	Fertilized (%)	Mean Fertilized (%)	SD
Control	na	A	99	1	100	99	98.7	0.58
		B	98	2	100	98		
		C	99	1	100	99		
NSB4	10	A	99	1	100	99	97.3	1.53
		B	97	3	100	97		
		C	96	4	100	96		
	50	A	63	37	100	63	57.7	6.11
		B	51	49	100	51		
		C	59	41	100	59		
	100	A	11	89	100	11	10.3	0.58
		B	10	90	100	10		
		C	10	90	100	10		
NSB5	10	A	100	0	100	100	98.0	2.00
		B	98	2	100	98		
		C	96	4	100	96		
	50	A	5	95	100	5	8.0	3.61
		B	12	88	100	12		
		C	7	93	100	7		
	100	A	8	92	100	8	8.3	1.53
		B	10	90	100	10		
		C	7	93	100	7		
NSB6	10	A	99	1	100	99	96.3	2.31
		B	95	5	100	95		
		C	95	5	100	95		
	50	A	86	14	100	86	85.3	3.06
		B	88	12	100	88		
		C	82	18	100	82		
	100	A	86	14	100	86	84.7	2.31
		B	86	14	100	86		
		C	82	18	100	82		
NSB2	10	A	95	5	100	95	95.7	0.58
		B	96	4	100	96		
		C	96	4	100	96		
	50	A	9	91	100	9	8.0	2.65
		B	10	90	100	10		
		C	5	95	100	5		
	100	A	6	94	100	6	6.7	2.08
		B	9	91	100	9		
		C	5	95	100	5		
NSB3	10	A	98	2	100	98	95.3	3.06
		B	92	8	100	92		
		C	96	4	100	96		

Sea Urchin Fertilization
ETC No. 961101

Sample ID	Conc. (%)	Rep	Number Fertilized	Number nfertilize	Total	Fertilized (%)	Mean	
							Fertilized (%)	SD
MCL10	50	A	62	38	100	62	43.0	16.82
		B	30	70	100	30		
		C	37	63	100	37		
	100	A	6	94	100	6	5.0	1.00
		B	5	95	100	5		
		C	4	96	100	4		
	10	A	98	2	100	98	94.3	4.04
		B	95	5	100	95		
		C	90	10	100	90		
50	A	76	24	100	76	65.3	11.59	
	B	67	33	100	67			
	C	53	47	100	53			
100	A	16	84	100	16	11.0	4.58	
	B	10	90	100	10			
	C	7	93	100	7			
MCL12	10	A	98	2	100	98	95.3	3.06
		B	96	4	100	96		
		C	92	8	100	92		
	50	A	6	94	100	6	7.3	1.53
		B	9	91	100	9		
		C	7	93	100	7		
	100	A	11	89	100	11	8.0	2.65
		B	6	94	100	6		
		C	7	93	100	7		

Appendix A

- 3.12 18 oz. tall, glass jar
- 3.13 Two large crystallization dishes
- 3.14 Wash bottles filled with deionized water and natural sea water
- 3.15 Transformer. 10-12 volt, with steel electrodes
- 3.16 Two syringes: 1cc (1ml), and 10cc (10 ml), with 18 gauge, blunt-tipped needles (tips cut off).
Or an acceptable substitute (i.e. a modified pipette tip attached to the syringe with 1/8 inch silastic tubing)
- 3.17 5 ml, automatic pipette
- 3.18 1 ml, adjustable pipette
- 3.19 Permanent marker
- 3.20 Sea urchins, 4 or 5 of each sex
- 3.21 Scintillation vials, 20 ml, disposable
- 3.22 250 ml glass exposure chamber
- 3.23 Plastic Plunger
- 3.24 20 ml grid-type petri dish
- 3.25 Formalin. 5% buffered in sea water. filtered
- 3.26 Acetic acid. reagent grade. 10% in sea water
- 3.27 Hypersaline brine (as needed)
- 3.28 Gloves. lab coat. and safety glasses
- 3.29 Data sheets (attached)
- 4.0 METHODS
- 4.1 Prepare samples.



- 4.1.1 Adjust salinity of sample to 28 to 30 ppt with hypersaline brine if necessary (see ETC SOP). Prepare dilutions if necessary.
- 4.2 **Fill test chambers.**
 - 4.2.1 Dispense 200 mls of sample or dilution of sample into each of three replicate exposure chambers.
- 4.3 **Prepare gamete dilution vials.**
 - 4.3.1 Label and fill the sperm dilution vials as follows:
 - A: 19 mls of NSW
 - B: 10 mls of NSW
 - C: 10 mls of NSW
 - D: 10 mls of NSW
 - E: 4 mls of NSW
 - 4.3.2 Place vials A, B, and D on ice for later use.
 - 4.3.3 Label and fill four egg dilution vials with 9 mls of NSW and set aside.
- 4.4 **Collect the eggs.**
 - 4.4.1 Select four female urchins and place in large crystallization dish, barely covering the tests with sea water.
 - 4.4.2 Direct microscope light on urchins to better view gamete release.
 - 4.4.3 Stimulate the release of eggs by touching the test with electrodes from the transformer.
NOTE: Do not let the electrodes touch the genital pore or gametes.
 - 4.4.4 Collect eggs from at least three of the females in the dish using a 10 cc syringe with a blunted tip.
 - 4.4.5 Remove the needle from the syringe before adding the eggs to a 50 ml conical centrifuge tube containing several mls of control seawater.
 - 4.4.6 Bring contents of centrifuge tube to maximum volume by adding control seawater.
 - 4.4.7 The egg stock may be held at room temperature for several hours before use and may be prepared during sperm exposure to sample or dilution of sample.
- 4.5 **Collect the sperm.**



-
- 4.5.1 Select four males and place in large dish, barely covering the urchins with sea water.
 - 4.5.2 Direct microscope light on the urchins to better view the release of gametes.
 - 4.5.3 Stimulate the release of sperm by touching the test with electrodes from the transformer.
NOTE: Do not let the electrodes touch the genital pore or gametes.
 - 4.5.4 Collect sperm from at least three of the males, using a 1 ml disposable syringe fitted with an 18-gauge, blunt tipped needle. Collect until syringe is full.
 - 4.5.5 Keep the syringe containing pooled sperm sample on ice.
 - 4.5.6 The sperm should be used within 1 hour of collection.
- 4.6 Prepare the sperm.**
- 4.6.1 Estimate the sperm concentration by preparing dilutions of 1:50, 1:100, 1:200, and 1:400, using 30 ppt seawater. NOTE: All sperm vials should be maintained on ice before starting the test.
 1. Add 1 ml of collected sperm to 19 ml of seawater in Vial A. Cap Vial A and mix by inversion.
 2. Add 10 mls of sperm suspension from Vial A to 10 mls of seawater in Vial B. Cap Vial B and mix by inversion.
 3. Add 10 mls of sperm suspension from Vial B to 10 mls of seawater in Vial C. Cap Vial C and mix by inversion.
 4. Add 10 mls of sperm suspension from Vial B to 10 mls of seawater in Vial D. Cap Vial D and mix by inversion.
 5. Discard 10 mls from Vial D. (The final volume of all sperm suspensions is 10 mls).
 - 4.6.2 Make a 1:2000 killed sperm suspension and determine the sperm/ml (SPM)
 1. Add 10 mls 10% acetic acid in seawater to Vial C. Cap Vial C and mix by inversion.
 2. Add 1ml of killed sperm from Vial C to 4 mls seawater in Vial E. Mix by gentle inversion.
 3. Add sperm from Vial E to both sides of the hemacytometer. Let the sperm settle for 15 minutes.
 4. Count the number of sperm in the central 400 squares on both sides of the hemacytometer using a compound microscope (400X).
 5. Average the counts from the two sides and calculate the SPM using the calculation: SPM in Vial E = 10^4 x average count from Vial E.



4.6.3 Calculate the SPM in all other suspensions using the SPM in Vial E.

1. SPM in Vial A = 40 x SPM in Vial E.
2. SPM in Vial B = 20 x SPM in Vial E.
3. SPM in Vial D = 5 x SPM in Vial E.
4. SPM in original sperm sample = 2000 x SPM in Vial E.

4.6.4 Select the vial with a sperm concentration greater than and closest to 5×10^7

4.6.5 Using the following calculation, dilute the sperm concentration of the chosen vial to 5×10^7 .

1. Actual SPM/ (5×10^7) = dilution factor (DF).
2. $(DF) \times 10 - 10$ = mls of seawater to add to vial.

4.7 Prepare the eggs.

4.7.1 Using a tabletop centrifuge, wash the pooled eggs twice with control seawater.

NOTE: This can be done while waiting for the sperm to settle on the hemacytometer.

1. Spin for two minutes at lowest possible setting.
2. Carefully pour off the overlying water.
3. Add more control seawater and spin again.

4.7.2 If the wash water becomes red, the eggs have lysed and must be discarded.

4.7.3 Remove the final wash water and refill the tube with control water.

4.7.4 Transfer the washed eggs from the centrifuge tube to a beaker containing a small volume (about 50 mls) of control water by gently inverting the tube to suspend the eggs and carefully pouring the contents into the beaker.

4.7.5 Estimate the egg concentration by preparing a 1:10 dilution using control seawater. NOTE: The desired egg stock concentration is 3500 ± 350 eggs/ml, the desired count for the dilutions is 350 ± 35 eggs/ml.

1. Dilute the egg stock by adding enough control water to the beaker to bring the egg stock to a volume of 200 ml.
2. Suspend the egg stock using gentle aeration.
3. Cut the point from a 1 ml pipette tip and use it to transfer 1 ml of suspended egg stock into two vials containing 9 mls of control water
4. Mix the contents of each vial by inversion and transfer 1 ml of eggs from each vial to a Sedgwick-Rafter counting chamber.



-
5. Count all of the eggs in the chamber using a dissecting microscope.
 6. Calculate the 'egg count' by averaging the counts from both vials
- 4.7.6 Calculate the egg stock concentration using the equation: $\text{Eggs/ml} = 10 \times (\text{egg count})$.
- 4.7.7 Dilute the egg stock to 3500 ± 350 eggs/ml.
1. If the egg count is equal to or greater than 350: $(\text{egg count}) - 350 = \text{volume (ml) of control water to add to egg stock}$.
 2. If the egg count is less than 350, allow the eggs to settle and remove enough control water to concentrate the eggs to greater than 350. repeat the count, and dilute the egg stock as above. NOTE: It requires 18 ml of an egg stock solution for each test with a control and five exposure concentrations (three replicates).
- 4.7.8 After diluting or concentrating the egg stock confirm the final egg count by repeating step 4.7.5.
1. Suspend the egg stock using gentle aeration.
 2. Cut the point from a 1 ml pipette tip and use it to transfer 1 ml of suspended egg stock into two vials containing 9 mls of control water.
 3. Mix the contents of each vial by inversion and transfer 1 ml of eggs from each vial to a Sedgwick-Rafter counting chamber.
 4. Count all of the eggs in the chamber using a dissecting microscope.
 5. Calculate the 'egg count' by averaging the counts from both vials.
- 4.8 Fertilize the eggs.**
- 4.8.1 Mix the egg stock well and subsample 100mls.
- 4.8.2 Pour the subsample into a clean beaker labeled 'embryo suspension'.
- 4.8.3 Within 1 hour of collection, add 1.75 mls of the proper sperm dilution to the beaker and mix well. NOTE: This will result in an egg:sperm ratio of 1:2500, which should allow acceptable egg fertilization.
- 4.8.4 Allow 1 hour for fertilization.
- 4.9 Start the test.**
- 4.9.1 Mix the embryo suspension (3500 eggs/ml), using gentle aeration.



- 4.9.2 Add 1 ml of egg suspension to each 100 mls of test solution in each exposure chamber using a cut, 1 ml pipette tip.
- 4.9.3 Determine initial counts (for survival endpoint) by gently suspending the test media in each control chamber using a plunger.
1. Sub-sample two 10 ml aliquots from each of the control chambers into two 20 ml scintillation vials.
 2. Preserve the samples by adding 2 ml of 2.5% buffered formalin and in seawater to each vial.
 3. Count all of the fertilized eggs in each vial. Record and average the counts to determine the actual number of embryos added at test initiation.
- 4.9.4 Incubate test chambers for 48 hours at $20 \pm 1^\circ\text{C}$.
- 4.9.5 Record physical data daily .
- 4.10 Terminate the test.**
- 4.10.1 Gently suspend the test media in each exposure jar using a plunger.
- 4.10.2 Sub-sample two 10 ml aliquots from each chamber into two 20 ml scintillation vials.
- 4.10.3 Preserve the samples by adding 2 ml of 2.5% buffered formalin and Rose Bengal in seawater to each vial.
- 4.11.4 Cap each vial tightly.
- 4.11 Evaluate the test.**
- NOTE: Vials may be evaluated immediately or they can be stored refrigerated for as long as one week.
- 4.11.1 Gently mix each vial by inversion.
- 4.11.2 Carefully pour the entire content into a 20 ml grid-type petri dish.
- 4.11.3 Observe the embryos using a compound microscope (40-100X) under a fume hood.
- 4.11.4 Count the total number of live larvae in each vial. Distinguish between normal and abnormal larvae. NOTE: Do not include the number of dead animals in either total.

- 4.11.5 Record the number 'normal' and 'abnormal' to determine development relative to the control. The total number of larvae is used to determine percent survival relative to the control and test initiation.



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1. OBJECTIVE

This document describes the procedures used to prepare elutriates from field collected sediment samples.

2. SAFETY

Sediment samples may contain hazardous biological or chemical constituents. Proper attire should be worn.

3. MATERIALS

Glassware

Detergent

Hydrochloric Acid Solution (10%)

Dilution water, use: disposal site water, clean seawater, or artificial sea/salt mixtures

Dredged material sample, at least 1 liter

Unfiltered dredging site water

Graduated cylinder

Magnetic stirrer

Stir bar

1ml pipette

Siphon

Receiving vessel

Centrifuge

Centrifuge tubes

Testing Chambers

4. METHODS

4.1 Cleaning the glassware

4.1.1 Wash with detergent.

4.1.2 Rinse five times with hot tap water.

4.1.3 Rinse with deionized water.

4.1.4 Place in a 10% HCL acid bath for at least 4 hours.

4.1.5 Remove from acid bath and rinse 4 times with deionized water.

4.2 Preparing the elutriate

4.2.1 Subsample approximately 1 L of homogenized sample.

4.2.2 Using volumetric displacement, combine, in a graduated cylinder, the homogenized sample with unfiltered dredging-site water in a sediment-to-water ratio of 1:4 on a volume basis.

4.2.3 Place the sediment-water mixture and a stir bar into the labeled piece of glassware.

4.2.4 Stir the mixture vigorously on a magnetic stirrer for 30 minutes.

4.2.5 Hand stir the mixture every 10 minutes using the 1 ml pipette.

4.2.6 At the end of the 30 minute mixing period, remove the mixture from the stirrer and allow to settle for 1 hour.

4.3 Preparing the supernatant

4.3.1 Carefully siphon off the supernatant into the centrifugation vessels without disturbing the settled material.

4.3.2 Centrifuge the supernatant until the suspension is clear enough at the first observation time for the organisms to be visible in the testing chambers.

NOTE: This step is only necessary with some very fine-grained dredged materials.

4.3.3 Prepare 100%, 50% and 10% dilutions of the supernatant and use immediately for testing.

Sea Urchin Fertilization
ETC No. 961101

Sample ID	Conc. (%)	Rep	Number Fertilized	Number nfertilize	Total	Fertilized (%)	Mean Fertilized (%)	SD
Control	na	A	99	1	100	99	98.7	0.58
		B	98	2	100	98		
		C	99	1	100	99		
NSB4	10	A	99	1	100	99	97.3	1.53
		B	97	3	100	97		
		C	96	4	100	96		
	50	A	63	37	100	63	57.7	6.11
		B	51	49	100	51		
		C	59	41	100	59		
100	A	11	89	100	11	10.3	0.58	
	B	10	90	100	10			
	C	10	90	100	10			
NSB5	10	A	100	0	100	100	98.0	2.00
		B	98	2	100	98		
		C	96	4	100	96		
	50	A	5	95	100	5	8.0	3.61
		B	12	88	100	12		
		C	7	93	100	7		
100	A	8	92	100	8	8.3	1.53	
	B	10	90	100	10			
	C	7	93	100	7			
NSB6	10	A	99	1	100	99	96.3	2.31
		B	95	5	100	95		
		C	95	5	100	95		
	50	A	86	14	100	86	85.3	3.06
		B	88	12	100	88		
		C	82	18	100	82		
100	A	86	14	100	86	84.7	2.31	
	B	86	14	100	86			
	C	82	18	100	82			
NSB2	10	A	95	5	100	95	95.7	0.58
		B	96	4	100	96		
		C	96	4	100	96		
	50	A	9	91	100	9	8.0	2.65
		B	10	90	100	10		
		C	5	95	100	5		
100	A	6	94	100	6	6.7	2.08	
	B	9	91	100	9			
	C	5	95	100	5			
NSB3	10	A	98	2	100	98	95.3	3.06
		B	92	8	100	92		
		C	96	4	100	96		

Sea Urchin Fertilization
ETC No. 961101

Sample ID	Conc. (%)	Rep	Number Fertilized	Number infertilize	Total	Fertilized (%)	Mean Fertilized (%)	SD
MCL10	50	A	62	38	100	62	43.0	16.82
		B	30	70	100	30		
		C	37	63	100	37		
	100	A	6	94	100	6	5.0	1.00
		B	5	95	100	5		
		C	4	96	100	4		
	10	A	98	2	100	98	94.3	4.04
		B	95	5	100	95		
		C	90	10	100	90		
MCL12	50	A	76	24	100	76	65.3	11.59
		B	67	33	100	67		
		C	53	47	100	53		
	100	A	16	84	100	16	11.0	4.58
		B	10	90	100	10		
		C	7	93	100	7		
	10	A	98	2	100	98	95.3	3.06
		B	96	4	100	96		
		C	92	8	100	92		
MCL12	50	A	6	94	100	6	7.3	1.53
		B	9	91	100	9		
		C	7	93	100	7		
	100	A	11	89	100	11	8.0	2.65
		B	6	94	100	6		
		C	7	93	100	7		

Appendix B

Appendix C

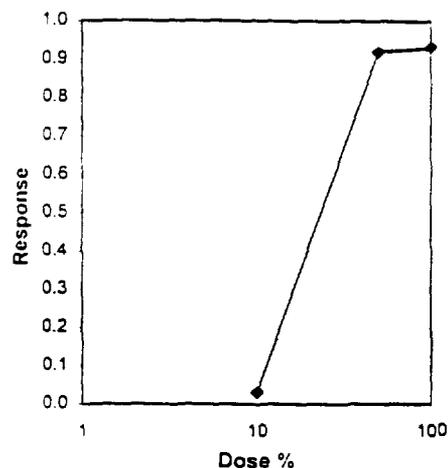
-Proportion Fertilized

Start Date:	Test ID: 961101	Sample ID: NSB2
End Date:	Lab ID:	Sample Type:
Sample Date:	Protocol: DL 87	Test Species: AP-Arbacia punctulata
Comments:		

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	0.9500	0.9600	0.9600
50	0.0900	0.1000	0.0500
100	0.0600	0.0900	0.0500

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)		Skew
IC01*	2.059	0.192	1.640	3.061	1.2569
IC05	11.253	0.213	10.348	12.187	0.1608
IC10	13.608	0.214	12.809	14.345	0.0505
IC15	15.421	0.245	14.447	16.363	0.1011
IC20	16.980	0.286	15.887	18.147	0.1338
IC25	18.403	0.331	17.114	19.773	0.1374
IC40	22.385	0.484	20.539	24.323	0.0819
IC50	25.117	0.606	22.880	27.452	0.0349
IC60	28.186	0.754	25.208	30.977	-0.0098
IC75	34.322	1.081	29.674	38.062	-0.0719
IC80	37.241	1.249	31.750	41.449	-0.0921
IC85	41.103	1.482	34.454	45.959	-0.1126
IC90	46.849	1.865	38.580	52.895	-0.0860
IC95	>100				
IC99	>100				



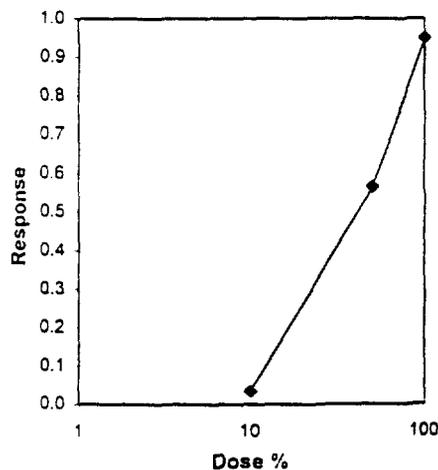
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Start Date:	Test ID: 961101-3	Sample ID: NSB3
End Date:	Lab ID:	Sample Type:
Sample Date:	Protocol: DL 87	Test Species: AP-Arbacia punctulata
Comments:		

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	0.9800	0.9200	0.9600
50	0.6200	0.3000	0.3700
100	0.0600	0.0500	0.0400

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	1.859	1.721	0.481	10.287	3.1014
IC05	11.716	1.785	5.986	18.595	0.3015
IC10	16.082	1.937	10.100	25.153	0.5669
IC15	19.786	2.238	12.358	30.578	0.3950
IC20	23.205	2.605	15.365	35.484	0.2667
IC25	26.506	3.043	17.324	40.582	0.2228
IC40	36.625	4.742	23.084	54.532	0.2764
IC50	44.294	5.223	27.261	60.731	-0.0963
IC60	51.946	4.279	33.953	62.904	-0.5841
IC75	62.182	3.295	49.455	72.735	-0.3668
IC80	67.003	3.006	54.917	77.239	-0.3418
IC85	73.343	2.612	62.293	83.055	-0.2621
IC90	82.696	2.112	73.802	91.434	-0.0124
IC95	>100				
IC99	>100				



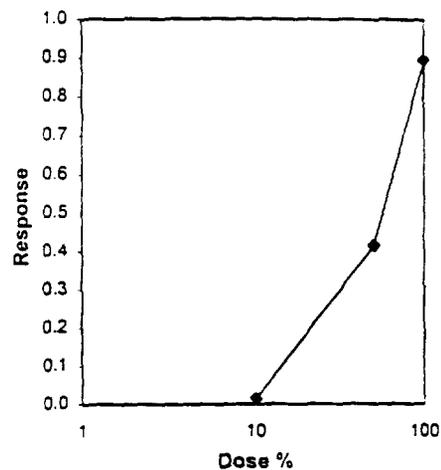
-Proportion Fertilized

Start Date:	Test ID: 961101-4	Sample ID:	NSB4
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	0.9900	0.9700	0.9600
50	0.6300	0.5100	0.5900
100	0.1100	0.1000	0.1000

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	5.776	3.365	0.000	19.726	0.5057
IC05	15.677	1.619	10.569	22.652	0.3266
IC10	21.425	1.675	15.836	28.619	0.2522
IC15	26.305	1.706	20.350	33.522	0.1720
IC20	30.811	1.751	24.685	37.920	0.0802
IC25	35.165	1.831	28.970	42.463	-0.0099
IC40	48.520	2.056	41.403	54.767	-0.5437
IC50	54.965	1.407	50.050	59.636	-0.4282
IC60	61.532	1.284	56.845	65.804	-0.4316
IC75	74.658	0.988	70.560	78.302	-0.3638
IC80	80.900	0.845	77.179	84.158	-0.2387
IC85	89.161	0.703	86.314	91.834	0.0934
IC90	>100				
IC95	>100				
IC99	>100				



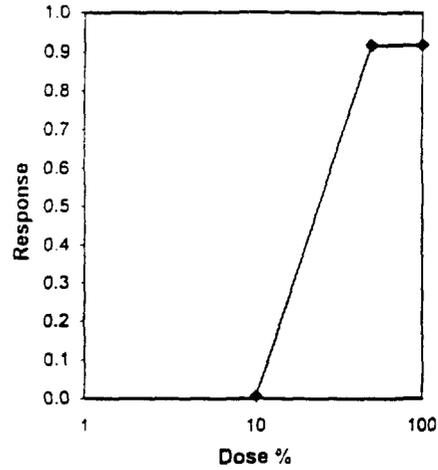
-Proportion Fertilized

Start Date:	Test ID: 961101-5	Sample ID:	NSB5
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	1.0000	0.9800	0.9600
50	0.0500	0.1200	0.0700
100	0.0800	0.1000	0.0700

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)		Skew
IC01	10.413	3.331	0.000	13.376	-0.9147
IC05	13.677	1.142	9.860	17.410	-0.0912
IC10	16.125	1.179	12.170	20.090	-0.0370
IC15	17.975	1.194	13.971	22.015	-0.0120
IC20	19.547	1.200	15.531	23.510	0.0053
IC25	20.966	1.201	16.842	24.891	0.0200
IC40	24.874	1.192	20.507	29.144	0.0672
IC50	27.508	1.183	23.019	32.089	0.1121
IC60	30.427	1.179	25.837	35.331	0.1814
IC75	36.153	1.218	31.461	41.740	0.3823
IC80	38.833	1.270	34.132	44.685	0.4911
IC85	42.341	1.375	37.663	48.501	0.6193
IC90	47.489	4.810	42.498	80.705	3.4099
IC95	>100				
IC99	>100				



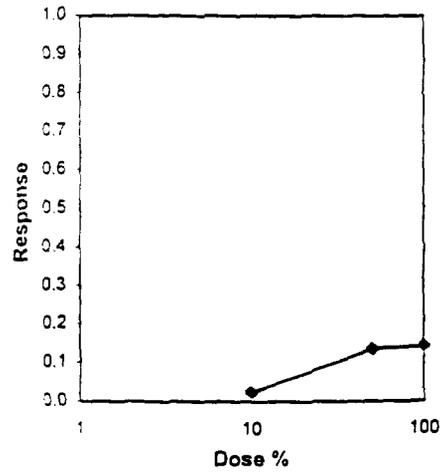
-Proportion Fertilized

Start Date:	Test ID: 961101-6	Sample ID:	NSB6
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	0.9900	0.9500	0.9500
50	0.8600	0.8800	0.8200
100	0.8600	0.8600	0.8200

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	2.691	3.253	0.618	20.617	1.6915
IC05	18.513	3.790	6.430	31.848	0.3072
IC10	36.223	3.798	22.491	49.380	0.0255
IC15	>100				
IC20	>100				
IC25	>100				
IC40	>100				
IC50	>100				
IC60	>100				
IC75	>100				
IC80	>100				
IC85	>100				
IC90	>100				
IC95	>100				
IC99	>100				



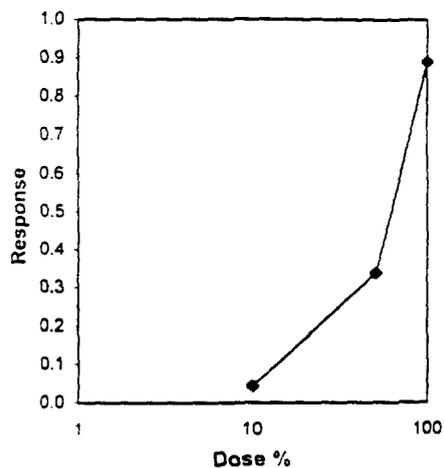
-Proportion Fertilized

Start Date:	Test ID: 961101-10	Sample ID:	MCL10
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	0.9800	0.9500	0.9000
50	0.7600	0.6700	0.5300
100	0.1600	0.1000	0.0700

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)		Skew
IC01*	1.475	1.753	0.494	10.371	3.6117
IC05	10.861	3.175	1.445	23.186	0.2628
IC10	17.545	3.340	7.300	32.916	0.2968
IC15	23.963	3.763	10.981	41.824	0.2514
IC20	30.436	4.521	14.765	50.576	0.1742
IC25	37.151	5.724	18.782	60.800	0.1181
IC40	53.457	3.479	33.424	63.136	-1.0057
IC50	59.187	2.746	45.327	68.124	-0.4004
IC60	65.556	2.602	54.626	74.619	-0.1755
IC75	78.105	2.859	69.201	89.499	0.2335
IC80	84.000	3.283	73.680	96.531	0.2471
IC85	91.736				
IC90	>100				
IC95	>100				
IC99	>100				



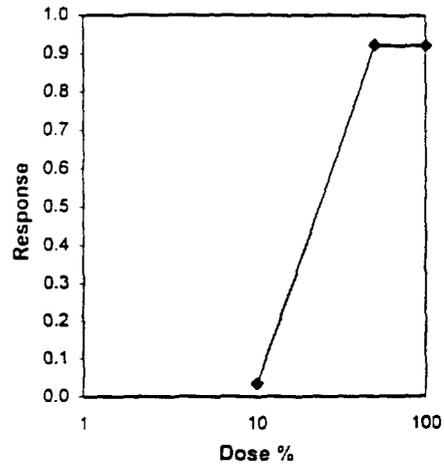
-Proportion Fertilized

Start Date:	Test ID: 961101-12	Sample ID:	MCL12
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9900	0.9800	0.9900
10	0.9800	0.9600	0.9200
50	0.0600	0.0900	0.0700
100	0.1100	0.0600	0.0700

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	1.859	2.272	0.447	18.259	2.6176
IC05	10.998	1.416	5.635	15.176	-0.6204
IC10	13.319	1.064	10.302	17.557	0.3138
IC15	15.106	1.076	12.012	19.384	0.2897
IC20	16.645	1.079	13.490	20.943	0.2738
IC25	18.050	1.077	14.846	22.354	0.2615
IC40	21.983	1.052	18.688	26.327	0.2309
IC50	24.685	1.021	21.459	28.835	0.2068
IC60	27.722	0.979	24.389	31.706	0.1700
IC75	33.797	0.905	30.453	37.387	0.0520
IC80	36.690	0.890	33.326	39.984	-0.0115
IC85	40.519	0.911	36.533	43.900	-0.0551
IC90	46.220	1.045	41.764	50.598	0.0177
IC95	>100				
IC99	>100				



Appendix D

Sample ID	Total Ammonia (mg/L)	Temp (C)	Salinity (ppt)	pH	Un-ionized Ammonia (mg/L)
NSB2	0.51	22.1	30	7.91	0.015
NSB3	0.21	22	30	8.25	0.013
NSB4	0.30	22.1	30	7.52	0.004
NSB5	0.02	22.1	30	7.82	0.000
NSB6	0.36	22	30	7.79	0.008
MCL10	3.30	22	30	7.56	0.045
MCL12	4.70	21.9	30	7.46	0.050

Appendix E

Sea Urchin Larval Development
ETC No. 961102

Sample ID	Conc. (%)	Rep	Number Normal	Number Abnormal	Total	Normal (%)	Mean Normal (%)	SD
Control	na	A	90	6	96	93.8	92.32	2.120
		B	70	5	75	93.3		
		C	80	9	89	89.9		
NSB4	10	A	86	7	93	92.5	90.09	2.079
		B	82	10	92	89.1		
		C	86	11	97	88.7		
	50	A	74	21	95	77.9	70.50	13.613
		B	67	18	85	78.8		
		C	40	33	73	54.8		
	100	A	24	30	54	44.4	31.93	14.851
		B	18	98	116	15.5		
		C	24	43	67	35.8		
NSB2	10	A	50	14	64	78.1	80.36	4.023
		B	68	12	80	85.0		
		C	53	15	68	77.9		
	50	A	1	88	89	1.1	0.81	0.705
		B	1	76	77	1.3		
		C	0	92	92	0.0		
	100	A	0	91	91	0.0	0.75	1.297
		B	0	112	112	0.0		
		C	2	87	89	2.2		
NSB3	10	A	59	8	67	88.1	84.17	5.146
		B	47	13	60	78.3		
		C	62	10	72	86.1		
	50	A	54	10	64	84.4	88.93	4.275
		B	65	5	70	92.9		
		C	60	7	67	89.6		
	100	A	66	2	68	97.1	82.75	14.076
		B	51	23	74	68.9		
		C	65	14	79	82.3		
NSB5	10	A	71	7	78	91.0	86.50	7.938
		B	72	7	79	91.1		
		C	58	17	75	77.3		
	50	A	7	106	113	6.2	4.95	2.504
		B	5	71	76	6.6		
		C	2	95	97	2.1		
	100	A	1	68	69	1.4	0.86	0.760
		B	1	88	89	1.1		
		C	0	63	63	0.0		
NSB6	10	A	100	10	110	90.9	91.72	0.953
		B	77	6	83	92.8		
		C	86	8	94	91.5		

Sea Urchin Larval Development
ETC No. 961102

Sample ID	Conc. (%)	Rep	Number Normal	Number Abnormal	Total	Normal (%)	Mean Normal (%)	SD
MCL10	50	A	45	5	50	90.0	89.79	3.538
		B	56	9	65	86.2		
		C	55	4	59	93.2		
	100	A	60	5	65	92.3	86.77	5.529
		B	65	15	80	81.3		
		C	59	9	68	86.8		
	10	A	67	9	76	88.2	88.19	0.548
		B	71	10	81	87.7		
		C	71	9	80	88.8		
MCL12	50	A	72	15	87	82.8	83.41	3.494
		B	68	10	78	87.2		
		C	57	14	71	80.3		
	100	A	57	24	81	70.4	72.85	4.266
		B	69	29	98	70.4		
		C	70	20	90	77.8		
	10	A	80	7	87	92.0	84.39	6.707
		B	57	15	72	79.2		
		C	64	14	78	82.1		
MCL12	50	A	59	22	81	72.8	70.64	4.679
		B	62	33	95	65.3		
		C	62	22	84	73.8		
	100	A	43	21	64	67.2	58.48	7.727
		B	43	39	82	52.4		
		C	48	38	86	55.8		

Appendix F

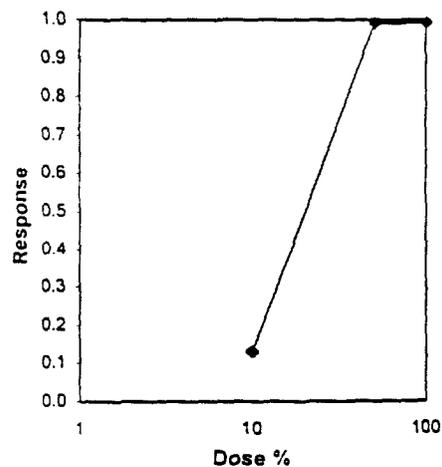
-Proportion Normal

Start Date:	Test ID: 961102-2	Sample ID: NSB2
End Date:	Lab ID:	Sample Type:
Sample Date:	Protocol: DL 87	Test Species: AP-Arbacia punctulata
Comments:		

Conc-%	1	2	3
S-Control	0.9375	0.9333	0.8989
10	0.7813	0.8500	0.7794
50	0.0112	0.0130	0.0000
100	0.0000	0.0000	0.0225

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew
IC01*	0.316	0.041	0.226	0.504
IC05*	2.193	0.491	1.301	4.665
IC10*	6.316	1.635	2.537	14.367
IC15	10.317	0.535	6.458	11.792
IC20	11.051	0.324	9.912	12.680
IC25	11.745	0.339	10.642	13.539
IC40	13.759	0.421	12.605	16.053
IC50	15.171	0.506	13.611	17.780
IC60	16.767	0.622	14.710	19.770
IC75	19.951	0.899	16.804	23.822
IC80	21.457	1.046	17.756	25.653
IC85	23.438	1.252	18.978	28.261
IC90	26.358	1.579	20.805	32.186
IC95	31.858	2.255	23.996	39.703
IC99	48.328			



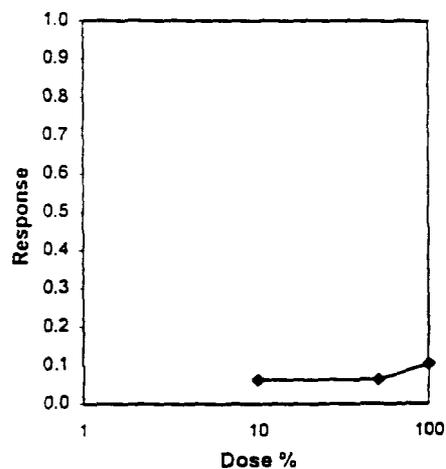
-Proportion Normal

Start Date:	Test ID: 961102-3	Sample ID:	NSB3
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9375	0.9333	0.8989
10	0.8806	0.7833	0.8611
50	0.8438	0.9286	0.8955
100	0.9706	0.6892	0.8228

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	0.606	0.412	0.252	4.182	3.2746
IC05*	6.400				
IC10	94.520				
IC15	>100				
IC20	>100				
IC25	>100				
IC40	>100				
IC50	>100				
IC60	>100				
IC75	>100				
IC80	>100				
IC85	>100				
IC90	>100				
IC95	>100				
IC99	>100				



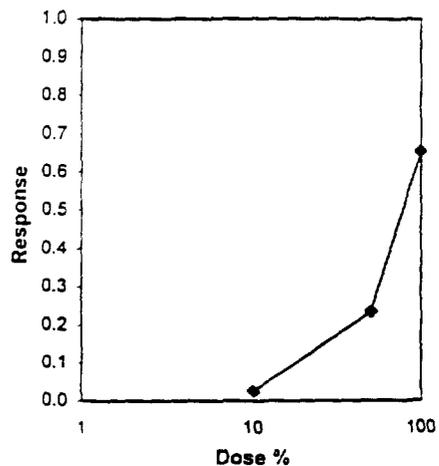
-Proportion Normal

Start Date:	Test ID: 961102-4	Sample ID:	NSB4
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9375	0.9333	0.8989
10	0.9247	0.8913	0.8866
50	0.7789	0.7882	0.5479
100	0.4444	0.1552	0.3582

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)		Skew
IC01*	1.881	3.910	0.000	21.807	1.0075
IC05	13.524	2.555	6.349	26.827	0.5305
IC10	21.290	5.625	8.806	49.730	0.8012
IC15	30.406	10.227	10.845	73.583	0.7366
IC20	41.088	9.345	11.413	72.844	0.0940
IC25	51.299	8.482	10.779	71.488	-0.6544
IC40	66.126	6.404	33.095	88.196	-0.1334
IC50	77.414	6.739	47.263	102.852	0.4324
IC60	91.022				
IC75	>100				
IC80	>100				
IC85	>100				
IC90	>100				
IC95	>100				
IC99	>100				



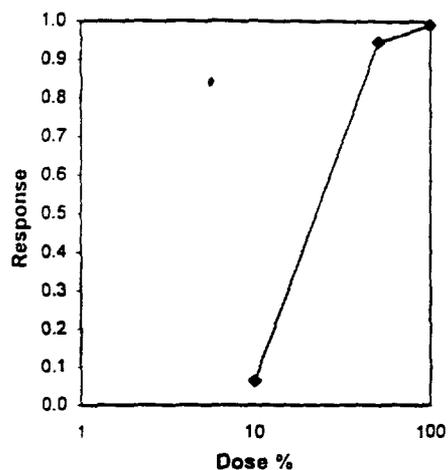
-Proportion Normal

Start Date:	Test ID: 961102-5	Sample ID:	NSB5
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9375	0.9333	0.8989
10	0.9103	0.9114	0.7733
50	0.0619	0.0658	0.0206
100	0.0145	0.0112	0.0000

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	0.601	2.757	0.067	21.047	2.1498
IC05*	6.302	3.514	0.000	17.396	0.0245
IC10	10.970	1.914	2.015	15.050	-1.1355
IC15	12.165	1.186	8.673	16.262	-0.1098
IC20	13.279	1.181	9.398	17.592	0.0742
IC25	14.351	1.210	10.033	18.865	0.0732
IC40	17.556	1.303	13.120	22.639	0.0375
IC50	19.881	1.384	15.128	25.348	-0.0288
IC60	22.579	1.499	17.090	28.464	-0.1423
IC75	28.178	1.832	21.374	34.824	-0.4001
IC80	30.916	2.042	23.419	37.929	-0.4907
IC85	34.599	2.370	24.696	42.049	-0.5581
IC90	40.189	2.957	26.348	48.400	-0.5656
IC95	51.424	4.286	28.708	65.451	-0.5048
IC99	97.179				



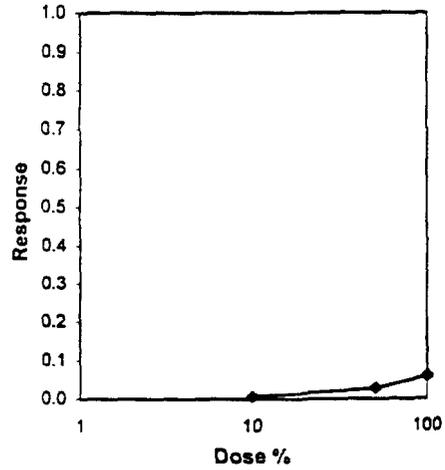
-Proportion Normal

Start Date:	Test ID: 961102-6	Sample ID:	NSB6
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9375	0.9333	0.8989
10	0.9091	0.9277	0.9149
50	0.9000	0.8615	0.9322
100	0.9231	0.8125	0.8676

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew
IC01	13.516			
IC05	82.062			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			
IC60	>100			
IC75	>100			
IC80	>100			
IC85	>100			
IC90	>100			
IC95	>100			
IC99	>100			



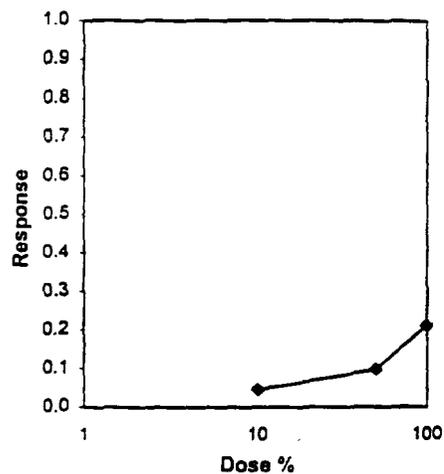
-Proportion Normal

Start Date:	Test ID: 961102-10	Sample ID:	MCL10
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control	0.9375	0.9333	0.8989
10	0.8816	0.8765	0.8875
50	0.8276	0.8718	0.8028
100	0.7037	0.7041	0.7778

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew	
IC01*	0.862	0.533	0.464	4.749	2.5859
IC05	12.111	7.320	1.676	45.701	2.7041
IC10	51.271	11.130	0.000	76.337	-0.3866
IC15	71.348				
IC20	94.491				
IC25	>100				
IC40	>100				
IC50	>100				
IC60	>100				
IC75	>100				
IC80	>100				
IC85	>100				
IC90	>100				
IC95	>100				
IC99	>100				



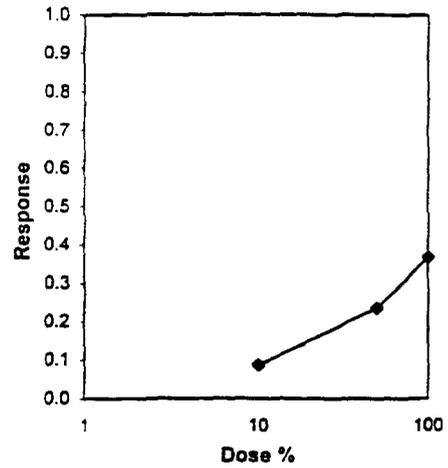
-Proportion Normal

Start Date:	Test ID: 961102-12	Sample ID:	MCL12
End Date:	Lab ID:	Sample Type:	
Sample Date:	Protocol: DL 87	Test Species:	AP-Arbacia punctulata
Comments:			

Conc-%	1	2	3
S-Control:	0.9375	0.9333	0.8989
10	0.9195	0.7917	0.8205
50	0.7284	0.6526	0.7381
100	0.6719	0.5244	0.5581

Log-Logit Interpolation (80 Resamples)

Point	%	SE	95% CL(Exp)	Skew
IC01*	0.449	1.383	0.161 9.730	6.1146
IC05*	3.787	3.671	0.367 27.434	1.6013
IC10	12.181	4.990	0.000 35.787	0.6613
IC15	22.203	6.055	2.937 50.451	0.3581
IC20	36.607	7.417	18.058 67.687	0.1991
IC25	54.507	7.258	31.895 94.440	0.2562
IC40	>100			
IC50	>100			
IC60	>100			
IC75	>100			
IC80	>100			
IC85	>100			
IC90	>100			
IC95	>100			
IC99	>100			



Unionized Ammonia Calculation for Pressure of 1 atm							Sampling Date: 8-Nov-96			
							Expt No: 961101.2			
							Elutriate			
Sample ID	Total Ammonia (mg/L)	Temp (C)	Salinity (ppt)	pH	Temp (K)	I	I Rounded	pK	Unionized Ammonia	
NSB2	0.51	22.1	30	7.91	295.26	6.66	7	9.33	0.015	
NSB3	0.21	22	30	8.25	295.16	6.66	7	9.33	0.013	
NSB4	0.30	22.1	30	7.52	295.26	6.66	7	9.33	0.004	
NSB5	0.02	22.1	30	7.82	295.26	6.66	7	9.33	0.000	
NSB6	0.36	22	30	7.79	295.16	6.66	7	9.33	0.008	
MCL10	3.30	22	30	7.56	295.16	6.66	7	9.33	0.045	
MCL12	4.70	21.9	30	7.46	295.06	6.66	7	9.33	0.050	

Appendix G



Science Applications International Corporation

Chain of Custody Record

Environmental Testing Center / 165 Dean Knauss Dr. / Narragansett, RI 02882 / Tel. (401) 782-1900 / Fax (401) 782-2330

Project: McAllister Point Client Name and Contact:

Sample No.	Containers		Collection		Sample Description	Requested Parameters
	No.	Type	Date	Time		
NSB4	1	Plastic Jar	10/29/96	3:45PM	0-18cm 3" Core Sample	Sediment Toxicity
NSB5	1	Plastic Jar	10/29/96	3:25 P.M.	"	"
NSB6	1	Plastic Jar	10/29/96	3:00P.M.	"	"
MCL-10	1	Plastic Jar	10/8/96	1:40P.M.	"	"
MCL-12	1	Plastic Jar	10/8/96	3:00P.M.	"	"
Not MCL-10 and MCL-12 Stored Frozen from date of collection to date of sampling						

Total :

Packed/Released By: Signature: <u>Glen W. King</u> Printed Name: <u>John W. King</u> Date Time: <u>11/1/96 17:20</u>	Received By: Signature: <u>K.J. McAfee SAIC</u> Printed Name: <u>K.J. McAfee</u> Date Time: <u>11/1/96 17:20</u>	Remarks:
Released By: Signature: <u>K.J. McAfee</u> Printed Name: <u>K.J. McAfee</u> Date Time: <u>11/4/96 9:20 a</u>	Received By: Signature: <u>Brian King</u> Printed Name: <u>Brian King</u> Date Time:	
Final Destination:	Contact Name and Phone Number:	
Shipping Method:	Page <u>1</u> of <u>1</u>	

Original Form Accompanies Shipment

**SPERM CELL TEST USING THE SEA URCHIN
*ARBACIA PUNCTULATA***

1.0 OBJECTIVE

- 1.1 This document describes the methods used to conduct the Sea Urchin Sperm Cell Test.
- 1.2 This test is used to measure the toxicity of water column samples to the gametes of the sea urchin *Arbacia punctulata* during a 1 hour and 20 minute exposure.

2.0 SAFETY

- 2.1 Environmental samples may contain hazardous biological or chemical constituents. Latex gloves (rinsed before wearing), tyvek labcoat, and safety glasses are to be worn.
- 2.2 Fertilized eggs preserved in formalin must be examined under a fume hood.

3.0 MATERIALS

- 3.1 Air pump
- 3.2 Plastic 1 ml pipettes
- 3.3 Centrifuge, bench top, variable speed
- 3.4 Fume hood
- 3.5 Dissecting microscope with detachable light
- 3.6 Compound microscope
- 3.7 Sedgwick-Rafter counting chamber
- 3.8 Hemacytometer
- 3.9 Count register, 2-place
- 3.10 Ice bucket
- 3.11 Capped centrifuge tubes, conical, 50 ml, plastic



- 3.12 18 oz. tall, glass jar
- 3.13 Two large crystallization dishes
- 3.14 Wash bottles filled with deionized water and natural sea water
- 3.15 Transformer, 10-12 Volt, with steel electrodes
- 3.16 Two syringes: 1 cc (1 ml), and 10 cc (10 ml), with 18 gauge, blunt-tipped needles (tips cut off), or an acceptable substitute (i.e. a modified pipette tip attached to the syringe with 1/4 inch silastic tubing)
- 3.17 5 ml, automatic pipette
- 3.18 1 ml, adjustable pipette
- 3.19 Permanent marker
- 3.20 Sea urchins, 4 or 5 of each sex
- 3.21 Scintillation vials, 20 ml, disposable
- 3.22 Formalin, 5% buffered in sea water, filtered
- 3.23 Acetic acid, reagent grade, 10% in sea water
- 3.24 Hypersaline brine (as needed)
- 3.25 Gloves, lab coat, and safety glasses
- 3.26 Data sheets (attached)
- 4.0 METHODS
- 4.1 **Prepare samples.**
 - 4.1.1 Adjust salinity of sample to 28 to 30 ppt with hypersaline brine if necessary (see ETC SOP). Prepare dilutions when required.
- 4.2 **Fill test chambers.**
 - 4.2.1 Dispense 5 mls of sample or dilution of sample into each of three replicate scintillation vials.



4.3 Prepare gamete dilution vials.

4.3.1 Label and fill the sperm dilution vials as follows:

- A: 19 mls of NSW
- B: 10 mls of NSW
- C: 10 mls of NSW
- D: 10 mls of NSW
- E: 4 mls of NSW

4.3.2 Place vials A, B, and D on ice for later use.

4.3.3 Label and fill four egg dilution vials with 9 mls of NSW and set aside.

4.4 Collect the eggs.

4.4.1 Select four female urchins and place in large crystallization dish, barely covering the animals with seawater.

4.4.2 Direct microscope light on urchins to view gamete release.

4.4.3 Stimulate the release of eggs by touching the urchin with electrodes from the transformer.
NOTE: Do not let the electrodes touch the genital pore or gametes.

4.4.4 Collect eggs from at least three of the females in the dish using a 10 cc syringe with a blunted tip.

4.4.5 Remove the needle from the syringe before adding the eggs to a 50 ml conical centrifuge tube containing several mls of seawater.

4.4.6 Bring contents of centrifuge tube to maximum volume by adding seawater.

4.4.7 The egg stock may be held at room temperature for several hours before use and may be prepared during sperm exposure to sample or dilution of sample.

4.5 Collect the sperm.

4.5.1 Select four males and place in large dish, barely covering the urchins with sea water.

4.5.2 Direct microscope light on the urchins to view the release of gametes.

4.5.3 Stimulate the release of sperm by touching the test with electrodes from the transformer.
NOTE: Do not let the electrodes touch the genital pore or gametes.



-
- 4.5.4 Collect sperm from at least three of the males, using a 1 ml disposable syringe fitted with an 18-gauge, blunt tipped needle. Collect until syringe is full.
- 4.5.5 Keep the syringe containing pooled sperm sample on ice.
- 4.5.6 The sperm should be used within 1 hour of collection.
- 4.6 Prepare the sperm.**
- 4.6.1 Estimate the sperm concentration by preparing dilutions of 1:50, 1:100, 1:200, and 1:400, using 30 ppt seawater.
NOTE: All sperm vials should be held on ice before starting the test.
1. Add 1 ml of collected sperm to 19 ml of seawater in Vial A. Cap Vial A and mix by inversion.
 2. Add 10 mls of sperm suspension from Vial A to 10 mls of seawater in Vial B. Cap Vial B and mix by inversion.
 3. Add 10 mls of sperm suspension from Vial B to 10 mls of seawater in Vial C. Cap Vial C and mix by inversion.
 4. Add 10 mls of sperm suspension from Vial B to 10 mls of seawater in Vial D. Cap Vial D and mix by inversion.
 5. Discard 10 mls from Vial D. (The final volume of all sperm suspensions is 10 mls)
- 4.6.2 Make a 1:2000 killed sperm suspension and determine the sperm/ml (SPM)
1. Add 10 mls 10% acetic acid in seawater to Vial C. Cap Vial C and mix by inversion.
 2. Add 1ml of killed sperm from Vial C to 4 mls seawater in Vial E. Mix by gentle inversion.
 3. Add sperm from Vial E to both sides of the hemacytometer. Let the sperm settle for 15 minutes.
 4. Count the number of sperm in the central 400 squares on both sides of the hemacytometer using a compound microscope (400X).
 5. Average the counts from the two sides and calculate the SPM using the calculation: SPM in Vial E = 10^4 x average count from Vial E.
- 4.6.3 Calculate the SPM in all other suspensions using the SPM in Vial E.
1. SPM in Vial A = 40 x SPM in Vial E.
 2. SPM in Vial B = 20 x SPM in Vial E.
 3. SPM in Vial D = 5 x SPM in Vial E.
 4. SPM in original sperm sample = 2000 x SPM in Vial E.
- 4.6.4 Select the vial with a sperm concentration greater than and closest to 5×10^7

4.6.5 Using the following calculation, dilute the sperm concentration of the chosen vial to 5×10^7

1. Actual SPM/ (5×10^7) = dilution factor (DF).
2. $[(DF) \times 10] - 10$ = mls of seawater to add to vial.

4.7 Prepare the eggs.

4.7.1 Using a tabletop centrifuge, wash the pooled eggs twice with seawater.

1. NOTE: This can be done while waiting for the sperm to settle on the hemacytometer.
1. Spin for two minutes at lowest possible setting.
2. Carefully pour off the overlying water.
3. Add more seawater and spin again.

4.7.2 If the wash water becomes red, the eggs have lysed and must be discarded.

4.7.3 Remove the final wash water and refill the tube with seawater.

4.7.4 Transfer the washed eggs from the centrifuge tube to a beaker containing a small volume (about 50 mls) of seawater by gently inverting the tube to suspend the eggs and carefully pouring the contents into the beaker.

4.7.5 Estimate the egg concentration by preparing a 1:10 dilution using seawater.

NOTE: The desired egg stock concentration is 2000 ± 200 eggs/ml, the desired count for the dilutions is 200 ± 20 eggs/ml.

1. Dilute the egg stock by adding enough seawater to the beaker to bring the egg stock to a volume of 200 ml.
2. Suspend the egg stock using gentle aeration.
3. Cut the point from a 1 ml pipette tip and use it to transfer 1 ml of suspended egg stock into two vials containing 9 mls of seawater
4. Mix the contents of each vial by inversion and transfer 1 ml of eggs from each vial to a Sedgwick-Rafter counting chamber.
5. Count all of the eggs in the chamber using a dissecting microscope.
6. Calculate the 'egg count' by averaging the counts from both vials

4.7.6 Calculate the egg stock concentration using the equation: Eggs/ml = $10 \times$ (egg count).

4.7.7 Dilute the egg stock to 2000 ± 200 eggs/ml.

1. If the egg count is equal to or greater than 200: (egg count) - 200 = volume (ml) of seawater to add to egg stock.



2. If the egg count is less than 200, allow the eggs to settle and remove enough control water to concentrate the eggs to greater than 200, repeat the count, and dilute the egg stock as above.

NOTE: It requires 18 ml of an egg stock solution for each test with a control and five exposure concentrations (three replicates).

- 4.7.8 After diluting or concentrating the egg stock confirm the final egg count by repeating step 4.7.5.

1. Suspend the egg stock using gentle aeration.
2. Cut the point from a 1 ml pipette tip and use it to transfer 1 ml of suspended egg stock into two vials containing 9 mls of control water.
3. Mix the contents of each vial by inversion and transfer 1 ml of eggs from each vial to a Sedgwick-Rafter counting chamber.
4. Count all of the eggs in the chamber using a dissecting microscope.
5. Calculate the 'egg count' by averaging the counts from both vials.

4.8 Start the test.

- 4.8.1 Within 1 hour of collection, add 100 μ l of appropriately diluted sperm to each test vial.

- 4.8.2 Record the time.

- 4.8.3 Incubate all test vials at $20 \pm 1^\circ\text{C}$ for 1 hour.

- 4.8.4 Mix the egg suspension (2000 eggs/ml), using gentle aeration.

- 4.8.5 Add 1 ml of egg suspension to each test vial using a cut, 1 ml pipette tip.

- 4.8.6 Incubate for 20 minutes at $20 \pm 1^\circ\text{C}$.

4.9 Terminate the test.

- 4.9.1 Preserve the samples by adding 2 ml of 2.5% buffered formalin in seawater to each vial.

4.10 Evaluate the test within 24 hours.

- 4.10.1 Transfer 1 ml of eggs from the bottom of a test vial (using a cut, 1 ml pipette tip) to a Sedgwick-Rafter counting chamber.

- 4.10.2 Observe the eggs using a compound microscope (100X) under a fume hood.

- 4.10.3 Count 100 eggs/sample.