CATALOG DOCUMENTATION
MAIA-ESTUARIES SUMMARY DATABASE
1997 and 1998 STATIONS
SEDIMENT TOXICITY DATA: "TOXICITY"

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1. DATASET IDENTIFICATION

1.1 Title of Catalog document
MAIA-Estuaries Summary Database
1997 and 1998 Stations
Sediment Toxicity Data

1.2 Authors of the Catalog entry
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1.3 Catalog revision date
April 30, 2000

1.4 Dataset name
TOXICITY

1.5 Task Group
MAIA Estuaries

1.6 Dataset identification code
006

1.7 Version
001

1.8 Request for Acknowledgment
EMAP requests that all individuals who download EMAP data acknowledge the source of these data in any reports, papers, or presentations. If you publish these data, please include a statement similar to: "Some or all of the data described in this article were produced by the U. S. Environmental Protection Agency through its Environmental Monitoring and Assessment Program (EMAP)".

2. INVESTIGATOR INFORMATION (for full addresses see Section 13)

2.1 Principal Investigators

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2.3 Sample Processing Investigators

3. DATASET ABSTRACT

3.1 Abstract of the Dataset

The TOXICITY data file reports three measures of sediment toxicity: a static ten-day test conducted using the amphipod *Ampelisca abdita*, a Microtox® assay performed on whole sediments, and a Microtox® assay performed on an organic extract of the sediment. One record is presented per sampling event. A record includes the results of the tests, and parameters indicating the statistical and biological significance of the results.

3.2 Keywords for the Dataset

Sediment toxicity, *Ampelisca abdita,* EC50 values, amphipod, Microtox®, whole sediments, interstitial pore water, biological significance

4. OBJECTIVES AND INTRODUCTION

4.1 Program Objective

The main objectives of the MAIA-Estuaries program are: (1) to evaluate the ecological condition of the Mid-Atlantic estuaries by measuring key properties of the water, sediment, and the community of organisms; (2) to focus attention on small estuaries in order to develop better monitoring approaches for these critical systems; and (3) to develop partnerships among federal and state environmental organizations.

The Environmental Monitoring and Assessment Program (EMAP) is an EPA research and monitoring program designed to provide unbiased assessments of the condition of selected resources over a wide region. A key feature of the program is a probabilistic sampling strategy that randomly selects sampling sites and assigns weighting factors based on area to all measured results. EMAP's strategy was adopted by the Mid-Atlantic Integrated Assessment (MAIA) program, which was designed to assess the conditions of the estuaries, forests, streams and lakes, and agricultural lands in the eight-state Mid-Atlantic region. This file contains data measured in MAIA estuaries during the Summers of 1997 and 1998. Samples were collected for water and sediment analyses primarily in 1997, with a few additional sites sampled in 1998. Fish samples were collected only in 1998. Several estuaries were designated as intensive sites and were sampled in greater detail (see STATIONS file).

The partners in MAIA-Estuaries program are: (1) The U.S. Environmental Protection Agency (USEPA), including both the Atlantic Ecology Division (AED) and the Gulf Ecology Division (GED); (2) National Park Service (NPS) under their project "Maryland Coastal Bays Monitoring"; (3) National Oceanographic and Atmospheric Administration (NOAA) which conducted sampling both in the Delaware Bay (DB) under their "National Status and Trends Program" and in the Carolinian Province (CP); and (4) The Chesapeake Bay Program (CBP), which is a consortium of federal, state, and local governments and nongovernmental organizations. Each partner was responsible for collecting, processing, and reviewing data. The USEPA Atlantic Ecology Division was responsible for final assembly and review of all data. Laboratories contracted to process samples are specified by the parameter LABCODE included in all data files (Section 4.4). Details regarding use of partner and LABCODE information are presented in the EVENTS metadata file.

4.2 Dataset Objective

The purpose of the TOXICITY data file is to report the results and biological significance of three sediment toxicity tests performed on sediment samples: the *Ampelisca* mortality assay, the Microtox® assay performed on whole sediments, and the Microtox® assay performed on organic extracts of sediments.

4.3 Background Discussion

The amphipod survival test is commonly used in North America to assess sediment quality. The test is simple in concept – amphipods are added to relatively unaltered sediment, and their survival rate is used as an indicator of sediment toxicity. *Ampelisca abdita* is used as the test organism because it is an ecologically important species in coastal waters and it is native to a wide range of waters along the U.S. eastern seaboard, along the eastern Gulf of Mexico, and along portions of the Californian coast. The amphipod survival test assesses the integrated effect of complex mixtures of compounds, but does not identify which compound or class of compounds may be the toxic agent. Ammonia in the porewater of the sediments can interfere with the assay; therefore the procedure calls for monitoring the ammonia concentration in the test sample and removal by flushing if above a threshold value. While some researchers hold that ammonia is an environmental toxin that should be monitored, the procedure used here precludes this approach in this data set.

The Microtox® test uses the bioluminescent bacterium *Vibrio fischeri* to assess the toxicity of sediments. Toxic exposure impairs respiration in the bacterium and results in inhibition of the bioluminescence. The results of two Microtox® tests are reported here, one performed on whole sediments and the other on organic extracts of the sediments. The tests are simple, fast, reproducible and inexpensive, and there is a wide range of published data regarding Microtox® response to specific compounds (Johnson and Long, 1998). The organic extraction procedure favors the extraction of neutral, non-ionic organic compounds such as aromatic and chlorinated hydrocarbons, but is less suited for other classes of toxicants such as metals and polar organic compounds.

The intention of sediment assays is to measure the toxicity of the sediments. The different tests are not necessarily expected to yield similar measures of toxicity on a sediment sample, as each test may respond to a different class of toxic compounds.

4.4 Summary of Dataset Parameters

*STATION	Station name
*EVNTDATE	Event date
SRVPCCON	Results of the *Ampelisca* test; survival rate of amphipod, expressed as percent of control survival. Smaller values indicate higher toxicity.
SRVPC_SG	Statistical significance of the amphipod test: Y if the p-value # 0.05, N if other.

4.4 Summary of Dataset Parameters, continued

ATOX_SIG	Biological significance of the amphipod test: Y if toxic, N if non-toxic. A sediment is classified toxic if amphipod survival in the test-sediment is less than 80% of the survival in the control-sediment, and the test values are statistically valid (p-value # 0.05).
EC50_MC	Results of the whole-sediment Microtox® test, reported as the concentration of sediment in solution (mass of dry sediments divided by mass of solution, expressed as a percent) which results in 50% mortality of the test organisms. Smaller values indicate higher toxicity.
MTOX_SIG	Biological significance of the Microtox® test (whole sediment test): Y if toxic, N if non-toxic. Sediments with a silt fraction $ 20% are classified as toxic if EC50_MC is # 0.2%, while sediments with a silt fraction <20% are toxic if EC50_MC is # 0.5% (see Section 5.2.2).
OE_EC50	Results of the Microtox® test performed on organic extracts of sediments, reported in units of (mg equivalent of wet sediment / mL organic extract). Smaller values indicate higher toxicity.
OE_SRI	Sediment Reference Index (organic extract Microtox® test); the ratio of OE_EC50 in the field sample to that in the reference sediment.
OE_SIG	Biological significance of the Microtox® test (organic extract test): Y if toxic, N if non-toxic. As is reported here, a sample is toxic when OE_SRI is > 1.
LABCODE	A code identifying data blocks grouped according to processing contract
	TOX-1 AED contract
	TOX-2 NOAA (Carolinian Province) contract
	TOC-4 NOAA (Delaware Bay) contract
	TOX-5 GED contract
QACODE	Quality assurance/quality control codes
	<blank> No qualification
	TOX-A EC50_MC is reported as maximum value possible; sample is non-toxic
YEAR	Year of sample collection: 1997 or 1998

* denotes parameters that should be used as key fields when merging data files

5. DATA ACQUISITION AND PROCESSING METHODS

5.1 Data Acquisition / Field Sampling

The sample collection methods used by USEPA field crews are described here. Significant variations by other MAIA partners are noted in Section 5.1.12. Details regarding MAIA partners are reported in the EVENTS data file.

5.1.1 Sampling Objective

Sediment sub-samples were collected for the measurement of toxicity in the sediments. The sub-samples were prepared from a homogenate of the upper two-centimeters of sediment grabs. The remaining portions of the grabs were used for grain size and chemical analyses.

5.1.2 Sample Collection: Methods Summary

Multiple sediment grabs were collected from each site using a Young-modified Van Veen grab sampler. The primary purpose of these grabs was to characterize the chemical and toxicological properties of the sediment. Each grab was nominally 440 cm^2 in area and up to 10 cm in depth, but only the top two centimeters of a grab were retained for the analyses described here. A sufficient number of grabs were processed to provide three liters of sediment. The sediment composite was homogenized and separated into two fractions for storage until analysis. One

fraction was frozen and used in the measurement of total organic carbon (TOC) and chemical contaminants. The second fraction was stored at 4° C in the dark, and was used for grain-size and toxicity analyses.

5.1.3 Beginning Sampling Dates
8 July 1997
13 July 1998

5.1.4 Ending Sampling Dates
8 October 1997
8 October 1998

5.1.5 Sampling Platform
Samples were collected from gasoline or diesel powered boats, 18 to 133 feet in length.

5.1.6 Sampling Equipment
A 1/25 m2, stainless steel (coated with Kynar), Young-modified Van Veen grab sampler was used to collect sediments.

5.1.7 Manufacturer of Sampling Equipment
Young's Welding, Sandwich, MA

5.1.8 Key Variables
Not applicable

5.1.9 Sample Collection: Methods Calibration
The sampling gear does not require calibration, although it was inspected regularly for damage by mishandling or impact on rocky substrates.

5.1.10 Sample Collection: Quality Control
Care was taken to minimize disturbance to the sediment grabs. Grabs that were incomplete, slumped, less than 7 cm in depth, or comprised chiefly of shelly substrates were discarded. The chance of sampling the same location was minimized by repositioning the boat five meters downstream after three sampling attempts.

5.1.11 Sample Collection: References
Strobel, C.J. 1998. Environmental Monitoring and Assessment Program - Mid-Atlantic Integrated Assessment. Estuaries Component, Field Operations and Safety Manual. U.S. EPA, Office of Research and Development, NHEERL-AED, Narragansett, RI. July, 1998.

Hyland, J.L., Balthis, L., Hackney, C.T., McRae, G., Ringwood, A.H., Snoots, T.R., Van Dolah, R.F., and Wade, T.L. 1998. Environmental quality of estuaries of the Carolinian Province: 1995. Annual statistical summary for the 1995 EMAP-Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 123 NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD.

5.1.12 Sample Collection: Alternate Methods
Not applicable

5.2 Data Preparation and Sample Processing
The processing methods used by USEPA contracts will be described here (LABCODE = TOX-1). Any significant variations by other MAIA partners are noted in Section 5.2.6.

5.2.1 Sample Processing Objective

Determine the toxicity of sediment samples using a 10-day *Ampelisca abdita* mortality assay and Microtox® assays performed on whole sediments or organic extracts of the sediments.

5.2.2 Sample Processing: Methods Summary

In the 10-day *Ampelisca abdita* assay, amphipods were exposed to sediments for 10 days under static conditions following EMAP procedures (EPA 1994, 1995). Sediment samples were stored in the dark at 4 °C prior to analysis. Control sediments were obtained from a clean site in Long Island Sound. Each sediment sample was passed through a 1 mm mesh to remove resident organisms, debris, *etc.*, and was stirred to homogenize. A batch of ten field samples was run with a control sample. Five replicates were analyzed for each sample. For each, 200 mL of sediment were placed in a glass container and covered with 600 mL of clean, filtered water (maintained at 20 °C, a salinity of 30ppt, and aerated to maintain a dissolved oxygen concentration >60% of saturation). Total ammonia concentration was measured colorimetrically on filtered pore water taken from a sixth replicate. For ammonia concentrations greater than 20 mg/L, the sediment was flushed until ammonia levels fell below 20 mg/L. Twenty juvenile amphipods (between 0.7 and 1.5 mm in length) were added to each test chamber for a ten-day exposure. The surviving amphipods were counted, and the results reported as the average number of amphipods surviving in the sample tests divided by the number of amphipods surviving in the control sediment, expressed as a percent. Lower values of this result indicate higher toxicity. The result was considered to be statistically significant if sample and control values were distinct with a p-value # 0.05 in a one-tailed t-test. The assay was taken to indicate toxicity if the survival rate was less than 80% of the control and the test was statistically significant.

Whole-sediment Microtox® assays were conducted in duplicate following the "large sample size" protocol of Microbics Corporation (1992). For each test and control, 7 g of sediment sample were diluted with autoclaved seawater to prepare a series of 13 solutions ranging in concentration from 19.7% to 0.005%. The concentrations were 'moisture-corrected' to reflect the weight of dry sediment, and are reported with units: mass of dry sediment per mass of solution, expressed as a percent. Luminescent bacteria (*Vibrio fischeri*) were incubated in each suspension for 20 minutes, the suspension was filtered, and the post-exposure luminescence in each of the filtrates was measured on a Microtox® Model 500 Analyzer. A log-linear regression model was used to determine an EC50_MC — the sediment concentration that reduced light production by 50% relative to a control (a nontoxic reagent blank). Lower values of EC50_MC indicate higher toxicity. Sediment grain-size can affect EC50_MC values, *e.g.*, fine-grained sediments absorb bacteria, thereby diminishing light production independently of any true change of toxicity (Ringwood, *et al.*, 1997). Therefore, the MAIA program uses two toxicity thresholds depending on sediment grain-size and EC50_MC levels. Sediments with a silt fraction $ 20% are classified as toxic if EC50_MC is # 0.2%, while sediments with a silt fraction <20% are toxic if EC50_MC is # 0.5%. The grain-size data are reported in the SEDGRAIN file.

The organic-extract Microtox® assay is an exploratory test (Johnson and Long, 1998) in the MAIA program. Sediment samples were screened to remove debris, and excess water was decanted and discarded. Each sample was homogenized and 10 g of the sediment (wet weight) were dried with anhydrous sodium sulfate and extracted by sonication with dichloromethane (DCM). The extract was carefully evaporated and concentrated under a flow of nitrogen, exchanged into a mixture of dimethylsulfoxide (DMSO), toluene and isopropyl alcohol (2:1:1), and brought to a final volume of 1 mL (the equivalent of 10 g of sediment, wet-weight). The extract was diluted 1:10 with DMSO to prepare the dilution series which was analyzed as described above to determine an OE_EC50 value. DMSO is non-toxic toward *Vibrio fischeri*. No color correction or removal of dissolved sulfur compounds were performed. The OE_EC50 value is expressed in units: mg equivalent wet sediment / mL DMSO, or mg eq / mL. Lower

values indicate greater toxicity. A control sample (clean sediment from Redfish Bay, Texas) was processed with each batch of samples. A Sediment Reference Index (SRI) was calculated as the ratio of the OE_EC50 values measured for the field and reference sediments. In this file, sediments were classified as toxic if the SRI was greater than one (the user may wish to use different threshold values).

5.2.3 Sample Processing: Methods Calibration

Not applicable

5.2.4 Sample Processing: Quality Control

Positive controls for the amphipod assays were performed as follows. Representative amphipods were routinely tested for response by determining the EC50 concentration of the reference toxicant sodium dodecyl sulfate (SDS). The amphipods were considered viable if the measured EC50 fell within the 95% confidence interval of previous QC checks. Each batch of assays was also accompanied by a negative control assay, which was identical to the routine procedures but the amphipods were exposed to sediments that were certified as clean. Five replicates were included in the control run. Batch results were accepted if the mean survival was equal to or greater than 85% and survival in the individual replicate chambers was not less than 80% (ASTM 1993). The Microtox® assays were run with the reference toxicant with each new batch of bacteria. These tests provided measures of the general quality of the bacterial populations and certifies the ability of the laboratory to produce results consistent with the expected toxicity range (*i.e.*, Microtox® EC50 values for the reference toxicant SDS were typically range 13-26 mg/L).

5.2.5 Sample Processing: References

American Society for Testing and Materials (ASTM). 1993. Guide for conducting 10-day static sediment toxicity tests with marine and estuarine amphipods. ASTM Standard Method E-1367-92, ASTM, Philadelphia, PA. 24p.

Johnson, B.T. and E.R. Long. 1998. Rapid toxicity assessment of sediment from estuarine ecosystems: a new tandem *in vitro* testing approach. Environmental Toxicology and Chemistry, 17(6): 1099-1106.

Microbics Corporation. 1992. Microtox® Update Manual, 129p. Carlsbad, CA.

Ringwood, A.H., M.E. DeLorenzo, P.E. Ross, and A.F. Holland. 1997. Interpretation of Microtox® solid-phase toxicity tests: the effects of sediment composition. Environmental Toxicology and Chemistry, 16(6): 1135-1140.

U.S. EPA. 1994. Methods for Assessing the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods. Narragansett, RI: U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/R-94/025.

U.S. EPA. 1995. Environmental Monitoring and Assessment Program (EMAP): Manual-Estuaries, Volume 1: Biological and Physical Analyses. Narragansett, RI: U.S. Environmental Protection Agency, Office of Research and Development, EPA/620/R-95/008.

5.2.6 Sample Processing: Alternate Methods

Total ammonia and un-ionized ammonia values were not reported for records indicated with LABCODE = TOX-2. However, the values were measured and used as process criteria in the amphipod survival test (Section 5.2.2).

6. DATA ANALYSIS AND MANIPULATIONS

6.1 Name of New or Modified Values
Not applicable

6.2 Data Manipulation: Description
SRVPCCON (survival as percent of control; result for amphipod survival assay) was calculated as the average number of amphipods surviving in the five replicate sample tests divided by the number of amphipods surviving in the control sediment, expressed as a percent.

SRVPC_P (statistical significance of amphipod survival result) is reported as 'Y' if SRVPCCON is statistically significant as indicated by a p-value less than 0.05 in a one-tailed t test, and 'N' if otherwise.

ATOX_SIG (biological significance of amphipod survival result) is reported as 'Y' if SRVPCCON is less than 80% and SRVPC_P is 'Y'; otherwise ATOX_SIG is reported as 'N'.

EC50_MC (result for whole-sediment Microtox® assay); sediment concentration that reduces light production by 50% relative to a control. The values have been moisture-corrected and are reported with units: percent dry-weight sediment in solution.

MTOX_SIG (biological significance of whole-sediment Microtox® result) is reported as 'Y' if silt fraction $ 20% and EC50_MC # 0.2%, or silt fraction <20% and EC50_MC # 0.5%. Otherwise, MTOX_SIG is reported as 'N'. The silt-fraction values are contained in the SEDGRAIN file.

OE_EC50 (result for organic-extract Microtox® assay); the equivalent wet-weight sediment concentration represented by the extract that reduces light production by 50% relative to a control. The units are: mg equivalent sediment wet weight / mL solvent, or mg eq / mL.

OE_SRI (Sediment Reference Index – organic-extract Microtox® assay); the value of OE_EC50 measured for sediments divided by the value measured for reference material. Values greater than one were labeled toxic by the partner agency performing the test.

OE_SIG Biological significance of the Microtox® assay (organic-extract): Y if toxic, N if non-toxic. A sample is toxic when OE_SRI is > 1.

7. DATA DESCRIPTION

7.1 Description of Parameters

7.1.1 Components of the Dataset

VARIABLE	TYPE	LEN	LABEL
STATION	Char	10	Station Name
EVNTDATE	Num	8	Event Date
SRVPCCON	Num	8	Ampelisca Survival as % of Control
SRVPC_SG	Num	8	Statistical significance of SRVPCCON
ATOX_SIG	Char	1	Biological significance of SRVPCCON
EC50_MC	Num	8	Moisture-corrected mean EC50 (%); whole sediment Microtox®
MTOX_SIG	Char	1	Biological significance of EC50_MC
OE_EC50	Num	8	EC50 (mg eq / mL); organic extract Microtox®

7.1.1 Components of the Dataset, continued

VARIABLE	TYPE	LEN	LABEL
OE_SRI	Num	8	Sediment Reference Index
OE_SIG	Char	1	Biological significance of OE_EC50
LABCODE	Char	5	Contract/Lab Identifier
QACODE	Char	5	QA Code
YEAR	Num	4	Year of sampling

7.1.2 Precision of Reported Values

The values are reliable to no more than three significant digits; however more significant digits may be reported in the dataset because of formatting restrictions.

PARAMETER	PRECISION	MIN	MAX	UNITS
SRVPCCON	0.1	0.0	115	%
EC50_MC	0.01	0.01	23.1	%
OE_EC50	0.01	0.28	273	mg eq/mL
OE_SRI	0.1	0.4	368	-

7.1.3 Minimum Value in Dataset

See Section 7.1.2

7.1.4 Maximum Value in Dataset

See Section 7.1.2

7.2 Data Record Example

7.2.1 Column Names for Example Records

STATION	EVNTDATE	SRVPCCON	SRVPC_SG	ATOX_SIG	EC50_MC	MTOX_SIG
OE_EC50	OE_SRI	OE_SIG	LABCODE	QACODE	YEAR	

7.2.2 Examples of Data Records

STATION	EVNTDATE	SRVPCCON	SRVPC_SG	ATOX_SIG	EC50_MC	MTOX_SIG
MA97-0001	8/25/97	91.1	N	N	0.92	N
MA97-0091	8/30/97	90.7	Y	N	2.72	N
MA97-0493	9/15/97	64.0	Y	Y	0.84	N

OE_EC50	OE_SRI	OE_SIG	LABCODE	QACODE	YEAR
			TOX-1	TOX-A	1997
			TOX-1		1997
2.43	43.0	Y	TOX-4		1997

8. GEOGRAPHIC AND SPATIAL INFORMATION

8.1 Minimum Longitude (Westernmost)

-77.4339 decimal degrees

8.2 Maximum Longitude (Easternmost)
-74.7230 decimal degrees

8.3 Minimum Latitude (Southernmost)
34.9670 decimal degrees

8.4 Maximum Latitude (Northernmost)
40.1470 decimal degrees

8.5 Name of Region
MAIA estuary region, consisting of Delaware Bay, Chesapeake Bay, the Delmarva coastal bays, Albemarle-Pamlico Sound, and contiguous estuaries.

9. QUALITY CONTROL AND QUALITY ASSURANCE

9.1 Measurement Quality Objectives
The measurement quality objectives of the EMAP-Estuaries program do not specify accuracy or precision requirements for toxicity measurements (see Valente and Strobel, 1993).

9.2 Data Quality Assurance Procedures
QA procedures include running blanks, spiked samples, and standard reference materials with each batch of samples. See Section 5.2.4 for discussion of these tests

9.3 Actual Measurement Quality
All of the data reported in this data file met the QA specifications listed in Section 5.2.4.

10. DATA ACCESS

10.1 Data Access Procedures
Data can be downloaded from the web

10.2 Data Access Restrictions
None

10.3 Data Access Contact Persons
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10.4 Dataset Format
ASCII (CSV) and SAS Export files.

10.5 Information Concerning Anonymous FTP
Not available

10.6 Information Concerning WWW
See Section 10.1 for WWW access

10.7 EMAP CD-ROM Containing the Dataset
Data not available on CD-ROM

11. REFERENCES

Holland, A.F., ed. 1990. Near Coastal Program Plan for 1990: Estuaries. EPA 600/4-90/033. U.S. EPA, Office of Research and Development, NHEERL-AED, Narragansett, RI. November 1990.

Kokkinakis, S.A., Hyland, J.L., and Robertson, A. 1994. Carolinian Demonstration Project - 1994 Field Operations Manual. Joint National Status and Trends/Environmental Monitoring and Assessment Program. NOAA/NOS/ORCA, Silver Spring, MD.

Plumb, R.H. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. Prepared for the U.S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredge and Fill Material. Published by Environmental Laboratory, U.S. Army Waterways Experiment Station, Vicksburg, MS. Technical Report EPA/CE-81-1.

Strobel, C.J. 1998. Environmental Monitoring and Assessment Program - Mid-Atlantic Integrated Assessment. Estuaries Component, Field Operations and Safety Manual. U.S. EPA, Office of Research and Development, NHEERL-AED, Narragansett, RI. Forthcoming.

Texas A & M University, Geochemical and Environmental Research Group. 1990. NOAA Status and Trends, Mussel Watch Program, Analytical Methods. Submitted to NOAA. Rockville (MD): U.S. Dept. of Commerce, National Oceanic & Atmospheric Administration, Ocean Assessment Division.

U.S. EPA. 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual-Estuaries, Volume 1: Biological and Physical Analyses. U.S. Environmental Protection Agency, Office of Research and Development, Narragansett, RI. EPA/620/R-95/008.

Valente, R. and Strobel, C.J. 1993. Environmental Monitoring and Assessment Program- Estuaries: 1993 Virginian Province Quality Assurance Project Plan. U.S. EPA,NHEERL-AED, Narragansett, RI. May 1993

12. TABLE OF ACRONYMS

AED	Atlantic Ecology Division
C	Degrees Celsius
CP	Carolinian Province
CBP	Chesapeake Bay Program
DB	Delaware Bay
DCM	Dichloromethane
DMSO	Dimethylsulfoxide
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
GED	Gulf Ecology Division
GERG	Geochemical and Environmental Research Group
MAIA	Mid-Atlantic Integrated Assessment
mg	Milligram
mg/L	Milligrams per liter
mL	Milliliter
NHEERL	National Health and Environmental Effects Research Laboratory

NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
ODU	Old Dominion University
QA/QC	Quality Assurance/Quality Control
TOC	Total Organic Carbon
TAMU	Texas A&M University
USEPA	United States Environmental Protection Agency
VER	Versar, Inc.
WWW	World Wide Web

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