CATALOG DOCUMENTATION
EMAP-ESTUARIES PROVINCE LEVEL DATABASE
LOUISIANIAN PROVINCE 1991-1994
WATER QUALITY VERTICAL PROFILE DATA

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1. DATA SET IDENTIFICATION

1.1 Title

EMAP-Estuaries Program Level Database
Louisianian Province
Water Quality Vertical Profile Data Summarized by Station

1.2 Catalog Author

Virginia Engle, U.S. Environmental Protection Agency - NHEERL/GED
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Tom Heitmuller, U.S. Geological Survey - BRD/GBPO

1.3 Catalog Revision Date

March 4, 1999

1.4 Data File Name

VP_WATR

1.5 Task Group

ESTUARIES

1.6 Data set identification code

00043, 00083, 00123, 00163

1.7 Version number for a data set

001

1.8 Requested acknowledgment

If you plan to publish these data in any way, EPA requires a standard statement for work is has supported:

"Although the data described in this article have been funded wholly or in part by the U.S. Environmental Protection Agency through its EMAP Estuaries Program, it has not been subjected to Agency review, and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred."

2. INVESTIGATOR INFORMATION

2.1 Principal Investigator

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2.2 Sample Collection Investigator

John M. Macauley
U.S. Environmental Protection Agency
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2.3 Sample Processing Investigator

Tom Heitmuller
U.S. Geological Survey
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2.4 Data Analysis Investigator

Virginia D. Engle
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NHEERL - GED

2.5 Additional Investigators

N/A

3. DATA SET ABSTRACT

3.1 Abstract of the Data Set

The Water Quality Vertical Profile data file is a summary of the physio-chemical properties of the water at a station at the time of sampling. A Hydrolab Surveyor II or it's replacement model, the H20, was used to record water quality parameters at regular intervals from the surface to the bottom of the water column. Salinity, temperature, pH, and dissolved oxygen were reported for each site. Light transmission was also measured by secchi depth and as percent of ambient light reaching a given depth.

3.2 Keywords for the Data file

Water quality, hydrographic data, salinity, dissolved oxygen, temperature

4. OBJECTIVES AND INTRODUCTION

4.1 Program Objective

The Environmental Monitoring and Assessment Program (EMAP) was designed to periodically estimate the status and trends of the Nation's ecological resources on a regional basis. EMAP provides a strategy to identify and bound the extent, magnitude and location of environmental degradation and improvement on a regional scale based on randomly located station sites. Only the randomly located Base Sampling Sites were included in this data set.

4.2 Data Set Objective

The objective of the Vertical Profile data set is to provide summary data of specific water column parameters at each station visited. These data may be used to characterize water quality parameters in the estuaries of the Louisianian Province.

4.3 Data Set Background Information

Habitat indicators provide important information about the environmental setting of a sample site. Salinity and temperature are among the most important factors controlling the distribution of biota and ecological processes in estuaries. Although water temperature is relatively stable during the summer sampling season in the Louisianian Province, salinity may vary widely both temporally and spatially. Salinity has a great impact on the community composition and diversity of benthic invertebrates. The magnitude of the difference between surface salinity and bottom salinity at a site can be used to determine whether or not an estuary is stratified. Salinity stratification often occurs when layers of water of differing salinities are prevented from mixing. This condition may lead to the depletion of dissolved oxygen from the bottom water layer which can have deleterious effects on the biota.

Dissolved oxygen (DO) concentration, an EMAP-E abiotic condition indicator, is a parameter of overwhelming importance to assessment endpoints and is one of the most important factors contributing to fish and shellfish mortality in estuarine and coastal waters. DO concentration is also a link in the eutrophication process, making it a critical component of the EMAP-E conceptual mode. Stresses that occur in conjunction with low DO (e.g., exposure to hydrogen sulfide) may cause as much, if not more, harm to aquatic biota than exposure to low DO alone. In addition, aquatic populations exposed to low DO may be more susceptible to the adverse effects of other stressors (e.g., disease, toxic chemicals).

Light transmission is a human use indicator of water clarity. The amount of light (photosynthetically active radiation or the intensity of light in the range of wavelengths used by algae in photosynthesis) being transmitted into the water column is also an important indicator of how much light is available to algae and submerged aquatic vegetation for primary production.

4.4 Summary of Data Set Parameters

Surface and bottom water quality parameters are reported as average values of two vertical profiles taken at a station. These include: temperature, salinity, dissolved oxygen concentration, pH, depth, light transmission, secchi depth, and photosynthetically active radiation (PAR). The average rate of light extinction was also calculated.

Surface and bottom water quality measurements were taken using probes attached to a Hydrolab Surveyor II/H20. Light was measured with a LICOR LI-1000 irradiometer and a secchi disk. Measurements were taken from within 0.1 meter of the surface of the water to within 0.2 meter of the bottom.

4.5 Year-Specific Information about Data

There were no differences among the sampling years, 1991-1994.

5. METHODS

5.1 Data Acquisition

5.1.1 Sampling Objective

To collect high-quality vertical water column profiles of salinity, temperature, dissolved oxygen concentration, pH and photosynthetically active radiation. One Surveyor cast and one LICOR cast were performed on each visit to EMAP sampling stations to collect these data. Measurements were reported as average values by depth from two profiles: one from the surface to the bottom and a second from the bottom back to the surface.

5.1.2 Sample Collection Methods Summary

The first activity performed at a station was to obtain a vertical profile of the water column using the Hydrolab

Surveyor II/H20 to measure salinity, temperature, dissolved oxygen concentration, pH, and bottom depth. A water column profile of PAR (a measurement of the intensity of light in the range of wavelengths used by algae in photosynthesis) was also taken using a Licor LI-1000 irradiometer. Measurements were recorded on field data sheets once for every meter depth from the surface (0.1 m depth) to within 0.2 meters of the bottom and, again, for every meter depth on the return from the bottom to the surface. Secchi depth was measured as the depth at which the secchi disk disappears, then reappears from view.

5.1.3 Beginning Sampling Date

09 July 1991
08 July 1992
06 July 1993
06 July 1994

5.1.4 Ending Sampling Date

10 September 1991
11 September 1992
19 August 1993
15 September 1994

5.1.5 Sampling Platform

Each team was supplied with a 25-foot SeaArk work boat equipped with a 7.5 L gas engine fitted with a Bravo outdrive, an "A" frame boom assembly and hydraulic winch. On-board electronics consist of: a Loran C unit, GPS (beginning in 1993), radar unit, 2 VHF radios, cellular phone, compass, a depth finder, a tool kit, and all required and suggested safety equipment. One completely outfitted spare boat was stored at the Field Operations Center (EPA Lab) as backup.

5.1.6 Sampling Equipment

A Hydrolab Surveyor II/H20 was used to measure salinity, temperature, dissolved oxygen concentration pH and bottom depth. A water column profile of PAR was also taken using a Licor LI-1000 radiometer. A standard secchi disk was used to measure secchi depth.

The Hydrolab Surveyor II/H20 unit is a self-contained array of instruments capable of measuring all the parameters mentioned above. The unit consists of a sonde that can be lowered through the water column by a cable which is attached to a digital display. The entire array runs off an external battery pack attached to the digital display. Measurements were taken and recorded at the surface (depth=0.1m) and at 1.0 m increments through 10.0 m of depth and at 5.0 m increments for depths > 10.0 m. In addition, a bottom measurement (approx. 0.2 m from bottom) was recorded.

Light measurements were recorded using a submersible light sensor lowered through the water column via a cable attached to a display unit/datalogger. Underwater readings were recorded simultaneously with ambient light measured from a sensor (deck cell) located on the boat and cabled to the same display unit. Measurements were recorded for the same depth profile as the water quality measurements.

5.1.7 Manufacturer of Sampling Equipment

Hydrolab Corp.

5.1.8 Key Variables

5.1.9 Sampling Method Calibration

Each day, prior to sampling activities, a quality control (QC) check was performed on the Surveyor II/H20. This was performed at the dock, in a protected area, or on station depending on weather conditions. If the instrument failed the QC check it was recalibrated. The light meter and sensors cannot be calibrated in the field. They are calibrated and certified by the factory for service up to 2 years. If an instrument was suspect, it was replaced.

5.1.10 Sample Collection Quality Control

A Hydrolab Surveyor II/H20 was recalibrated prior to sampling activities when the following conditions occurred during the QC check:

5.1.10.1 The unit was allowed to equilibrate for 5 minutes. After equilibration, temperature was read and oxygen saturation for that temperature at sea level (760 mm Hg) was determined. If the displayed DO value was different from the standard value, the unit was adjusted to the correct value.

5.1.10.2 pH readings were checked with pH 7.0 and pH 10.0 standard buffers. If the displayed pH values did not match the standards, the unit was adjusted to the correct values.

5.1.10.3 Salinity was checked against a verified seawater standard. If the displayed salinity value was different from the standard value, the unit was adjusted to the correct value.

5.1.10.4 During calibration, if the depth reading was not "0", the unit was adjusted accordingly.

5.1.11 Sample Collection Method Reference

Macauley, J.M. 1991. Environmental Monitoring and Assessment Program-Near Coastal Louisianian Province: 1991 Monitoring Demonstration. Field Operations Manual. EPA/600/X-91/XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. 1992. Environmental Monitoring and Assessment Program: Louisianian Province:1992 Sampling: Field Operations Manual. EPA/ERL-GB No. SR-119. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. 1993. Environmental Monitoring and Assessment Program: Louisianian Province:1993 Sampling: Field Operations Manual. EPA/ERL-GB No. SR-XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. 1994. Environmental Monitoring and Assessment Program: Louisianian Province:1993 Sampling: Field Operations Manual. EPA/ERL-GB No. SR-XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

5.2 Data Preparation and Sample Processing

Sample processing methods not applicable for water quality vertical profile data.

5.2.1 Data Preparation Objective

N/A

5.2.2 Data Processing Methods Summary

N/A

5.2.3 Sampling Processing Method Calibration

N/A

5.2.4 Sample Processing Quality Control

N/A

5.2.5 Sample Processing Method Reference

N/A

5.2.6 Sample Processing Method Deviations

None

6. DATA MANIPULATIONS

6.1 Name of New or Modified Values

AVG_K TRNS_1MT

6.2 Data Manipulation Description

6.2.1 Average rate of light extinction

AVG_K represents the average rate of light extinction for Photosynthetically Active Radiation (PAR). At each station location, a vertical profile taken by a LICOR LI-1000 irradiometer provides measurements of photosynthetically active radiation (PAR) and depth. The decrease in the amount of light is correlated with the increase in depth. K is calculated as -1 * ln(PAR) at each depth. AVG_K is the average K over all depths for which K was calculated.

6.2.2 Transmissivity value measured at 1 meter

TRNS_1MT represents the TRaNSmissivity value (%) measured at one (1) MeTer below the surface of the water column. In non-turbid waters, the selective absorption of certain wavelengths of light is the primary cause of the decrease in the intensity of transmitted light. Radiant energy is lost in turbid solutions primarily by absorption, while incident light loss can be related to the concentration of suspended material which causes scattering of light. The distance over which light is lost is affected by the absorption and scattering of light. Transmissivity is the percent of ambient light transmitted through the water column. At each station location, the photosynthetically active radiation (PAR) was measured one meter below the surface of the water column using a Licor LI-1000 irradiometer with the instrument light sensor immersed in 1 meter of water. PAR represents the actual amount of light in micro-Einsteins/sec/m2 reaching 1 meter below the surface. Underwater readings were recorded simultaneously with ambient light measured from a sensor (deck cell) located on the boat. Transmissivity (%) equals the ratio of underwater light to ambient light as a percent. The transmissivity at 1 meter depth was used as an indicator of water clarity where TRNS_1MT=10% was equivalent to being unable to see your hand in front of your face and TRNS_1MT=25% was equivalent to being unable to see your feet in waist-deep water.

6.3 Data Manipulation Examples

6.4 Data Manipulation Computer Code File

6.5 Data Manipulation Computer Code Language

6.6 Data Manipulation Computer Code

7. DATA DESCRIPTION

7.1 Description of Parameters

7.1.1 Parameter Name

Field Name	Data Type	Max Field Len	Format	Field Label
STA_NAME	Char	8	$8.	The Station Identifier
AVG_K	Num	8	7.2	Average Rate of Light Extinction
BTM_DO	Num	8	5.1	Dissolved Oxygen (mg/L) at Bottom
BTM_PAR	Num	8	5.	PAR (mE/m2/s) at Bottom
BTM_PH	Num	8	5.1	pH (units) at Bottom
BTM_SAL	Num	8	5.2	Salinity (ppt) at Bottom
BTM_TEMP	Num	8	5.2	Temperature at Bottom
BTM_TRNS	Num	8	4.	Transmissivity (%) at Bottom
QA_CODE	Char	30	$30	Quality Assurance Code for Data
SECCHI	Num	8	5.2	Secchi Depth (m)
SRF_DO	Num	8	5.1	Dissolved Oxygen (mg/L) at Surface
SRF_PAR	Num	8	5.	PAR (mE/m2/s) at Surface
SRF_PH	Num	8	5.1	pH (units) at Surface
SRF_SAL	Num	8	5.2	Salinity (ppt) at Surface
SRF_TEMP	Num	8	5.2	Temperature at Surface
SRF_TRNS	Num	8	4.	Transmissivity (%) at Surface
TRNS_1MT	Num	8	4.	Transmissivity (%) at 1 meter depth
VP_NAME	Char	80	$80	Full file specification of profile data
VST_DATE	Num	8	YYMMDD6	Date the Sample was Collected

7.1.6 Precision to which values are reported

The number of decimal places for each value reflects the precision of the probe.

7.1.7 Minimum Value in Data Set by Parameter

1991
1992
1993
1994

SRF_SAL
0
0
0
0

SRF_TEMP
27.75
25.95
27.00
24.70

SRF_DO
4.4
3.4
4.8
3.4

SRF_PH
5.6
6.3
5.2
6.3

SRF_PAR
32
70
11
18

SRF_TRNS
11
27
24
2

TRNS_1MT
0
0
0
0

BTM_SAL
0
0
0
0

BTM_TEMP
26.85
24.40
24.50
24.60

BTM_DO
0.1
0.0
0.1
0.2

BTM_PAR
-4
0
0
-227

BTM_TRNS
0
0
0
0

BTM_PH
5.2
6.2
6.4
6.7

AVG_K
0.41
0.65
0.11
0.50

SECCHI
0.20
0
0
0

7.1.7 Maximum Value in Data Set by Parameter

1991
1992
1993
1994

SRF_SAL
37.35
35.50
36.45
36.60

SRF_TEMP
33.35
32.70
34.00
31.95

SRF_DO
14.8
14.1
12.9
10.1

SRF_PH
9.4
9.4
9.2
8.9

SRF_PAR
1719
1714
1722
1870

SRF_TRNS
108
133
97
94

TRNS_1MT
86
56
62
62

BTM_SAL
40.38
37.55
36.60
36.70

BTM_TEMP
32.00
32.00
34.00
31.80

BTM_DO
11.3
10.0
12.8
9.2

BTM_PAR
884
728
1662
677

BTM_TRNS
52
45
89
46

BTM_PH
10.5
9.4
9.0
8.9

AVG_K
12.45
8.45
4.14
6.25

SECCHI
3.50
4.50
3.00
3.50

7.2 Data Record Example

7.2.1 Column Names for Example Records

OBS SECCHI STA_NAME SRF_SAL SRF_TEMP SRF_DO SRF_PH SRF_PAR SRF_TRNS
BTM_SAL BTM_TEMP BTM_DO BTM_PAR BTM_TRNS BTM_PH AVG_K VP_NAME
QA_CODE SRF_FLR SRF_DENS BTM_FLR BTM_DENS MAX_FLR COMP_PAR K_PAR
SS_CONC TRNS_1MT VST_DATE

7.2.2 Example Data Records

OBS	STA_NAME	SRF_SAL	SRF_TEMP	SRF_DO	SRF_PH	SRF_PAR	SRF_TRNS	TRNS_1MT	BTM_SAL
1	LA91LR01	26.75	28.80	6.4	7.8	939	76	25	28.10
2	LA91LR02	33.20	29.65	7.3	8.0	1595	94	75	33.15
3	LA91LR03	25.30	29.65	6.6	7.9	493	35	17	33.00
4	LA91LR05	21.40	28.60	7.0	8.2	696	69	46	34.10
5	LA91LR06	6.05	29.05	7.2	7.6	565	67	31	6.60

OBS	BTM_TEMP	BTM_DO	BTM_PAR	BTM_TRNS	BTM_PH	AVG_K	SECCHI	VST_DATE
1	28.50	6.3	142	11	7.8	1.74	2.50	910721
2	29.20	7.3	885	52	8.0	0.41	2.00	910721
3	28.90	5.2	21	1	7.8	3.23	2.90	910722
4	27.90	5.4	74	6	8.0	1.60	1.50	910818
5	28.80	7.0	84	10	7.5	2.12	1.50	910822

OBS	VP_NAME
1	\\HARPO\SASDATA\EMAP91\D1\FIELD\QC\HYDROPRO.DAT
2	\\HARPO\SASDATA\EMAP91\D1\FIELD\QC\HYDROPRO.DAT
3	\\HARPO\SASDATA\EMAP91\D1\FIELD\QC\HYDROPRO.DAT
4	\\HARPO\SASDATA\EMAP91\D1\FIELD\QC\HYDROPRO.DAT
5	\\HARPO\SASDATA\EMAP91\D1\FIELD\QC\HYDROPRO.DAT

OBS	QA_CODE
1	P-A
2	P-A
3	P-A
4	P-A
5	P-A

7.3 Related Data Sets

7.3.1 Related Data Set Name

7.3.2 Related Data Set Identification Code

8. GEOGRAPHIC AND SPATIAL INFORMATION

8.1 Minimum Longitude

-97 Degrees 27 Minutes 13.20 Decimal Seconds

8.2 Maximum Longitude

-82 Degrees 39 Minutes 28.20 Decimal Seconds

8.3 Maximum Latitude

30 Degrees 48 Minutes 30.00 Decimal Seconds

8.4 Minimum Latitude

26 Degrees 02 Minutes 55.80 Decimal Seconds

8.5 Name of the area or region

Louisianian Province - Coastal distribution of sampling is along the Gulf of Mexico from the Rio Grande, TX to Anclote Key, FL. States represented: Texas, Louisiana, Alabama, Mississippi, Florida

8.6 Direct Spatial Reference Method

Point

8.7 Horizontal Coordinate System Used

Universal Transverse Mercator

8.8 Resolution of Horizontal Coordinates

0.5

8.9 Units for Horizontal Coordinates

Meters

8.10 Vertical Coordinate System

N/A

8.11 Resolution of Vertical Coordinates

N/A

8.12 Units for Vertical Coordinates

N/A

9. QUALITY CONTROL / QUALITY ASSURANCE

9.1 Measurement Quality Objectives

Measurement quality objectives were outlined in the Quality Assurance Project Plan . Accuracy and precision goals are outlined below:

Data Type	Accuracy Goal	Maximum Precision Goal	Allowable Completeness Goal
DO	±0.5 mg/l	10 %	100 %
Salinity	±1.0 ppt	10 %	100 %
Depth	±0.5 m	10 %	100 %
pH	±0.2 units	NA	100 %
Temperature	±1.0 deg C	NA	100 %

9.2 Quality Assurance/Control Methods

Data from vertical profiles which did not meet the QA requirements were not included in this data file.

9.2.1 Hydrolab Surveyor II/H20 probes were calibrated each day prior to utilization in that days' field monitoring. The Surveyor's internal calibration values for DO, salinity, depth or pH were adjusted according to standard protocols (see section 4.1.5). If a Surveyor repeatedly failed the calibration QC check, it was replaced with another instrument before setting out into the field.

9.2.2 Occasionally, an individual probe failed to operate properly while the vertical profile was being taken. If this happened, the measurements that would have been taken for that probe at that station, were not recorded. In the data file, these measurements are represented by a missing value and a QA code as follows:

P-A = Profile acceptable
PH-X = pH not measured due to instrument failure
PL-X = neither pH nor light measured due to instrument failure
PS-X = neither pH nor salinity measured due to instrument failure
LT-X = light not measured due to instrument failure

9.3 Actual Measurement Quality

The field crew was required to calibrate each Hydrolab Surveyor II/H20 every day. If the instrument did not pass the calibration

QC then another instrument was to be used in its place and run through the same calibration check. The QA Officer, Louisianian Province Manager, and/or other designee(s) at the Base Operations Center would verify that a calibration QC had been completed for each Hydrolab Surveyor II/H20 prior to its use at a site and that the calibration met the criteria.

Occasionally, both the primary and backup instruments would not pass the QC calibration. When this situation occurred, a QA Code (QA_CODE) would be applied to any data retrieved from a Hydrolab Surveyor II/H20 that did not pass the calibration check.

10. DATA ACCESS

10.1 Data Access Procedures

A Data Request Package can be requested from a contact under Section 7.3. Data can be downloaded from the WWW site.

10.2 Data Access Restrictions

Data can only be accessed from the WWW site.

10.3 Data Access Contact Persons

Dr. J. Kevin Summers
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macauley.john@epa.gov (E-MAIL)

10.4 Data Set Format

Data can be transmitted in a variety of formats derived from SAS data files when a Data Request Form is submitted.

10.5 Information Concerning Anonymous FTP

Not accessible

10.6 Information Concerning World Wide Web

Data can be downloaded from the WWW

10.7 EMAP CD-ROM Containing the Data set

Data not available on CD-ROM.

11. REFERENCES

11.1 EMAP References

Heitmuller, P.T. and R. Valente. 1991. Environmental Monitoring and Assessment Program: EMAP-Estuaries Louisianian Province: 1991 quality assurance project plan. EPA/ERL-GB No. SR-120. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. 1991. Environmental Monitoring and Assessment Program-Near Coastal Louisianian Province: 1991 Monitoring Demonstration. Field Operations Manual. EPA/600/X-91/XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. and J.K. Summers. 1991. Environmental Monitoring and Assessment Program, Near Coastal - Louisianian Province: 1991 Field Reconnaissance Report - East Region. EPA/600/04-91/XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. and J.K. Summers. 1991. Environmental Monitoring and Assessment Program, Near Coastal - Louisianian Province: Field Training Manual - Crew Chiefs. EPA/600/05-91/XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Macauley, J.M. and J.K. Summers. 1991. Environmental Monitoring and Assessment Program, Near Coastal - Louisianian Province: Field Training Manual - Crews. EPA/600/05-91/XXX. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561.

Summers, J.K., J.M. Macauley and P.T. Heitmuller. 1991. Environmental Monitoring and Assessment Program. Implementation Plan for Monitoring the Estuarine Waters of the Louisianian Province - 1991 Demonstration. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561. EPA/600/5-91/228.

Summers, J.K., J.M. Macauley, J.M., P.T. Heitmuller, V.D. Engle, A.M. Adams and G.T. Brooks. 1992. Annual Statistical Summary: EMAP-Estuaries Louisianian Province - 1991. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32561. EPA/600/R-93/001.

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

11.2 Background References

Engle, V.D., J.K. Summers, G.R. Gaston. 1994. A Benthic Index of Environmental Condition of Gulf of Mexico Estuaries. Estuaries. 17:372-384.

Summers, J. Kevin, John F. Paul, Andrew Robertson. 1995. Monitoring The Ecological Condition Of Estuaries In The United States. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL 32651.

12. GLOSSARY AND TABLE OF ACRONYMS

12.1 Acronym used in the Detailed Documentation

12.2 Definition of Acronym

13. PERSONNEL INFORMATION

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