

# ***UMCES***

***UNIVERSITY OF MARYLAND CENTER for ENVIRONMENTAL SCIENCE***

***CHESAPEAKE BAY:  
WATER QUALITY MONITORING PROGRAM  
ECOSYSTEMS PROCESSES COMPONENT (EPC)***

***QUALITY ASSURANCE PLAN - FY2003***

***JULY 2002 - JUNE 2003***

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**A Program Supported by the  
Department of Natural Resources  
State of Maryland**

# Maryland Chesapeake Bay Water Quality Monitoring Program

## **Ecosystem Processes Component (EPC)**

Quality Assurance Project Plan for Water Quality  
Monitoring in Chesapeake Bay for FY 2003

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## ACRONYMS AND ABBREVIATIONS

BRIS	Broomes Island, Patuxent River monitoring station
BUVA	Buena Vista, Patuxent River monitoring station
CBL	Chesapeake Biological Laboratory
DGPS	Differential Global Positioning System
DIP (or $\text{PO}_4^{-3}$ )	Dissolved inorganic phosphorus
DNR	Department of Natural Resources
DO	Dissolved Oxygen
Eh	redox potential of sediment porewater
EPA	Environmental Protection Agency
EPC	Ecosystem Processes Component
ICES	International Council for the Exploration of the Sea
KCl	Potassium chloride
Kd	Water column light attenuation
m	meters
MDE	Maryland Department of the Environment, Annapolis, MD
MINI-SONE	abbreviated SONE measurements
MRPT	Marsh Point, Patuxent River monitoring station
mV	millivolts
NASL	Nutrient Analytical Services Laboratory
$\text{NH}_4^+$	Ammonium
NI	Not interpretable
NIST	National Institute of Standards and Technology
$\text{NO}_2^-$	Nitrite
$\text{NO}_2^- + \text{NO}_3^-$	Nitrite plus nitrate
NTU	nephelometric turbidity unit
ODU	Old Dominion University
PAR	Photosynthetically Active Radiation
PC	Particulate carbon
PI	Principal Investigator
PN	Particulate nitrogen
PP	Particulate phosphorus
$\text{PO}_4^{-3}$	Dissolved inorganic phosphorus
ppt	parts per thousand
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RFO	Research Fleet Operations
SAV	Submerged aquatic vegetation
SONE	Sediment Oxygen and Nutrient Exchanges
STLC	St. Leonard Creek, Patuxent River monitoring station
TSS	seston (total suspended solids)
TVS	total volatile solids
VIMS	Virginia Institute of Marine Science
YSI	Yellow Springs Instrument
VFX	Vertical Flux Array

# 1. INTRODUCTION

## 1.1 Project Description

During the middle decades of the twentieth century a considerable number of environmental measurements were made at a number of locations in Chesapeake Bay and its tributary rivers. Measurements included physical, chemical and limited biological variables and from these early measurements a considerable increase in understanding of estuarine physics, chemistry and biology was achieved. However, these measurements were not made in a consistent fashion and, as a result, were of limited utility in some applications. For example, dissolved nutrient measurements may have been made at a series of sites in the Patuxent River for a year or more and then efforts were relocated to a few sites in the mainstem bay. At some later time nutrient measurements were again made in the Patuxent but at different stations and at different times of the year using different sampling and analytical methodologies. A review of water quality measurements made in the Patuxent from the late 1930's until 1978 identified 44 separate studies, most of which were of too short a duration or at so limited a number of stations that detection of trends was not possible (Mihursky and Boynton, 1978). Similar problems were evident in other areas of the Bay and tributaries as well. Following completion of the first EPA Chesapeake Bay Program this serious limitation was clearly identified and a strong recommendation emerged to develop a long-term water quality monitoring program that would be capable of accurately assessing the current status of the Bay and be useful in detecting trends resulting from human activities. It was recognized that long-term measurements were needed to overcome the expected year-to-year variability due to climate variability and to ultimately assess changes due to both deleterious human activities and restoration efforts by management.

This Quality Assurance Project Plan (QAPP) describes the implementation of one component of the Maryland portion of the EPA Chesapeake Bay monitoring program described in *Chesapeake Bay: A Framework for Action* (EPA, 1983). This portion of the program is known as the "Ecosystem Processes Component (EPC). The EPC has focused monitoring efforts in three areas including: (1) measurements of sediment influences on water column water quality; (2) description of water quality in shallow water zones of tributary rivers; and (3) monitoring epiphytic growth on seagrass leaves. Details concerning objectives and methodologies used in the EPC are contained in this report.

## 1.2 Objectives

The Chesapeake Bay Water Quality Monitoring Program was initiated to provide guidelines for restoration, protection and future use of the mainstem estuary and its tributaries and to provide evaluations of implemented management actions directed towards alleviating some critical pollution problems. A description of the complete monitoring program is provided in Magnien *et al.* (1987) and the Chesapeake Bay program web page (<http://www.chesapeakebay.net> and <http://www.dnr.state.md.us/bay/monitoring/eco/index.html>). In addition to the EPC program portion, the monitoring program also has components that measure:

- Freshwater, nutrient and other pollutant input rates,
- chemical and physical properties of the water column,
- toxicant levels in sediments and organisms,
- phytoplankton and zooplankton community characteristics (abundances, biomass and primary production rates) and
- benthic community characteristics (abundances and biomass).

While early work of the EPC focused primarily on the importance of fluxes across the sediment-water interface and the dynamics of these interactions, the program has grown and diversified since that time. It continues to diversify its research to better meet the changing goals of the monitoring program (Boynton *et al.*, 1997, 1998, 1999, 2000, 2001). This has involved expansion of some program elements and the discontinuation of others as well as the development of tools that improve monitoring capabilities. Several years ago, EPC developed techniques to spatially evaluate sediment water fluxes in a more cost effective manner. More recently evaluation of near-shore water quality conditions relative to submerged vegetation (SAV) and SAV epiphytic growth have become an important portion of the program. Two years ago, EPC developed continuous surface water quality mapping techniques for the program. The design of this equipment has recently been updated. Additional, smaller elements, are occasionally added to the EPC program to collect small data sets for specific purposes (*e.g.* grain size of sediments).

The program is composed of distinct but complimentary study elements:

- The first element of the EPC program involves the characterization of the present state of Patuxent River estuary (including spatial and seasonal variation) relative to sediment-water oxygen and nutrient exchanges and sediment oxygen consumption rates. This involves shipboard measurements of sediment-water oxygen and nutrient exchanges (fluxes) at four (4) long-term (historic) monitoring stations located in Patuxent River.
- Determine the long-term trends that develop in sediment-water nutrient exchanges and sediment oxygen consumption rates in response to pollution control programs in the Patuxent River estuary.
- The third program element has two components. The first is continuous surface water quality mapping using the DATAFLOW V surface water quality mapping system. This effort will provide estimates of surface water quality parameters (salinity, water temperature, dissolved oxygen, fluorescence, and turbidity) and total depth at high spatial resolution (1 sample per 50-100 m). The second is the evaluation of epiphyte strips as a method for assessment of light attenuation due to epiphytic fouling on SAV leaves.
- Integrate the information collected in this program with other elements of the monitoring program to gain a better understanding of the processes affecting water quality of the Chesapeake Bay and its tributaries and the maintenance and restoration of living resources.

## 1.3 Sampling Design and Data Quality Objectives

### 1.3.1 MINI-SONE Stations

Four long-term monitoring stations on the Patuxent River (Figure 1-1, Table 1-2), St. Leonard Creek (STLC), Broomes Island (BRIS), Marsh Point (MRPT) and Buena Vista (BUVA), will be sampled using an abbreviated set of sampling measurements referred to as MINI-SONE. At these stations an abbreviated set of measurements, referred to as MINI-SONE, will be made monthly. The basic methodology (obtaining sediment cores, pre-incubation handling, incubation techniques) has not changed since SONE sampling began in 1985. The sampling frequency for MINI-SONE is based on the seasonal patterns of sediment water exchanges observed in previous studies conducted in the Chesapeake Bay region (Kemp and Boynton, 1980, 1981; Boynton et al., 1982; and Boynton and Kemp, 1985). MINI-SONE data will be collected in July, August and September 2002 and in June 2003. SONE stations were selected in the Patuxent Estuary using 2 criteria:

1. Each station was located at a depth corresponding to the most predominant depth in that sector of the estuary and
2. Stations were spaced out so as to encompass most of the mesohaline (stratified) region of the estuary.

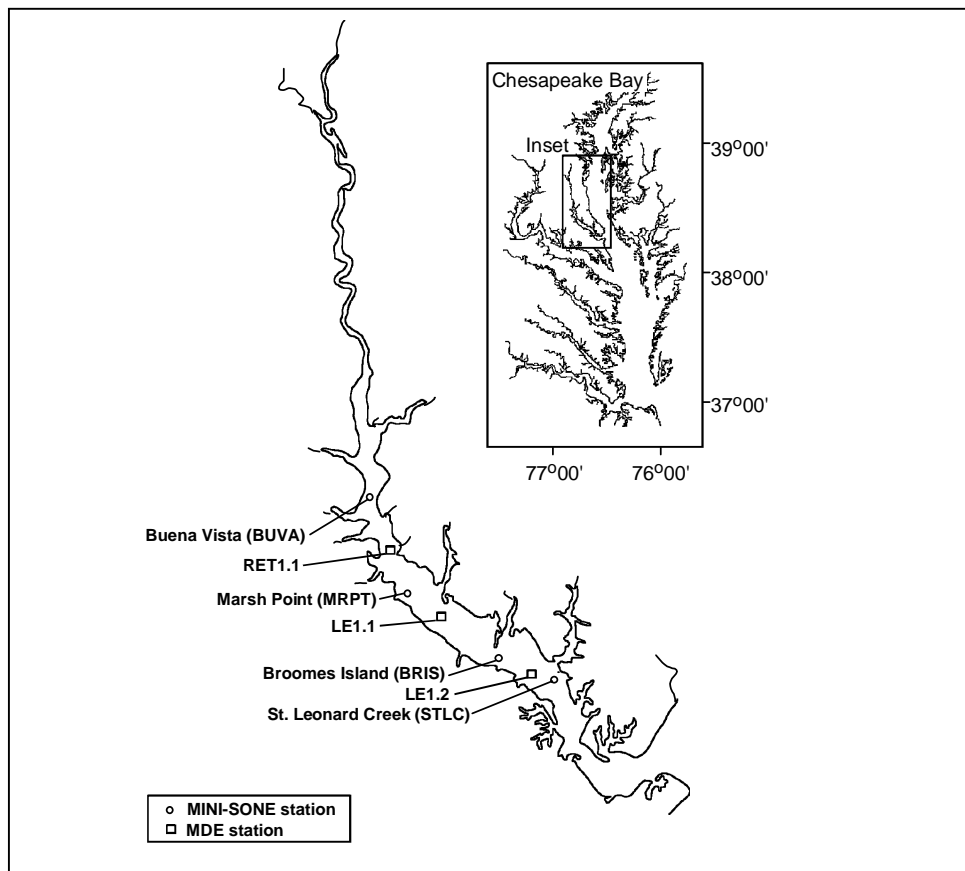


Figure 1-1. Location of four MINI-SONE Stations sampled in Patuxent River, Chesapeake Bay.

**Table 1-1. MINI-SONE Station Code, Grid Location and Nearest DNR Station**

\* Station depths from 2001 data (average of 4 measurements).

<b>STATION CODE</b>	<b>LATITUDE (DGPS)</b>	<b>LONGITUDE (DGPS)</b>	<b>STATION DEPTH * (m)</b>	<b>DNR STATION</b>	<b>BAY SEGMENT</b>
Patuxent River					
BUVA	38° 31.050'	76° 39.783'	6.0	RET 1.1	RET1
MRPT	38° 26.767'	76° 37.900'	6.38	LE1.1	LE1
BRIS	38° 23.600'	76° 33.067'	15.25	LE1.2	LE1
STLC	38° 22.817'	76° 30.067'	6.63	LE1.2	LE1

### **1.3.2 Submerged Aquatic Vegetation (SAV) Habitat Evaluation**

#### **1.3.2.1 Severn and Magothy Rivers**

Near-shore monitoring of water quality conditions and epiphyte fouling rates will be conducted at 2 sites in each river system. In the Magothy River, sites will be located at stations MGST and MGWH at a depth of approximately one meter. In the Severn River sites will be located at stations SRSF and SR04, also at a depth of approximately one meter. At each site, water column physical data such as dissolved oxygen, temperature, conductivity and light attenuation will be measured along with a suite of dissolved nutrient concentrations, chlorophyll-a and suspended solids. Artificial substrates will also be deployed to evaluate the role epiphytic growth may have on light attenuation for SAV. This monitoring will be conducted for four (4) consecutive weeks each in the summer of 2002. In the Severn River, sites will be located at stations SRSF and SR04 also at a water depth of approximately 1m. All sites were selected to coincide with existing beds of SAV and if possible to be adjacent to DNR high frequency monitoring locations.

#### **1.3.2.2 Patuxent River**

At 2 locations (SV5A, SV09) in the Patuxent River, a full suite of water quality parameters will be measured approximately bi-weekly from July – October 2002 and April – June 2003. Epiphyte fouling rates will be measured for 3 consecutive weeks in the summer of 2002. These sites were selected because they have been extensively monitored in previous years and represent a range of conditions found on the river. In addition, a qualitative evaluation of the health and density of the SAV transplants will be made approximately on a monthly basis. A quantitative assessment of SAV coverage and density will be made seasonally.

### **1.3.3 Continuous Surface Water Quality Mapping: DATAFLOW V Mapping System**

The sponsor (MD DNR) selected the Magothy and Severn Rivers for continuous surface water quality mapping operations. Each mapping cruise in the Magothy and Severn Rivers will follow an approximate square wave pattern frequently traversing from shallow waters (as shallow as can be navigated in safety) out to channel depths, along the channel, back into shallow waters, paralleling the shoreline, then back to the channel. Due to the likely presence of many navigational hazards and limitations due to sea conditions, the actual cruise track will be determined on the day of operation. A total of 14 mapping cruises will be completed in each of these two small tributary systems approximately biweekly from July through October 2001 and April through June 2003.

The purpose of DATAFLOW is to assess the spatial variability in water quality. The spatial resolution of the data collected depends on the speed and cruise track of the vessel. However, both are constrained by time and funds available to perform a practical assessment. It has been shown (EPC Interpretive #19, Boynton *et al.*, 2002) that high resolution spatial sampling can uncover patterns in water quality that are missed by single fixed station monitoring. The purpose of the calibration stations is to correlate DATAFLOW sensor output to universally measured parameters ( $K_d$ , secchi) and laboratory derived results (TSS, Chlorophyll-*a*) collected simultaneously. The goal of high frequency buoys is to temporally characterize water quality patterns at a particular location rather than spatial characterization. The data collected by a buoy would essentially be similar to the data collected by DATAFLOW at a single moment in time. Correlation to laboratory values or universally measured parameters would still be required.

#### **1.3.3.1 Dataflow Calibration Stations**

In addition to the high-resolution data collected by DATAFLOW V, additional calibration data will be collected at 8 locations within each tributary. Two calibration stations within each tributary will also coincide with locations of DNR high-frequency data collection. The remaining sites will be selected to represent a large signal range needed for sensor calibration. At these locations, water samples will be collected for the analysis of dissolved nutrient concentrations, chlorophyll-*a* (active and total), phaeophytin, total suspended solids and total volatile solids. Measurements of PAR will be made to calculate water column light attenuation ( $K_d$ ). Secchi depth measurements will be taken.

## 2. MEASURED PARAMETERS

Some parameters — conductivity, salinity, temperature, dissolved oxygen, Secchi depth — are measured *in situ*. The other measured parameters — including nitrogen, phosphorus, carbon, total suspended solids and chlorophyll-*a* are determined in the laboratory. Tables 2-1 and 2-2 list the parameters measured, the detection limits and method references. Details of sample collection, sample processing and storage, and analytical procedures are described in Appendix A.

**Table 2-1. A Summary of Field Parameters, Method Reference and Performance Criteria.**

Matrix	Parameter (Units)	Method Reference - Field	Minimum Detection Limit	Holding Time and Condition
Water	Temperature (C)	Probe WTEMPF01: p. A- <i>xlii</i>	0.1 C	<i>In situ</i>
Water	Depth Sample and Total (m)	Research Vessel Meter Block SAMDF03: p. A- <i>xii</i> Calibrated Depth Pole SAMDF04: p. A- <i>xii</i> Research Vessel Fathometer TOTDF01: p. A <i>xiii</i>	>0.3 m  0.1m  0.3m	<i>In situ</i>
Water	Dissolved Oxygen (mg l <sup>-1</sup> )	Probe DOF01: p. A- <i>xviii</i>	0.3 mg l <sup>-1</sup>	<i>In situ</i>
Water	Conductivity (mS cm <sup>-1</sup> )*	Probe CONDF01: p. A- <i>x</i> COND06: p. A- <i>x</i>	1 mS cm <sup>-1</sup>	<i>In situ</i>
Water	Salinity (ppt)	Probe SALINITYF04: p. A- <i>xxxv</i>	0 ppt	<i>In situ</i>
Water	Secchi depth (m)	Disk 25.5 cm diameter SECCIF01: p. A- <i>xxxv</i>	0.1 m	<i>In situ</i>
Water	Photosynthetically Active Radiation (μE or μM m <sup>-2</sup> sec <sup>-1</sup> )	<i>Li-cor</i> Li-192SA EPARD_ZF01: p. A- <i>xxxiii</i>	0.1 μE (or 0.1 μM m <sup>-2</sup> sec <sup>-1</sup> )	<i>In situ</i>
Sediment	Redox potential (mV)	Calomel reference electrode and a platinum electrode EHA14: p. A- <i>xxii</i>	50 mV	<i>In situ</i>
Water	Chlorophyll- <i>a</i> (%FS)	6025 Chlorophyll Probe FLURF01: p. A- <i>xxiv</i>	0 %	<i>In situ</i>
Water	Turbidity (NTU)	Probe TURB: p. A- <i>xlvi</i>	0.1 NTU	<i>In situ</i>

\* mS cm<sup>-1</sup> (European measurement) = 1 mmho cm<sup>-1</sup> (European and USA equivalent)

**Table 2-2. A Summary of Analytical (Laboratory) Parameters, Method Reference and Performance Criteria.**

<b>Matrix</b>	<b>Parameter (Units)</b>	<b>Method Reference - Analytical</b>	<b>MDL***</b>	<b>Precision (% CV)*</b>	<b>Accuracy (percent spike recovery)</b>
Water	Ammonium ( $\mu\text{M}$ )	Berthelot Reaction NH4FL01: p. A-i	0.0030 $\mu\text{M}$	< 5%	90-110%
Sediment/ Epiphyte	Active Chlorophyll- <i>a</i>	Flourescence after acidification SDCHAA19: p. A-iv	0.60 $\mu\text{g l}^{-1}$	-	-
Sediment/ Epiphyte	Total Chlorophyll- <i>a</i>	Flourescence before acidification SDCHTA18: p. A-vii	0.51 $\mu\text{g l}^{-1}$	-	-
Water	Dissolved Inorganic Phosphorus ( $\mu\text{M}$ )	Antimony-phospho-molybdate complex PO4FL01: p. A-xv	0.0007 $\mu\text{M}$	< 5%	90-110%
Water	Nitrite ( $\mu\text{M}$ )	Diazo compound NO2FL01 p. A-xxv	0.0003 $\mu\text{M}$	< 5%	90-110%
Water	Nitrate + Nitrate ( $\mu\text{M}$ )	Copper-cadmium reduction NO23FL01: p. A-xxviii	0.0007 $\mu\text{M}$	< 5%	90-110%
Sediment	Sediment Particulate Carbon (% [wt])	Combustion in O <sub>2</sub> PCL01: p. A-xxxvi	0.13%	< 5%**	-
Sediment	Sediment Particulate Nitrogen (% [wt])	Combustion in O <sub>2</sub> PNL01: p. A-xl	0.0084%	< 5%**	-
Sediment	Sediment Particulate Phosphorus (% [wt])	Antimony-phospho-molybdate complex PPL01: p. A-xxxvii	0.0087%	< 5%**	-
Water/ Epiphyte	Seston ( $\text{mg l}^{-1}$ )	Retention on standard glass filter pad TSSA13: p. A-xli	2.4 $\text{mg l}^{-1}$	< 10%	-
Water/ Epiphyte	Total Volatile Solids ( $\text{mg l}^{-1}$ )	Retention on standard glass filter pad + combustion + weight by difference TVSA13: p. A-xlv	0.9 $\text{mg l}^{-1}$	< 10%	-

\* Concentration dependent

\*\* BCSS-1

\*\*\* MDL Method Detection Limit as on June 4, 2002.

**Note: In the laboratory seven replicates were used.**

**No replicates were used in the field.**

### **3. FIELD MEASUREMENTS AND SAMPLING**

#### **3.1 MINI-SONE Element**

##### **3.1.1 Water Column Profiles**

At each MINI-SONE station, vertical water column profiles of temperature, salinity and dissolved oxygen are measured at 2 meter intervals from the surface to the bottom. Turbidity of surface waters is measured using a Secchi disc.

##### **3.1.2 Water Column Nutrients**

Near-bottom (approximately 1/2 meter above the bottom) water samples are collected using polyethylene jugs and a high volume submersible pump system. Samples are filtered immediately, where appropriate, using 0.7  $\mu\text{m}$  GF/F filter pads, and immediately frozen in plastic AA vials. Samples are analyzed by Nutrient Analytical Services Laboratory (NASL) for the following dissolved nutrients: ammonium ( $\text{NH}_4^+$ ), nitrite ( $\text{NO}_2^-$ ), nitrite plus nitrate ( $\text{NO}_2^- + \text{NO}_3^-$ ) and dissolved inorganic phosphorus corrected for salinity (DIP or  $\text{PO}_4^{3-}$ ). On each dataflow cruise water samples are collected at 8 stations and analyzed for chlorophyll-*a*, TSS and TVS using the same methods described in Section 4.

##### **3.1.3 Sediment Profiles**

At each MINI-SONE station an intact sediment core is used to measure the redox potential (Eh) of the sediment porewater. Sediment redox (mV) of each core is measured at one centimeter above the sediment surface, directly at the sediment surface and at one, two and five centimeters below the sediment surface. Additionally, surficial sediments are sampled for total and active sediment chlorophyll-*a* to a depth of 1 cm. Particulate carbon (PC), particulate nitrogen (PN), particulate phosphorus (PP), are sampled to a depth of 1 cm.

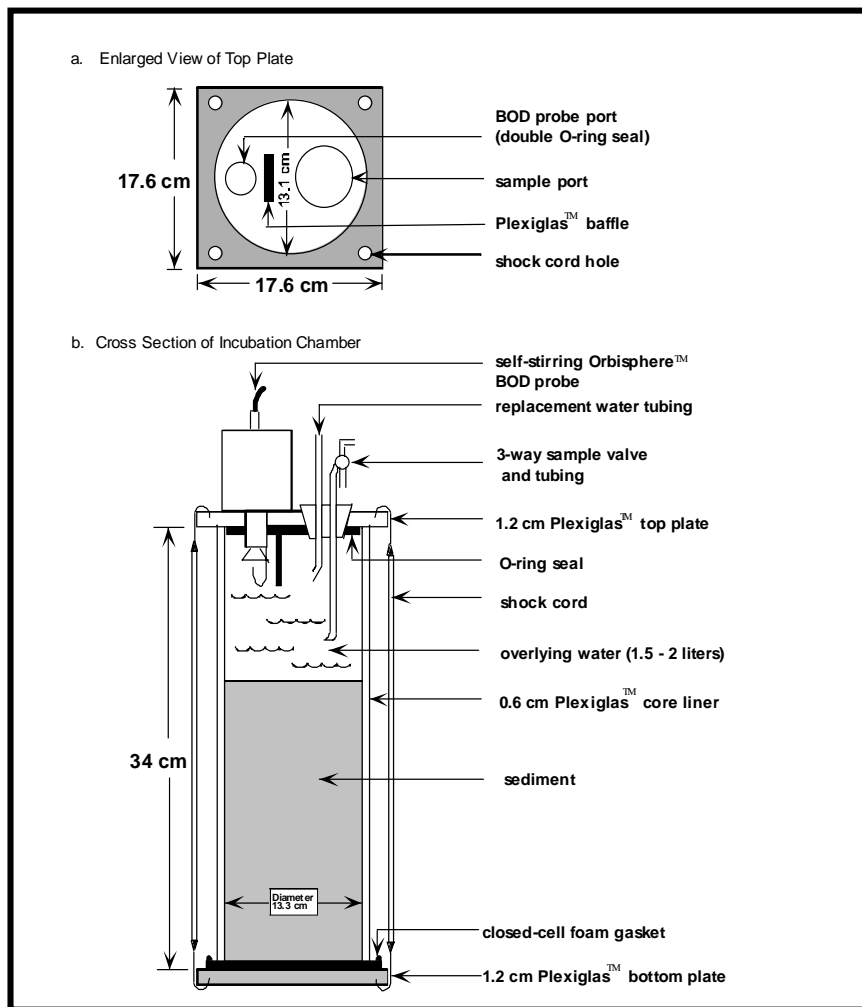
##### **3.1.4 Sediment Flux Measurements**

The protocols used in MINI-SONE flux estimates are an abbreviated set of measurements of the standard SONE techniques. MINI-SONE stations use a single sediment core with no blank. Intact sediment cores constitute a benthic microcosm where changes in oxygen, nutrient and other compound concentrations are determined.

A single intact sediment core is collected at each station using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If the sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-1). The core is then placed in a darkened, temperature controlled holding tank where overlying water in the core is slowly replaced by

fresh bottom water to ensure that water quality conditions in the core closely approximate *in situ* conditions.

During the period in which the flux measurements are taken, the cores are placed in a darkened temperature controlled bath to maintain ambient temperature conditions. The overlying water in a core is gently circulated with no induction of sediment resuspension via stirring devices attached to oxygen probes. Oxygen concentrations are recorded and overlying water samples (35 ml) are extracted from each core every 60 minutes during the incubation period. Standard SONE stations are incubated for 4 hours and a total of 5 measurements are taken, while MINI-SONE stations are incubated for 3 hours with a total of 4 measurements taken. As a water sample is extracted from a core, an equal amount of ambient bottom water is added to replace the lost volume. Water samples are filtered and immediately frozen for later analysis for ammonium ( $\text{NH}_4^+$ ), nitrite ( $\text{NO}_2^-$ ), nitrite plus nitrate ( $\text{NO}_2^- + \text{NO}_3^-$ ) and dissolved inorganic phosphorous (DIP or  $\text{PO}_4^{3-}$ ). Oxygen and nutrient fluxes are estimated by calculating the mean rate of change in concentration over the incubation period and converting the volumetric rate to a flux using the volume to area ratio of each core.



**Figure 3-1. Schematic Diagram of the Incubation Chamber**

**a. Enlarged View of Top Plate**

**b. Cross Section of Incubation Chamber**

## **3.2 Submerged Aquatic Vegetation (SAV) Near-Shore Habitat Evaluation**

### **3.2.1 SAV Water Quality Field Methods**

At each of the near-shore stations, water quality parameters were measured at 0.5 meters below the water surface. This water depth roughly corresponds to mid-water column depth at each of the near-shore stations where total water depth was approximately 1 meter mean low water. Water column physical parameters and water column nutrients were measured at this depth.

### **3.2.2 Physical Parameters**

Temperature, salinity, conductivity, and dissolved oxygen measurements were collected with a Yellow Springs International (YSI) 600R, YSI 6920 or YSI 6600 multi-parameter water quality monitor. Water column turbidity was estimated with a secchi disk, while water column light flux in the photosynthetically active frequency range (PAR) was measured with a *Li-Cor* LI-192SA underwater quantum sensor. Light flux measurements were collected at three discrete water depths in order to calculate water column light attenuation (Kd). Weather and sea-state conditions such as air temperature, percent cloud cover, wind speed and direction, total water depth, and wave height were also recorded.

### **3.2.3 Water Column Nutrients**

Whole water samples were collected in polyethylene jugs with a hand pump, and a portion immediately filtered with a 25 mm, 0.7  $\mu\text{m}$  (GF/F) glass fiber filter. Both the filtered portion and the remaining whole water samples were placed in coolers for transport back to the laboratory for further processing. The filtered portion was analyzed by the NASL for ammonium ( $\text{NH}_4^+$ ), nitrate ( $\text{NO}_2^-$ ), nitrite plus nitrate ( $\text{NO}_2^- + \text{NO}_3^-$ ) and phosphate ( $\text{PO}_4^{3-}$ ). Whole water portions were filtered in the laboratory using 47 mm 0.7  $\mu\text{m}$  (GF/F) glass fiber filters and were analyzed by NASL for the following particulate nutrients: total volatile solids (TVS), and total and active chlorophyll-*a* concentrations where total chlorophyll-*a* includes chlorophyll-*a* plus breakdown products. On each dataflow cruise water samples are collected at 8 stations and analyzed for chlorophyll-*a*, TSS and TVS using the same methods described in Section 4.

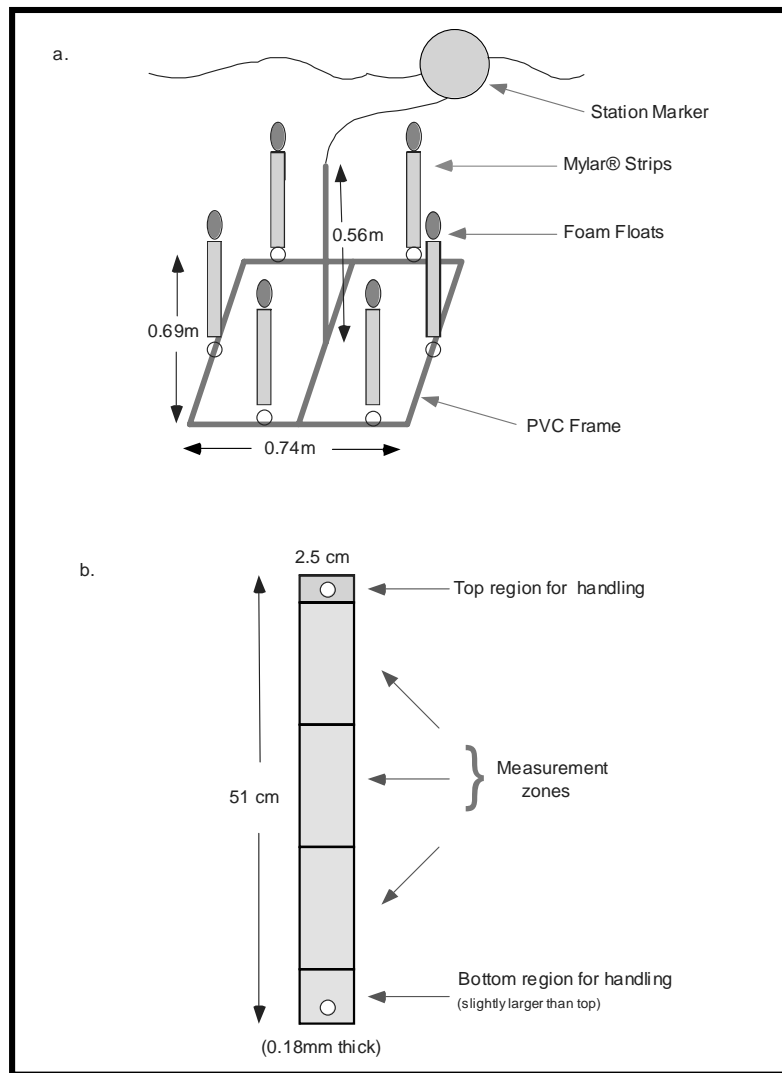
## **3.3 Epiphyte Growth Measurement Method**

In order to assess the light attenuation potential of epiphytic growth on the leaves of submerged aquatic vegetation (SAV), artificial substrata in the form of thin strips of Mylar<sup>®</sup> polyester plastic were deployed at each of the six near-shore stations for periods of 6 - 8 days. During each cruise throughout the sampling season, replicate strips exposed to natural fouling were retrieved and new strips deployed. The use of transparent Mylar<sup>®</sup> provided a means to estimate light

attenuation due to epiphytic growth and sediment accumulation, as well as to quantify the organic and inorganic components of the fouling.

### 3.3.1 Description of Epiphyte Collector Arrays

Each collector array (Figure 3-2.) consists of a square PVC frame situated horizontally with a vertical PVC shaft oriented in the center of the square. To this shaft is attached a line with a small surface float that allows for easy location of the collector. Each collector array holds six strips per deployment. Mylar® strips (2.5 cm wide x 51 cm long and 0.7 mil thick) are attached to the frame so that the top is allowed to move freely in the water column. Small foam floats (~3.5 x 3.3 cm) are attached to the top of the strip to help maintain a vertical position in the water column at all times.



**Figure 3-2. Diagram of SAV Epiphyte Collector Array.**

**a. Epiphyte Collector Array**

**b. Mylar® strips**

### **3.3.2 Sampling the Epiphyte Collector Arrays**

To retrieve the epiphyte collector strips, each collector array is gently removed from the water and suspended from the gunwale of the vessel. A single representative Mylar<sup>®</sup> strip is removed each for chlorophyll-*a* and TVS analysis. The pre-marked 5 inch center section of each strip is cut into smaller pieces and placed in a 60ml centrifuge tube. The tubes are placed in an ice filled cooler for transport back to the laboratory. Upon arrival at the laboratory, the tubes are immediately frozen and transferred to NASL for further processing. The variation in epiphyte accumulation on Mylar strips within a single site for a single deployment is quite small but depends on the location being monitored. Maximum % standard error (%SE) among strips is  $\pm 25\%$  total accumulation for both epiphyte chlorophyll-*a* or epiphyte dry mass.

### **3.3.3 Processing Total Epiphyte Material**

Sections of Mylar<sup>®</sup> strips collected for TSS/TVS analysis are scraped of all material and rinsed with distilled water and diluted to a fixed volume (400 - 500 ml). The solution is mixed as thoroughly as possible on a stir plate until homogenized. A small aliquot (10 to 50 ml) is then extracted with a glass pipette and filtered through a 47 mm 0.7  $\mu\text{m}$  (GF/F) glass fiber filter. Once filtered, the pads were immediately frozen and delivered to NASL for analysis.

## **3.4 Continuous Surface Water Quality Mapping: DATAFLOW V Mapping System**

DATAFLOW V is a compact, self-contained surface water quality mapping system, suitable for use in a small boat operating a planing speeds of about 25 KT. The system collects water through a pipe ("ram") deployed on the transom of the vessel, pumps it through an array of water quality sensors, then discharges the water overboard. A bubble trapping device ensures that no air bubbles are conveyed to the sensors, preventing errors that might be caused by such bubbles.

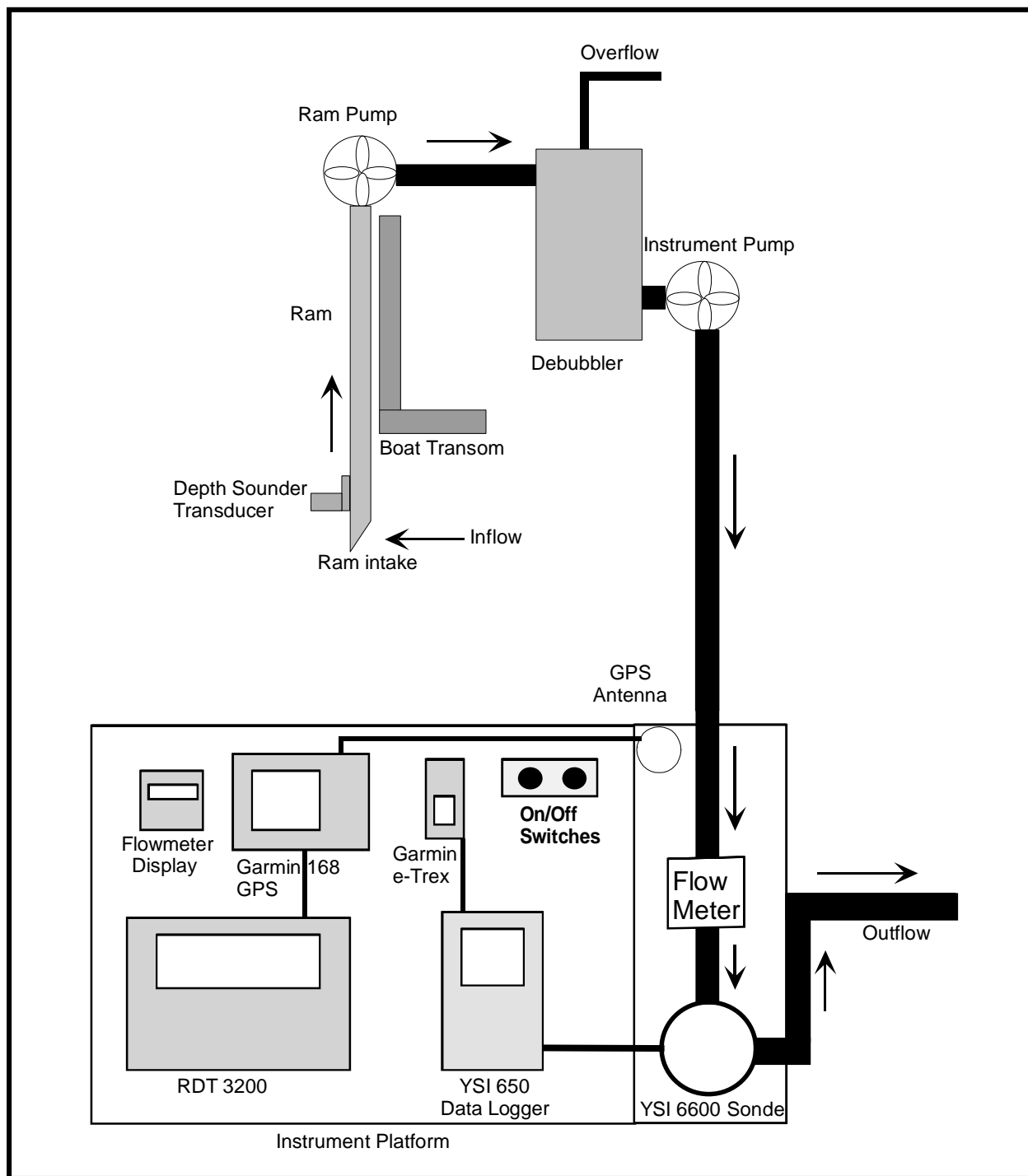
### **3.4.1 Water Quality Instrumentation**

DATAFLOW V (Figure 3-3) has a YSI 6600 Sonde equipped with a flow through chamber. The sensors include a Clark-type YSI 6562 DO probe, a YSI 6560 conductivity/temperature probe, a 6026 turbidity probe, and a 6025 chlorophyll probe. The sonde transmits data collected from the sensors to a YSI 650 data logger. On each dataflow cruise water samples are collected at 8 stations and analyzed for chlorophyll-*a*, TSS and TVS using the same methods described in Section 4.

### **3.4.2 Positioning and Depth Information**

DATAFLOW V is equipped with a hand-held Garmin e-Trex global positioning system and a Garmin 168 global positioning system with a built in depth sounder. The Garmin e-Trex GPS

transmits position data to the YSI 650 data logger through a NMEA 0183 version 2.0 data format. The data logger matches the position data with sensor data for each observation. Positioning errors are expected to be less than 15 m. The Garmin 168 GPS transmits NMEA data to a Procomm Plus communication program running on a Westcor RDT 3200 portable computer. The data is transmitted in a NMEA 0183 version 2.3 data format. The data is then



**Figure 3-3. Schematic diagram of DATAFLOW V illustrating the path of water through the instrument.** Seawater is picked up behind the transom of the research vessel through the "ram." A centrifugal pump mounted on the ram ("ram pump") pulls up the seawater and pushes it into the debubbler. The debubbler fills and overflows. Air and excess water are pushed out of the debubbler through the overflow hose. A centrifugal pump ("instrument pump") mounted at the bottom of the debubbler draws water out of the pump and pushes it to the sensors. The water first runs through a flow meter. The flow meter is wired to a horn that sounds if the flow rate falls below  $3 \text{ l s}^{-1}$ . If flow is interrupted during sampling, the horn sounds informing operators that a problem exists. The water exits the flow meter and enters the YSI flow-through chamber. The water runs across the sensor probes and exits the flow-through chamber before being discharged overboard. The displays for the YSI 650 data logger, Garmin 168 GPS, Garmin e-Trex GPS, flow meter display, and RDT 3200 are located on the instrument platform.

processed through a Perl program. This removes time, position, and depth data. The depth data is then merged with the data collected from the YSI 650 data logger through a SAS program and then put into an Excel file.

### **3.4.3 Flow Meter**

DATAFLOW V is equipped with an inline flow meter. Although the flow rate does not affect any of the sensor readings, decreased flow is an indication of either a partial blockage or an interruption of water flow to the instrument. Thus, the flow data is used in the field as a diagnostic tool to ensure that the instrument is working properly and later as a quality assurance tool, to verify that water flow was uninterrupted. A boat horn is wired to the flow meter. If the flow is interrupted and the flow rate falls below  $3.0 \text{ l s}^{-1}$ , the horn sounds and warns the operators that a problem must be corrected.

## **4. LABORATORY ANALYSIS**

Methods for the determination of dissolved and particulate nutrients are as follows: ammonium ( $\text{NH}_4^+$ ), nitrite ( $\text{NO}_2^-$ ), nitrite plus nitrate ( $\text{NO}_2^- + \text{NO}_3^-$ ), and dissolved inorganic phosphorus (DIP or  $\text{PO}_4^-$ ) are measured using the automated method of EPA (1979); particulate carbon (PC) and particulate nitrogen (PN) samples are analyzed using an Elemental Analyzer; particulate phosphorus (PP) concentration is obtained by acid digestion of muffled-dry samples (Aspila *et al.*, 1976); methods of Strickland and Parsons (1972) and Parsons *et al.* (1984) are followed for chlorophyll-*a* analysis.

All analytical (laboratory) parameters are analyzed at the University of Maryland's Chesapeake Biological Laboratory (CBL), Nutrient Analytical Services Laboratory.

## **5. DATA MANAGEMENT, VERIFICATION AND DOCUMENTATION**

The objectives of QA/QC standards are to provide accurate measurement of water quality and SAV parameters in Patuxent River. Over the 17 years that the EPC has been making these measurements consistent protocols have been developed in the field. Together with laboratory procedures already in place and used by NASL and data management procedures, the data obtained can be analyzed and interpreted so that the final report submitted will meet the objectives stated for this study. Information derived from the report will be useful to managers making decisions concerning Patuxent River.

### **5.1 QA/QC Field Checks**

Cruises are scheduled well ahead of time with Research Fleet Operations (RFO). A schedule for activities for each day of the individual cruises is submitted to the PI and other members of staff. Cruises that are canceled due to weather or mechanical problems with the research vessel are rescheduled.

Rather than take field duplicates, samples are collected at 8 stations to capture the variability throughout the study site. Due to tidal transport returning to the initial station would not produce comparable results: it would be equivalent to taking another calibration station.

## **5.2 Preparation of Collection Gear**

During the last few days prior to initiating a research cruise all the necessary equipment involved in the collection of water and sediment samples, incubation of sediment cores and collection of physical water quality data are inventoried according to “checklists”. All equipment is checked to insure that it is fully operational and has been properly cleaned. The equipment is packed into containers that provide for easy transport and loaded aboard the research vessel. The “checklist” is then re-examined to verify the presence of all necessary gear.

Standards and reagents involved in the calibration of instrumentation are made according to a schedule of shelf life (*i.e.* daily, weekly or seasonally) or if the supply is exhausted. All chemicals are handled, prepared and stored in accordance with standard laboratory practices.

Lost samples are a rarity and in those instances a code is inserted into the data to record the problems encountered (See Section 5.3.1.2). Details of sample collection are found in Appendix A.

### **5.2.1 Potential Contamination**

During the course of a research cruise different steps are taken to insure that the chances for contamination are minimized. These practices involve almost constant washing of equipment during the course of a cruise. All containers used to collect bulk raw water are rinsed with copious amounts of sample (station) water before they are filled and are thoroughly cleaned with fresh water and dried at the end of the cruise. Containers from which samples will be taken for chemical analysis are rinsed additionally with deionized water. The apparatus for taking the sediment samples as well as the incubation equipment is all washed thoroughly with station water before it is used to collect samples. Upon completion of the cruise they are cleaned with fresh water as well. All containers into which are placed water and sediment samples for chemical analysis (after being fully processed) are single use/disposable plastic vials and centrifuge tubes that require no cleaning. All syringes and other laboratory equipment used in processing these samples are washed with deionized water between each use. All glassware associated with the preparation of standards and reagents is cleaned with copious amounts deionized water and acid washed when appropriate.

## 5.2.2 Calibration Procedures and Frequency

All instruments (YSI 6920/600/6600 and Orbisphere) involved in the collection of physical water quality data (temperature, conductivity, salinity and dissolved oxygen) are calibrated daily. Dissolved oxygen calibration incorporates a standard air calibration based on air temperature and barometric pressure. Conductivity/salinity is calibrated with a 0.10 molar standard of potassium chloride. Temperature is calibrated by the manufacturer only when the instrument is returned for service.

All instruments are maintained in accordance with manufacturers specifications. Standards and reagents involved in the calibration of instrumentation are made according to a schedule of shelf life (*i.e.* daily, weekly or seasonally) or if the supply is exhausted. All chemicals are handled, prepared and stored in accordance with standard laboratory practices. If any apparent problems arise the instrument is removed from use until the malfunction can be diagnosed and remedied.

All of the sensors for the continuous surface water quality mapping system must be calibrated. The conductivity sensor, water temperature sensor, dissolved oxygen sensor and transmissometer are calibrated in the laboratory against known standards. These standards are as follows:

<b>Parameter</b>	<b>Calibration Method</b>
Conductivity	10 mmol KCl
Dissolved Oxygen	Air Calibration
Transmissometer	Turbidity Standards / Field Calibration
Fluorometer	Laboratory Standard / Field Calibration

Laboratory calibrations are performed daily for dissolved oxygen and conductivity also occasionally for transmittance and fluorescence. Although laboratory air calibrations are performed for the dissolved oxygen sensor, several Winkler titrations are performed regularly to ensure proper calibration. For transmittance and fluorescence, the manufacturer recommends that the instrument be calibrated against *in-situ* properties measured in the field. A variable number of water samples are collected in a field deployment that are analyzed for total and active chlorophyll-*a* and total suspended solids concentrations. These field standards are related to sensor readings via regression procedures. An example of the calibration curve derived for chlorophyll-*a* is shown in Figure 5-1. Note that each cruise has its own calibration curve.

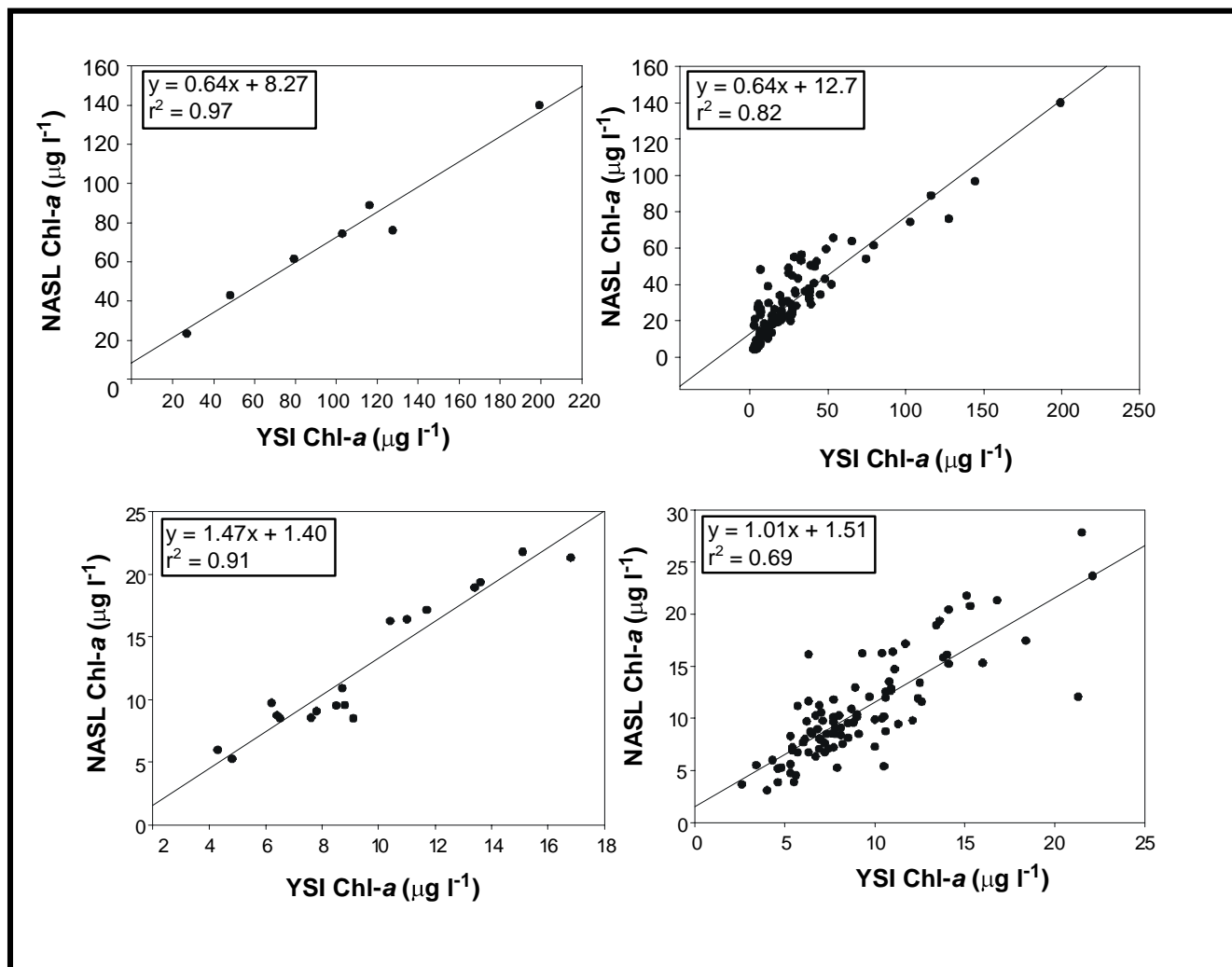


Figure 5-1. Chlorophyll-a calibration curves for:  
 a. Severn River, May 21, 2001  
 b. Severn River 2001 (14 cruises)  
 c. Tangier Sound July 30, 2001 and  
 d. Tangier Sound 2001 (6 cruises)

### 5.3 Recording of Field Data

All field data is recorded on specially prepared field data sheets that are included as Appendix A. The initials of the person recording the data are recorded on each data sheet. The raw data sheets are reviewed for possible missing data values due to sample collection problems prior to data entry. These sheets are filed in the laboratory. A cruise log book is also kept.

### **5.3.1 General Information Related to Data Sets**

#### **5.3.1.1 Naming Conventions**

Data files are given unique names which are a combination of an alpha code reflecting the name of the data set, the type of data set and a numeric descriptor which indicates the number of the cruise.

#### **5.3.1.2 Incorporation of Error Codes in Data Tables**

In order to keep a record of problems experienced while collecting data a one or two letter alpha code (Appendix D) is entered in the data table that describes the problems associated with questionable parameter values. Valid entries from the Sediment Data Management Plan (EPA, 1989) are used and where necessary additional codes which are related to the EPC have been added.

#### **5.3.1.3 Data Tables QA/QC Control**

Data recorded by instruments in the field are entered directly onto specially prepared data sheets. A blank data set for each data set is included in Appendix C. Data from samples analyzed by NASL are returned in written format. Data are keyed into Microsoft Excel using the specific data set layout developed during the continuing effort begun in August 1989 to standardize all EPC data files. Hard copies of the files are manually checked for errors. Data files are corrected, a second printout produced which is re-verified by a different staff member.

#### **5.3.1.4 Continuous Surface Water Quality Mapping - Raw Data Sets**

The data are electronically transferred from the datalogger to a computer at the end of each day of sampling. The data are stored as an ASCII text file. This file is retained indefinitely as the original record of the data collection. Due to the enormous quantity of data no hard copy will be submitted.

### **5.3.2 Submission of Data Files**

Files are submitted as ASCII files. Wherever possible the EPC abbreviations for variables are used. Additional information regarding the format of the data and details of variable labels, file structure and data and sampling anomalies are to be submitted as a metadata file to fulfill the requirements of the EPA Chesapeake Bay Liaison Office (EPA/CBLO).

### 5.3.2.1 Continuous Surface Water Quality Mapping - Processing of Data

Very little post-processing is required before the data can be used. However, there are two kinds of problems that occur occasionally: misread positioning information and erroneous values caused by electronic noise. Both problems can usually be detected easily by visually scanning the data, by calculating summary statistics, or by calculating the difference between successive observations. Post-calibrations of the transmissometer, fluorometer and dissolved oxygen sensors are applied to the Excel data sets.

## 5.4 Description of Individual Data Sets

### 5.4.1 MINI-SONE Data Sets

The data collected at each MINI-SONE station are organized into five data sets:

**WATER COLUMN PROFILES** (Filename: **MNHPRFxx**, Appendix C-1.1) contain temperature, salinity and dissolved oxygen data measured at two meter intervals in the water column.

**WATER COLUMN NUTRIENTS** (Filename: **MHNUTxx**, Appendix C-1.2) report bottom water dissolved nutrient concentrations.

**SEDIMENT PROFILES** (Filename: **MNSPRFxx**, Appendix C-1.3) include redox potential and sediment measurements of total and active chlorophyll-*a* concentrations.

**CORE DATA** (Filename: **MNCDATxx**, Appendix C-1.4) lists dissolved oxygen and nutrient measurements in MINI-SONE sediment-water flux chambers.

**SEDIMENT-WATER FLUX** (Filename: **MNFLUXxx**, Appendix C-1.5) is a summary table providing oxygen and nutrient flux data.

### 5.4.2 SAV Habitat Evaluation Data Sets

Data files are given unique names that are a combination of an alpha code reflecting the type of data set and a numeric descriptor indicating the year (yyyy) of the SAV samples were collected.

**WATER QUALITY MEASUREMENTS** (Filename: **WCNDyyyy**, Appendix C-2.1) contains temperature, salinity and dissolved oxygen data measured at 0.5 meters below the water surface.

**WATER COLUMN LIGHT ATTENUATION MEASUREMENTS** (Filename: **WCLTyyyy**, Appendix C-2.2) reports photosynthetically active

radiation (PAR) measurements to at least three depths and the subsequent calculated Kd values for each station.

**WATER COLUMN NUTRIENT MEASUREMENTS** (Filename: **WCNTyyyy**, Appendix C-2.3) contains dissolved nutrients, and chlorophyll-*a* (active and total) concentrations in the surface waters at each station.

**EPIPHYTE BIOMASS MEASUREMENTS** (Filename: **ECHLyyyy**, Appendix C-2.4) contains epiphyte chlorophyll-*a* concentrations (total and active), (Filename: Raw data file - **EVLRYyyy**, Appendix C-2.5; Mean data file - **EVLMyyyy**, Appendix C-2.6) contains total epiphyte dry weight and percent inorganic fraction measurements.

### 5.4.3 Continuous Surface Water Quality Mapping Data Sets

Two data sets contain the continuous surface water quality measurements, however **please note** that due to the large quantity of data no hard copy of the data is submitted, but a single parameter sheet is found in Appendix B. QA/QC checks identify missing data that are documented in these data sets using the appropriate code.

Filename **DFslCDyyyy** (where sl = sample designation), the field calibration data set contains: date, time, latitude, longitude, total depth; concurrent YSI instrument readings for temperature, salinity, dissolved oxygen (DO), fluorescence, and transmissometer value; secchi depth, PAR (for the calculation of Kd) as well as laboratory analyses for active chlorophyll-*a*, total chlorophyll-*a*, phaeophytin, total suspended solids and total volatile solids.

Filename **DFslMDmddy** (where sl = sample designation), the screened data set contains: date, time, latitude, longitude for each record of water temperature, salinity (ppt), dissolved oxygen ( $\mu\text{g l}^{-1}$ ), fluorescence ( $\mu\text{g l}^{-1}$ ) and transmissometer values (NTU). In addition, includes estimated active chlorophyll-*a*, total chlorophyll-*a* and light attenuation coefficient based on the raw instrument readings and the field calibrations.

### 5.5 Preparation and Checking of Data Tables

MINI-SONE data recorded by instruments in the field are entered directly onto specially prepared data sheets. Data from samples analyzed by NASL are returned in written format. Data are keyed into Microsoft Excel using the data table format developed during the SONE program in August 1989 when all EPC data files were standardized. Hard copies of the data files are manually checked for errors. Data files are corrected, a second printout produced which is re-verified by a different staff member. The full data set is plotted and outlier values reevaluated. Values below detection limits are also indicated in the data tables.

NASL laboratory data are inputted in a pre-determined format onto IBM compatible floppy disks in Microsoft Excel spreadsheet format on a microcomputer. Print-outs of the data are made and verified by laboratory personnel. Any necessary corrections are noted and made. Data are checked using a series of programs to verify the following:  $\text{NH}_4^+$ , dissolved phosphorus  $\text{PO}_4^-$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$ . Any data errors are given specific error codes. Final printed data files are created. These data are incorporated into either the MINI-SONE or epiphyte data sets.

Epiphyte data from samples analyzed by NASL are returned in written format. Data are keyed into a spreadsheet format from the original data sheets developed for the program and hard copies are printed and checked against the original data by a separate staff member. Data files also contain the last revision date for each file.

## 5.6 Calculations

The format of the calculations given below follows that used in the Excel files:

### 5.6.1 Salinity

Salinity can be measure *in-situ* with a probe. Traditionally from 1984 until 2001 salinity was calculated from conductivity and temperature (Parameter: COND).

$$\text{SALIN (ppt)} = [20 + (0.69608) \times (\text{CONDUCTIVITY} - 32.188)] + [(0.0013094) \times (\text{CONDUCTIVITY} - 32.188)^2] - [(0.000011918) \times (\text{CONDUCTIVITY} - 32.188)^3] + [(0.0000001792) \times (\text{CONDUCTIVITY} - 32.188)^4] - [(3.1112 \times 10^{-9}) \times (\text{CONDUCTIVITY} - 32.188)^5]$$

### 5.6.2 Oxygen Saturation

Oxygen saturation is the measured oxygen concentration relative to oxygen saturation at sample temperature and salinity (Weiss, 1970).

$$\text{DO SAT (\%)} = (100 \times \text{DO}) / (1.428 \times \text{EXP}(-173.4292 + (249.6339 \times (100 / (\text{TEMPERATURE} + 273)))) + (143.3483 \times \text{LN}((\text{TEMP} + 273) / 100)) - (21.8492 \times ((\text{TEMPERATURE} + 273) / 100)) + \text{SALINITY} \times (-0.033096 + (0.014259 \times ((\text{TEMPERATURE} + 273) / 100)) - 0.0017 \times ((\text{TEMPERATURE} + 273) / 100)^2))$$

### 5.6.3 Eh

Corrected Eh represents Eh relative to the hydrogen electrode.

$$\text{Eh CORRECTED (mV)} = \text{Eh MEASURED} + 244$$

## 5.6.4 Flux Variables

### 5.6.4.1 Calculations

Core Water Depth represents height of water above the sediment surface in the MINI-SONE chamber.

$$\text{Core H}_2\text{O Depth} = (\text{CORE VOLUME}/139)/100$$

General method for calculating net sediment-water fluxes:

$$\text{NET DO FLUX [gO}_2\text{/m}^2\text{.d)]} = [(\text{DO SLOPE}) \times (\text{CORE H}_2\text{O DEPTH}^a) \times (1440^b)]$$

$$\text{NET NUTRIENT FLUX [\mu M/(m}^2 \cdot \text{hr)]} = [(\text{VARIABLE SLOPE}^c) \times (\text{Core H}_2\text{O DEPTH}^a) \times (60^d) \times (1000^e)]$$

- where *a* converts measurements from volumetric to areal basis  
*b* converts time units from per minute to per day  
*c* variables are NH<sub>4</sub><sup>+</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>2</sub><sup>-</sup> + NO<sub>3</sub><sup>-</sup> and DIP  
*d* converts time units from minutes to hours  
*e* converts mass units from mM to μM.

Specific calculations used are:

a. Dissolved oxygen:

$$\text{DO FLUX [gO}_2\text{/m}^2\text{.day)]} = [(\text{DO SLOPE}) \times 1440 \times (\text{CORE H}_2\text{O DEPTH})]$$

$$\text{DO FLUX MEAN [gO}_2\text{/m}^2\text{.day)]} = \text{SUM} [\text{DO FLUX (1)} + \text{DO FLUX (2)} + \text{DO FLUX (3)}/\text{OBS}]$$

where OBS is the number of valid observations and does not include non-interpretable (NI) value.

b. Ammonium:

$$\text{NH}_4^+ \text{ FLUX [\mu MN/(m}^2 \cdot \text{hr)]} = (\text{NH}_4^+ \text{ SLOPE} \times 60 \times \text{CORE H}_2\text{O DEPTH}) \times 1000$$

$$\text{NH}_4^+ \text{ FLUX MEAN [\mu MN/(m}^2 \cdot \text{hr)]} = \text{SUM} [\text{NH}_4^+ \text{ FLUX (1)} + \text{NH}_4^+ \text{ FLUX (2)} + \text{NH}_4^+ \text{ FLUX(3)}/\text{OBS}]$$

c. Nitrite:

$$NO_2^- \text{ FLUX } [\mu\text{MN}/(\text{m}^2 \cdot \text{hr})] = (NO_2^- \text{ SLOPE} \times 60 \times \text{CORE H2O DEPTH}) \times 1000$$

$$NO_2^- \text{ FLUX MEAN } [\mu\text{MN}/(\text{m}^2 \cdot \text{hr})] = \text{SUM}[NO_2^- \text{ FLUX}(1) + NO_2^- \text{ FLUX}(2) + NO_2^- \text{ FLUX}(3)]/\text{OBS}$$

d. Nitrite plus nitrate:

$$NO_2^- + NO_3^- \text{ FLUX} [\mu\text{MN}/(\text{m}^2 \cdot \text{hr})] = (NO_2^- + NO_3^- \text{ SLOPE} \times 60 \times \text{CORE H2O DEPTH}) \times 1000$$

$$NO_2^- + NO_3^- \text{ FLUX MEAN } [\mu\text{MN}/(\text{m}^2 \cdot \text{hr})] = \text{SUM}[NO_2^- + NO_3^- \text{ FLUX}(1) + NO_2^- + NO_3^- \text{ FLUX}(2) + NO_2^- + NO_3^- \text{ FLUX}(3)]/\text{OBS}$$

e. Dissolved Inorganic Phosphorus:

$$DIP \text{ FLUX } [\mu\text{MP}/(\text{m}^2 \cdot \text{hr})] = (DIP \text{ SLOPE} \times 60 \times \text{CORE H2O DEPTH}) \times 1000$$

$$DIP \text{ FLUX MEAN } [\mu\text{MN}/(\text{m}^2 \cdot \text{hr})] = \text{SUM}[DIP \text{ FLUX}(1) + DIP \text{ FLUX}(2) + DIP \text{ FLUX}(3)]/\text{OBS}$$

#### 5.6.4.2 Criteria for accepting, rejecting and modifying variable slopes used in calculating net sediment water fluxes.

Two methods to measure each variable can be reviewed in appendix A. Nutrient concentrations are plotted against time of sampling and the slope of this curve is used to calculate net sediment-water exchanges. The following steps assume that all data have been previously verified following normal protocols.

1. If the slope of the nutrient concentrations vs time plot is statistically significant, the slope is used in calculating fluxes without modification.
2. Occasionally, there are plots which indicate a clear increasing or decreasing trend in concentrations over time but which have **one** data point which diverges strongly (either higher or lower concentration) from the trend. We consider these divergent data to represent contaminated samples (either by addition of the compound or addition of water having a much lower concentration of the compound) and they are not used. The slope is recalculated using lower degrees of freedom and a higher "t" value as the criteria for significance. If the slope is statistically significant, it is used in calculating fluxes.
3. If the concentration vs. time plots are erratic (*i.e.* no statistically significant increasing or decreasing trend in concentration over time) and if the difference in concentration among variables is **greater than** twice the detection limit for that variable, the data for that variable

are considered to be non-interpretable. The slope is not calculated and the entry for that variable in the MNFLUXxx file is recorded as "NI".

4. If the concentration vs. time plots are erratic (*i.e.* no statistically significant increasing or decreasing trend in concentration over time) and if the difference in concentration among variables is **less than** twice the detection limit for that variable, then the slope is taken to be zero and the net sediment-water flux is reported as zero. Occasionally, statistically significant slopes have been found for some variables (mostly nitrite and dissolved inorganic phosphorus) where concentration differences over the incubation period do not exceed twice the reported detection limit. These slopes are used to calculate net sediment-water exchanges.

### 5.6.5 Calculation of Kd

PAR is measured at two depths:

$$Kd = (-1/(DEPTH1-DEPTH2)) \times LN(PAR2/PAR1)$$

where *PAR1* is PAR measured at *DEPTH 1*  
and *PAR2* is PAR measured at *DEPTH 2*

## 6. PROJECT QUALITY ASSURANCE/QUALITY CONTROL

For information related to parameter accuracy and precision please refer to Table 2-2.

### 6.1 Audit

The NASL at the Chesapeake Biological Laboratory provides nutrient analyses to University, State and Federal agencies. As part of the laboratory's QA/QC program, NASL participates in cross calibration exercises with other institutions and agencies whenever possible. Refer to D'Elia *et al.* (1997) for specific details but some examples include:

- Particulate carbon and nitrogen cross calibration with Woods Hole Oceanographic Institution and Horn Point Environmental Laboratory.
- International Council for the Exploration of the Sea (ICES) inorganic nutrient round-robin communication. The fourth international inter-comparison report was published in 1991 (Kirkwood, Aminot and Perttilä, 1991).
- Comparisons of dissolved nutrient analyses conducted at Horn Point Environmental Laboratory, Bigelow Laboratory, the University of Delaware and the University of New Hampshire.

- Quarterly cross calibration exercises with Virginia Institute of Marine Science (VIMS) and Old Dominion University (ODU). The most recent inter-comparison (November 1995) confirmed all parameters routinely analyzed by these laboratories as part of the Chesapeake Bay Monitoring Program. Samples from various saltness and nutrient regimes were analyzed under this exercise.
- Environmental Protection Agency (EPA) unknown audits for various nutrients have been conducted.
- EPA audits of known nutrients were analyzed using samples in different salinity water while looking for possible matrix effects.

NASL has analyzed National Institute of Standards and Technology (NIST) and National Research Board of Canada reference materials, primarily estuarine sediment, as a check for their particulate and sediment carbon, nitrogen and phosphorus methods.

As part of the Chesapeake Bay Mainstem Monitoring Program, the laboratory analyzes approximately ten percent of the total sample load for QA/QC checks. These samples include laboratory duplicates and spike analyses. Two audits are completed each year, the most recent was completed in winter 2002 (February).

Specific EPC procedures include inorganic nitrogen (ammonium  $[\text{NH}_4^+]$ , nitrite  $[\text{NO}_2^-]$ , nitrite plus nitrate  $[\text{NO}_2^- + \text{NO}_3^-]$  and dissolved inorganic phosphorus [DIP or  $\text{PO}_4^{3-}$ ] for which a standard curve usually comprising five concentrations encompassing the expected range for that particular sample set, are analyzed at the beginning of each new run. A standard, which is treated as a sample, is analyzed at least every 20 samples. Baseline corrections are determined either manually or automatically, depending on the instrument providing the analysis. Data needed to calculate concentrations are recorded along with the sample concentration in laboratory notebooks, a carbon copy of which is provided to the EPC group. This procedure is also carried out for other parameters performed by the laboratory in support for the EPC effort. Precision and limits of detection for the variables are included in D'Elia *et al.* (1997) and included as part of the sampling procedure in Appendix A.

## 6.2 Sample Custody

Upon arrival at NASL, samples are counted, observed for potential problems (melting, broken containers, *etc.*) and placed in a freezer until analysis. Sample information and date of arrival are recorded on a log sheet.

## 6.3 Instrument Maintenance

Analytical instruments are maintained on a regular basis and records are kept of hours of operation, scheduled maintenance, pump tube changes, *etc.* A critical spare parts inventory is

maintained for each instrument. Instrument down-time is minimized by troubleshooting instrument problems telephonically with manufacturers and service representatives. Spare parts can be received within 24 hours via next-day air service.

## 7. DATA ANALYSIS AND REPORTING

### 7.1 Analysis of existing data

The PI has analyzed and reported water quality information of the Chesapeake Bay and related tributaries including the Potomac, Patuxent, Choptank and Susquehanna Rivers since 1985. Two data sets, the Vertical Flux Array (VFX) data set and the Sediment Oxygen and Nutrient Exchanges (SONE) data set are now complete. Yearly technical reports have been submitted continuously since 1984, published results and numerous presentations have been made at various program review and professional meetings. Various smaller studies with particular reference to distinct ecologically important aspects of the EPC program have been completed, data collected, analyzed and the results included in the final report. The PI has also suggested new areas where additional data could improve the quality of the EPC study, *e.g.* the inclusion of the high resolution bottom water chlorophyll-*a* mapping to improve the spatial dynamics of the study.

All data files are delivered as flat ASCII files.

### 7.2 Reports

Two reports will be delivered.

- **Level I: Data and Progress Report** will contain data tables for activities conducted between January and June, 2002. An electronic copy of the text (Microsoft Word 97) and a read-only PDF version of the report are to be submitted.
- The second report is the comprehensive **Level I: Interpretive Report**, that will be delivered as a draft, and will then be updated to reflect the corrections required by the contracting officer. This report will include graphics and statistical analyses of these data with particular emphasis on the major objectives of DNR monitoring program. Comparisons will be made with relevant scientific literature. An electronic copy of the text of this report Microsoft Word will be submitted, in addition to a read-only PDF version of the report. Graphics files or individual data used to construct the graphics will not be supplied.

Additional deliverables:

- An updated QAPP document for fiscal year 2003 will be submitted. Both hard copy and electronic copy of the final QAPP will be provided.

- Monthly reports documenting progress made with field work and in data management will be submitted.

All reports are submitted by Dr. Walter R. Boynton, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, MD 20688-0038 to Mr. Bruce Michael, Maryland Department of Natural Resources, Resource Assessment Administration, Tide Water Ecosystems Assessment Division, Tawes State Office Building, D-2, 580 Taylor Avenue, Annapolis, MD 20401.

## **8. PROJECT ORGANIZATION AND RESPONSIBILITIES**

This section lists the individuals responsible for the major aspects of the EPC of Maryland's Chesapeake Bay Water Quality Monitoring Program.

The collection and preparation of samples, plus data entry and management will be completed at Chesapeake Biological Laboratory under the direction of Professor Walter Raymond Boynton (PI). All correspondence regarding this project should be addressed to: Dr. Walter R. Boynton, Chesapeake Biological Laboratory, University of Maryland, Center for Environmental Science, P.O. Box 38, Solomons, MD 20688-0038. All sediment and water quality analyses are performed by Nutrient Analytical Services Laboratory (NASL) at the Chesapeake Biological Laboratory.

### **Principal Investigator: Professor Walter Boynton**

**RESPONSIBILITIES:** The principal investigator (PI), Dr. Walter Boynton, will supervise all activities associated with this project. This includes field work, data management and report writing. He will be responsible for all stages of the analysis of samples, resolving problems that may arise, and assure the satisfactory completion of the study. He is responsible for data review and oversight and submission of data. The PI will review the results of the analyses and approve the quality assurance/quality control protocols to insure the validity of the results. The PI will administer the financial and technical requirements of the project and be responsible for preparing the data and progress report and the final report to be submitted at the end of the project. He will also meet, at regular time intervals, with the other members of staff to discuss and review their responsibilities in relation to the project. The PI will respond to questions by the contracting agencies regarding the completion of different stages of the project and the reports that have to be submitted as part of the deliverables outlined in the project contract.

### **Field Program Coordinator: Robert M. Stankelis, **Senior Faculty Research Assistant (1997-Present)****

**RESPONSIBILITIES:** Mr. Robert M. Stankelis oversees the field program, is responsible for portions of the data analysis and report preparation. He reports to the principal investigator.

**Field Program Supervisor: Eva K.M. Bailey**  
**Faculty Research Assistant (2002)**

RESPONSIBILITIES: Ms. Eva K. M. Bailey assists in field program management and is responsible for data analysis, report preparation and presentation. She reports to the principal investigator.

**Field Program Assistant: Brian W. Bean**  
**Faculty Research Assistant (2001 - Present)**

RESPONSIBILITIES: Mr. Brian W. Bean assists in data collection, data analysis, and instrument maintenance.

**Field Program Assistant: Paul W. Smail**  
**Faculty Research Assistant (2002 - Present)**

RESPONSIBILITIES: Mr. Paul W. Smail assists in data collection, data analysis, and instrument maintenance.

**Seasonal Field Program Assistant: Maria A.C. Ceballos**  
**Seasonal Field Assistant (2002)**

RESPONSIBILITIES: Ms. Maria A.C. Ceballos assists in data collection, data analysis, and instrument maintenance.

**Data Manager: Dr. Frances Mary Rohland**  
**Associate Research Scientist (1989-Present)**

RESPONSIBILITIES: Dr. Frances M. Rohland is responsible for preparing monthly reports, reviewing data sheets and data entry procedures, producing and documenting the final data sets and for some data analysis. She is also responsible for the final report manuscript and graphics preparation. She reports to the principal investigator.

She is the current webmaster working on the development of the Ecosystems Ecology web page:  
<http://cblcbos1.cbl.umces.edu/sone/>

## 9. REFERENCES

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**Boynton, W.R. and W.M. Kemp.** 1985. Nutrient regeneration and oxygen consumption by sediments along an estuarine salinity gradient. *Mar. Ecol. Prog. Ser.* 23:45-55.

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- Boynton, W.R., W.M. Kemp, J.M. Barnes, F.M. Rohland, L.L. Matteson, L.L. Magdeburger, J.D. Hagy III, J.M. Frank, B.F. Sweeney, M.M. Weir and R.M. Stankelis.** 1997. Ecosystem Processes Component Level 1 Interpretive Report No. 14. Chesapeake Biological Laboratory (CBL), University of Maryland System Center for Environmental and Estuarine Studies, Solomons, MD 20688-0038. Ref No. [UMCEES]CBL 97-009a.
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- Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, J.M. Frank and J.M. Lawrence.** 2001. Ecosystem Processes Component Level 1 Interpretive Report No. 18. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 01-0088.
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- Kemp, W.M. and W.R. Boynton.** 1980. Influence of biological and physical factors on dissolved oxygen dynamics in an estuarine system: implications for measurement of community metabolism. *Estuar. Coast. Mar. Sci.* 11:407-431.
- Kemp, W.M. and W.R. Boynton.** 1981. External and internal factors regulating metabolic rates of an estuarine benthic community. *Oecologia* 51:19-27.
- Kirkwood, D., A. Aminot and M. Perttilä.** 1991. International Council for the Exploration of the Sea (ICES) Report on the Results of the 4<sup>th</sup> Intercomparison Exercise for Nutrients in Sea Water. No 174. ISSN 1017-6195.
- Magnien R.E. et al.** 1987. Monitoring for management actions. First Biennial Report. The Maryland Office of Environmental Programs, Chesapeake Bay, Water Quality Monitoring Program, Baltimore, MD.
- Mihursky, J.A. and W.R. Boynton.** 1978. A review of the Patuxent Estuary Data Base. Final Report to Maryland Department of Natural Resources Power Plant Siting Program. Ref. No. [UMCES] CBL 78-157.
- Parsons, T.R., Y. Maita and C.M. Lalli.** 1984. Determination of chlorophylls and total carotenoids: Spectrophotometric method. pp. 101 - 112 *in* Parsons, T.R., Y. Maita and C.M. Lalli. A manual of chemical and biological methods for seawater analysis. Pergamon Press, Oxford.
- Strickland, J.D.H. and T.R. Parsons.** 1972. A practical handbook of seawater analysis. *Fish. Res. Bd. Can. Bull.* 167 (second edition).
- Weiss, R.F.** 1970. The solubility of nitrogen, oxygen and argon in water and seawater. *Deep Sea Research* 17:721- 735.

# APPENDIX A: EPC PARAMETERS

***APPENDIX A: NOTE:***

Note that "DNR/EPC ABBREVIATION; ANALYTICAL METHOD NO. AND FIELD METHOD NO." in each of the descriptions of parameters in this section were originally coded following the guidelines outlined in:

**Environmental Protection Agency (EPA).** 1989. The Sediment Data Management Plan, Chesapeake Bay Program. United States Environmental Protection Agency, CBP/TRS 29/89.

This plan was made available to us when the first data dictionary for the EPC program was compiled in 1990.

At this time we have reviewed and wherever possible we have standardized and used water quality parameter abbreviations, "NEW\_METHOD" codes from the CBP Water Quality Database (1984 - present) Data Dictionary (<http://www.chesapeakebay.net/data/index.html>) the online data dictionary at the Chesapeake Information Management System (CIMS) Data Hub (<http://www.chesapeakebay.net/cims/>), incorporating them into our document. We have not changed sediment or SAV parameters.



**A-1. EPC Parameter: Ammonium**

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx),  
MINI-SONE Core Data (MNCDATxx)  
SAV Water Column Nutrients (WCNTyyyy)

CBP/ABBREVIATION: *NH4F*

ANALYTICAL METHOD NO.: NH4FL01

METHOD SUMMARY: The ammonium in a filtered water sample is by the Berthelot Reaction in which a blue-colored compound similar to indophenol forms when a solution of ammonium salt is added to sodium phenoxide, followed by the addition of sodium hypochlorite. The addition of a potassium sodium tartrate and sodium citrate solution prevents precipitation of hydroxides of calcium and magnesium.

INSTRUMENTATION: Technicon TrAAcs-800 Nutrient Analyzer

REFERENCES:

- (1) **Technicon Industrial Systems.** 1986. Technicon Industrial Method No 804-86T. Technicon Industrial Systems, Tarrytown, NY 10591.  
and: United States Environmental Protection Agency. 1979. Methods of chemical analysis of water and wastes. Off. Res. Devel. Cincinnati, OH. EPA-600/4-79-  
as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.11.
- (2) **Clesceri, L.S., A.E. Greenberg and R.R. Trussell (Editors).** 1989. Standard methods for the examination of water and waste water. Am. Public Health Assoc., Am. Water Works Assoc. and Water Pollution Control Federation. Washington, DC. (Section: 4500-NH3 H. Automated Phenate Method).

REPORTED UNITS: micromolar ( $\mu\text{M}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0030 $\mu\text{M}$	May 2002

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FIELD METHOD NO.: DISNF08

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx)  
SAV Water Column Nutrients (WCNTyyyy)

COLLECTION DEVICE:

**MINI-SONE:** Gould deep well submersible pump; flow rate is 40 liters per minute.

**SAV Water Column Nutrients:** Hand held boat pump.

SAMPLE COLLECTION:

**MINI-SONE:** A bottom water sample is collected approximately 0.5 meters above bottom.

**SAV Water Column Nutrients:** Hand held boat pump.

Samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7 $\mu$ m glass fiber filter pad.

SAMPLE PRESEVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

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FIELD METHOD NO.: CDNTF16

STUDY ELEMENT: MINI-SONE Core Data (MNCDATxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

SAMPLE COLLECTION: One intact sediment core is obtained at each MINI-SONE station using a modified Bouma box corer. After deployment and retrieval of the box corer, the Plexiglass liner containing the sediment sample is removed and visually inspected for disturbance. The sediment fills slightly more than half the volume of the chamber, the remaining

top half being filled with *in-situ* bottom water. The top and bottom of the chambers are sealed and the chambers placed in a darkened water-filled holding incubator to maintain ambient temperature. Just prior to incubation the overlying core water is replaced by fresh bottom water to ensure that water quality conditions in the cores closely approximate *in-situ* conditions.

The core is transferred to a circulating, temperature controlled water bath. Oxygen probes and sample tubes are inserted (Figure 3-2) and the core is allowed to stabilize for 10 minutes prior to sampling. Gentle circulation of water with no sediment resuspension is maintained in the cores during the measurement period via the stirring devices attached to the Orbisphere oxygen probes. A total of four water samples are extracted from the core at 60 minute intervals during the 3 hour incubation period. Water samples are filtered through Whatman GF/F 2.5 cm diameter, 0.7 µm glass fiber filters and collected in Auto- Analyzer (AA) vials and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen -20 C

#### REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-2.1. EPC Parameter: Chlorophyll-*a* - Active**

CBP/EPC ABBREVIATION: *CHLA*

STUDY ELEMENTS: MINI-SONE Sediment Profile (MNSPRFxx)  
SAV Water Column Nutrients (WCNTyyyy)  
SAV Epiphyte Biomass Measurements (ECHLyyyy)  
Continuous Surface Water Quality Mapping (DFslCDyyyy)

ANALYTICAL METHOD NO.: SDCHAA19 (NEW\_METHOD: CHLAL03)

METHOD SUMMARY: The total chlorophyll-*a* sample is acidified and measured fluorometrically. Active chlorophyll-*a* is then determined by subtracting the value obtained following acidification from the total chlorophyll-*a* value.

LABORATORY INSTRUMENTATION: Turner Designs Model TD 700

REFERENCES:

- (1) **Strickland, J.D.H. and T.R. Parsons.** 1972. A practical handbook of seawater analysis. Bull. 167 (Second Edition), Fisheries Research Board of Canada, Ottawa, Canada.
- (2) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.64

REPORTED UNITS:

**Surficial Sediments:** milligrams per meter squared ( $\text{mg m}^{-2}$ )

**Water:** micrograms per liter ( $\mu\text{g l}^{-1}$ )

**SAV Epiphyte Biomass Measurements:** micrograms per strip ( $\mu\text{g strip}^{-1}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	$0.60 \mu\text{g l}^{-1}$	September 1998 - Present

PRECISION:	N/A	Not available
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FIELD METHOD NO.: SEDPF13

STUDY ELEMENTS: MINI-SONE Sediment Profile (MNSPRFxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

**SAMPLE COLLECTION:** An open-ended 60 ml syringe is very slowly inserted into the intact sediment column contained within a Plexiglass microcosm, to a depth of 5-6 cm. A stopper is placed on the open end and the sample extracted. The syringe plunger is then inserted in the bottom of the syringe, the stopper removed from the top and the sediment sample slowly extruded to the desired height. Presently sediments are sampled to a depth of one centimeter. The surficial sediment sample is placed in a centrifuge tube and frozen.

**SAMPLE PRESERVATION:** Frozen -20 C

Samples are placed in an ice-filled cooler onboard the research vessel and frozen (-20 C) upon reaching shore.

**REFERENCES:**

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
  - (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.
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**FIELD METHOD NO.:** PPCHF10

**STUDY ELEMENTS:** SAV Water Column Nutrients (WCNTyyyy)  
Continuous Surface Water Quality Mapping (DFsICDyyyy)

**COLLECTION DEVICE:**

**SAV Water Column Nutrients:** Hand Held Boat Pump

**Continuous Surface Water Quality Mapping:** Water discharged from a short tube located immediately after the discharge from the surface mapping instrument is collected in a 1 liter beaker.

**SAMPLE COLLECTION:**

**SAV Water Column Nutrients:** A water sample is taken at approximately 0.5 meters below the surface.

**Continuous Surface Water Quality Mapping:** On the research vessel the beaker is rinsed several times in the discharge flow, then filled with water, noting the exact time of collection (to the second) from the Global Positioning System. This facilitates later matching of chlorophyll-*a* measurements with concurrent fluorescence readings from the instrument.

Both water samples are filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7 $\mu$ m glass fiber filter pad.

SAMPLE PRESEVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.
- (3) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank.** 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

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FIELD METHOD NO.: EPIF01

STUDY ELEMENT: SAV Epiphyte Biomass Measurements (ECHLyyyy)

COLLECTION DEVICE: Mylar<sup>®</sup> strips (2.5 cm x 51 cm x 0.18mm)

SAMPLE COLLECTION: Mylar<sup>®</sup> strips are deployed *in-situ* for approximately one week to collect epiphytic material. Chlorophyll-*a* is extracted directly off Mylar<sup>®</sup> strips using analytical method SDCHAA19.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-2.2. EPC Parameter: Chlorophyll-a - Total**

EPC ABBREVIATION: *CHLa TOTAL*

STUDY ELEMENTS: MINI-SONE Sediment Profile (MNSPRFxx)  
SAV Water Column Nutrients (WCNTyyyy)  
SAV Epiphyte Biomass Measurements (ECHLyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy;  
DFslCDyyyy)

ANALYTICAL METHOD NO.: SDCHTA18 (NEW\_METHOD: CHLAL03)

METHOD SUMMARY: Prior to analysis, the sample is thawed and chlorophyll-a extracted overnight in 40 ml of 90% acetone. The sample is read fluourometrically.

LABORATORY INSTRUMENTATION: Turner Designs Model TD 700

FIELD INSTRUMENTATION: Yellow Springs Instrument (YSI) 6025 Chlorophyll probe

REFERENCES:

- (1) **Strickland, J.D.H. and T.R. Parsons.** 1972. A practical handbook of seawater analysis. Bull. 167 (Second Edition), Fisheries Research Board of Canada, Ottawa, Canada.
- (2) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.64

REPORTED UNITS:

**Surficial Sediments:** milligrams per meter squared ( $\text{mg m}^{-2}$ )

**Water:** micrograms per liter ( $\mu\text{g l}^{-1}$ )

**SAV Epiphyte Biomass Measurements:** micrograms per strip ( $\mu\text{g strip}^{-1}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	$0.51 \mu\text{g l}^{-1}$	September 1998 - Present

PRECISION:	N/A	Not available
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FIELD METHOD NO.: SEDPF13

STUDY ELEMENTS: MINI-SONE Sediment Profile (MNSPRFxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample

is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

**SAMPLE COLLECTION:** An open-ended 60 ml syringe is very slowly inserted into the intact sediment column contained within a Plexiglass microcosm, to a depth of 5-6 cms. A stopper is placed on the open end and the sample extracted. The syringe plunger is then inserted in the bottom of the syringe, the stopper removed from the top and the sediment sample slowly extruded to the desired height. Presently sediments are sampled to a depth of one centimeter. The surficial sediment sample is placed in a centrifuge tube and frozen.

**SAMPLE PRESERVATION:** Frozen -20 C

**REFERENCES:**

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

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**FIELD METHOD NO.:** PPCHF10

**STUDY ELEMENTS:** SAV Water Column Nutrients (WCNTyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy)

**COLLECTION DEVICE:**

**SAV Water Column Nutrients:** Hand Held Boat Pump

**Continuous Surface Water Quality Mapping:** Water discharged from a short tube located immediately after the discharge from the surface mapping instrument is collected in a 1 liter beaker.

**SAMPLE COLLECTION:**

**SAV Water Column Nutrients:** A water sample is taken at approximately 0.5 meters below the surface.

**Continuous Surface Water Quality Mapping:** The beaker is rinsed several times in the discharge flow, then filled with water, noting the exact time of collection (to the second) from the Global Positioning System. This facilitates later matching of chlorophyll-*a* measurements with concurrent fluorescence readings from the instrument.

Both water samples are filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen -20 C

Samples are placed in an ice-filled cooler onboard the research vessel and frozen upon reaching shore.

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.
- (3) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank.** 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

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FIELD METHOD NO.: EPIF01

STUDY ELEMENT: SAV Epiphyte Biomass Measurements (ECHLyyyy)

COLLECTION DEVICE: Mylar<sup>®</sup> strips (2.5 cm x 51 cm x 0.18mm)

SAMPLE COLLECTION: Mylar<sup>®</sup> strips are deployed *in-situ* for approximately one week to collect epiphytic material. Chlorophyll-*a* is extracted directly off Mylar<sup>®</sup> strips using analytical method SDCHTA18.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-3. EPC Parameter: Conductivity\***

CBP/EPC ABBREVIATION: **COND**

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRFxx)  
SAV Water Column Profile (WCNDyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy)

FIELD METHOD NO.: CONDF01

**COLLECTION DEVICE:**

Yellow Springs Instrument (YSI) Model 600R  
Yellow Springs Instrument (YSI) Model 6920  
**Continuous Surface Water Quality Mapping:** Yellow Springs Instrument (YSI) 6600  
in the DATAFLOW V System.

**SAMPLE COLLECTION:**

**MINI-SONE:** Electrodes are directly exposed to sample water that is supplied using a Gould deep well submersible pump with a flow rate of 40 liters per minute.

**SAV Water Column Profile:** Conductivity measurements are made *in-situ*.

REPORTED UNITS: millimhos per centimeter ( $\text{mmho cm}^{-1}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	150 $\text{mmho cm}^{-1}$	0.1 $\text{mmho cm}^{-1}$	July 1984-Present

**REFERENCES:**

- (1) **Instruction Manual, 600 Multi-Parameter Water Quality Monitor.** 1996. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.
- (2) **Instruction Manual and Service Manual, YSI 6920 Multi-Parameter Water Quality Monitor.** 1996. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

**\*Note:** *In the past we routinely reported salinity values based on algorithms contained within CTD instruments. At present we are using salinity values recorded by the probe.*

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FIELD METHOD NO.: COND06

STUDY ELEMENT: Continuous Surface Water Quality Mapping (DFslMDmmdyy)

SAMPLE COLLECTION: Water is pumped from approximately 10 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a flow rate of at least 7 l

m<sup>-1</sup>. The conductivity probes are located in-line and are directly exposed to a continuous flow of ambient water. Conductivity value is transmitted directly to YSI 650 data logger.

REPORTED UNITS: millisiemens (mS)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	100 mS	0.1 mS	June 1999 - Present

REFERENCE:

- (1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

**A-4.1. EPC Parameter: Depth - Sample**

EPC ABBREVIATION: *SAMPLE DEPTH*

FIELD METHOD NO.: SAMDF03

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRF<sub>xx</sub>)  
MINI-SONE Water Nutrients (MNHNUT<sub>xx</sub>)

COLLECTION DEVICE: Research Vessel Meter Block

SAMPLE COLLECTION: The cable meter is a single purchase block equipped with a digital readout which indicates the length of sampling wire deployed.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	100 m	>0.3 m	July 1984-Present

REFERENCES:

(1) **Research Fleet Operations**, UMCES, Box 38, Solomons, MD 20688.

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FIELD METHOD NO.: SAMDF04

STUDY ELEMENT: SAV Water Column Profile (WCND<sub>yyyy</sub>)

COLLECTION DEVICE: Calibrated depth pole

SAMPLE COLLECTION: The calibrated depth pole is marked off at 0.25 meter intervals which indicates the sample depth.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	3.25 m	0.25 m	June 1997-Present

**A-4.2. EPC Parameter Variable: Depth - Total**

EPC ABBREVIATION: **TOTAL DEPTH**

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRFxx)  
MINI-SONE Water Nutrients (MHNUTxx)  
SAV Water Column Profile (WCNDyyyy)  
Continuous Surface Water Quality Mapping (DFslCDyyyy)

FIELD METHOD NO.: TOTDF01

COLLECTION DEVICE:

**MINISONE:** Research Vessel Fathometer (Raytheon V800)

**Continuous Surface Water Quality Mapping:** Research vessel fathometer (GARMIN GPS/Sounder 135)

SAMPLE COLLECTION: The electronic signal of the Fathometer is directed to the bottom and the echo from that signal is recorded and reported in units of either feet or meters.

**Continuous Surface Water Quality Mapping:** The electronic signal of the fathometer is directed to the bottom and the echo from the signal is recorded. The depth data is transmitted as an ASCII string via the NMEA 0183 v1.5 data bus to a digital port on the datalogger, which records the depth data continuously.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	995 m	0.3 m	July 1984-Present

**Continuous Surface Water Quality Mapping:**

	Upper Limit	Lower Limit	Dates Valid
	600m	0.5 m	June 1999-Present

REFERENCES:

- (1) Research Fleet Operations, UMCES, Box 38, Solomons, MD 20688.
- (2) Operations Manual, Garmin GPS/Sounder 135.

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FIELD METHOD NO.: SAMDF04

STUDY ELEMENT: SAV Water Column Profile (WCNDyyyy)

COLLECTION DEVICE: Calibrated depth pole

SAMPLE COLLECTION: The calibrated depth pole is marked off at 0.25 meter intervals and indicated the sample depth.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	3.25 m	0.25 m	June 1997-Present

## A-5. EPC Parameter: Dissolved Inorganic Phosphorus\*

CBP/EPC ABBREVIATION: *PO4F*

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx)  
MINI-SONE Core Data (MNCDATxx)  
SAV Water Column Nutrients (WCNTyyyy)

ANALYTICAL METHOD NO.: PO4FL01

METHOD SUMMARY: A filtered water sample is reacted with ammonium molybdate and antimony potassium tartrate in an acid medium to form an antimony phosphomolybdate complex which is reduced to an intensely blue colored complex by ascorbic acid. The sample is measured colorimetrically at 880 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon Auto-Analyzer II

### REFERENCES:

- (1) **Technicon Industrial Systems.** 1973. Ortho phosphate in water and seawater. Technicon Industrial Method No. 155-71W/Tentative. Technicon Industrial Systems, Tarrytown, NY 10591. p.6.  
and: United States Environmental Protection Agency. 1979. Methods for chemical analysis of water and wastes. Method #365.1. Off. Res. Devel. Cincinnati, OH. EPA-600/4-79-020.  
as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.29.
- (2) **D'Elia, C.F., P.A. Steudler and N. Corwin.** 1977. Determination of total nitrogen in aqueous samples using persulfate digestion. *Limnol. Oceanogr.* 22: 760-764.
- (3) **Valderrama, J.C.** 1981. The simultaneous analysis of total nitrogen and total phosphorus in natural waters. *Mar. Chem.* 10:109-122.

REPORTED UNITS: micromolar ( $\mu\text{M}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Date Valid
	N/A	0.0007 $\mu\text{M}$	May 2002

**\*NOTE: Water column dissolved inorganic phosphorus values are adjusted using a small correction value:**

(Dissolved Inorganic Phosphorus - (salinity x 0.000816))

### REFERENCE:

- (1) **Froelich, P.N. and M.E.Q. Pilson.** 1978. Systematic absorbance errors with Technicon Auto Analyzer II Colorimeters. *Water Research* 12:599-603.

FIELD METHOD NO.: DISNF08

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx)  
SAV Water Column Nutrients (WCNTyyyy)

COLLECTION DEVICE:

**MINI-SONE:** Gould deep well submersible pump; flow rate is 40 liters per minute.

**SAV Water Column Nutrients:** Hand held boat pump.

SAMPLE COLLECTION:

**MINI-SONE:** A bottom water sample is collected approximately 0.5 meter above bottom.

**SAV Water Column Nutrients:** A surface water samples is collected approximately 0.5 meter below surface.

Samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESEVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

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FIELD METHOD NO.: CDNTF16

STUDY ELEMENT: MINI-SONE Core Data (MNCDATxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample

is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

**SAMPLE COLLECTION:** One intact sediment core is obtained at each MINI-SONE station using a modified Bouma box corer. After deployment and retrieval of the box corer, the Plexiglass liner containing the sediment sample is removed and visually inspected for disturbance. The sediment fills slightly more than half the volume of the chamber, the remaining top half being filled with *in-situ* bottom water. The top and bottom of the chambers are sealed and the chambers placed in a darkened water-filled holding incubator to maintain ambient temperature. Just prior to incubation the overlying core water is replaced by fresh bottom water to ensure that water quality conditions in the cores closely approximate *in-situ* conditions.

The core is transferred to a circulating, temperature controlled water bath. Oxygen probes and sample tubes are inserted (Figure 3-2) and the core is allowed to stabilize for 10 minutes prior to sampling. Gentle circulation of water with no sediment resuspension is maintained in the cores during the measurement period via the stirring devices attached to the Orbisphere oxygen probes. A total of four water samples are extracted from the core at 60 minute intervals during the 3 hour incubation period. Water samples are filtered through Whatman GF/F 2.5 cm diameter, 0.7 µm glass fiber filters and collected in Auto- Analyzer (AA) vials and immediately frozen.

**FILTER TYPE/PORE SIZE:** Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

**SAMPLE PRESERVATION:** Frozen -20 C

**REFERENCES:**

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-6.1. EPC Parameter: Dissolved Oxygen (Method 1)**

CBP/EPC ABBREVIATION: *DO*

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRFxx)  
SAV Water Column Profile (WCNDyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy;  
DFslCDyyyy)

FIELD METHOD NO.: DOF01

COLLECTION DEVICE:

Yellow Springs Instrument (YSI) Model 600R  
Yellow Springs Instrument (YSI) Model 6920

SAMPLE COLLECTION:

**MINI-SONE:** The oxygen probe is directly exposed to sample water, which is supplied using a Gould deep well submersible pump with a flow rate of 40 liters per minute.

**SAV Water Column Profile:** DO measurements are made *in-situ*.

An electrical current, proportional to the partial pressure of dissolved oxygen in the sample, is recorded and converted to units of milligrams per liter.

REPORTED UNITS: milligrams per liter ( $\text{mg l}^{-1}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	20 $\text{mg l}^{-1}$	0.3 $\text{mg l}^{-1}$	July 1984-Present

REFERENCE:

- (1) **Instruction Manual, 600 Multi-Parameter Water Quality Monitor.** 1996. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.
- (2) **Instruction Manual and Service Manual, YSI 6920 Multi-Parameter Water Quality Monitor.** 1996. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

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FIELD METHOD: DOF08

STUDY ELEMENT: Continuous Surface Water Quality Mapping (DFslMDmmdyy;  
DFslCDyyyy)

COLLECTION DEVICE: Rapid Pulse - Clarke type, polarographic, Yellow Springs Instrument (YSI) 6562 DO Probe

**SAMPLE COLLECTION:** An electrical current, proportional to the partial pressure of dissolved oxygen in the water, is recorded and converted internally to units of milligrams per liter. The water sample is pumped from approximately 10 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a flow rate of at least 7 l m<sup>-1</sup>. The dissolved oxygen probe is located in-line and are directly exposed to a continuous flow of ambient water.

Dissolved oxygen information is transmitted directly to YSI 6562 data logger.

**REPORTED UNITS:** milligrams per liter

<b>DETECTION LIMITS:</b>	Upper Limit	Lower Limit	Dates Valid
	20 mg l <sup>-1</sup>	0.3 mg l <sup>-1</sup>	June 1999 - Present

**REFERENCE:**

- (1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

**A-6.2. EPC Parameter: Dissolved Oxygen (Method 2; also called Sediment Oxygen Consumption [SOC])**

EPC ABBREVIATION: *DO*

STUDY ELEMENT: MINI-SONE Core Data (MNCDATxx)

ANALYTICAL METHOD NO.: CDDOA26

METHOD SUMMARY: Gentle circulation of water with no sediment resuspension is maintained in the cores during the measurement period via the stirring devices attached to the Orbisphere oxygen probes. Oxygen concentrations in the water overlying sediment cores are recorded every 60 minutes, depending on the rate of oxygen uptake.

REFERENCES:

- (1) **Instruction Manual for Oxygen Measuring System Model 2610.** Undated. Orbisphere Laboratories, 70 Kinderkamac Road, Emerson, NJ 07630.

REPORTED UNITS: milligrams per liter ( $\text{mg l}^{-1}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	20 $\text{mg l}^{-1}$	0.05 $\text{mg l}^{-1}$	May1985-Present

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FIELD METHOD NO.: CDDOF15

STUDY ELEMENT: MINI-SONE Core Data (MNCDATxx)

COLLECTION DEVICE: Obisphere Oxygen Indicator Model 2610  
Oxygen Probe Model 2112

SAMPLE COLLECTION: One intact sediment core is obtained at each MINI-SONE station using a modified Bouma box corer. After deployment and retrieval of the box corer, the Plexiglass liner containing the sediment sample is removed and visually inspected for disturbance. The sediment fills slightly more than half the volume of the chamber, the remaining top half being filled with *in-situ* bottom water. The top and bottom of the chambers are sealed and the chambers placed in a darkened water-filled holding incubator to maintain ambient temperature. Just prior to incubation the overlying core water is replaced by fresh bottom water to ensure that water quality conditions in the cores closely approximate *in-situ* conditions.

The core is transferred to a circulating, temperature controlled water bath. Oxygen probes and sample tubes are inserted (Figure 3-2) and the core is allowed to stabilize for 10 minutes prior to sampling. Gentle circulation of water with no sediment resuspension is maintained in the cores during the measurement period via the stirring devices attached to the Orbisphere oxygen probes. Oxygen concentrations are measured at 60 minute intervals during the 3 hour incubation period.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-7. EPC Parameter: *Eh***

EPC ABBREVIATION: *Eh MEAS*

STUDY ELEMENTS: MINI-SONE Sediment Profile (MNSPRF<sub>xx</sub>)

ANALYTICAL METHOD NO.: EHA14

COLLECTION DEVICE: Corning pH/Ion Meter 450

SAMPLE COLLECTION: *Eh* is measured using a calomel reference electrode and a platinum electrodes. *Eh* is a measure of the chemical environment (oxidizing or reducing) at a specific depth in the sediment column measured relative to the calomel electrode. Both electrodes are calibrated using Zobel's solution and are inserted into the water overlying the sediment core, this measurement is recorded for the overlying water. The calomel electrode is left in the overlying water while the platinum electrode is inserted in holes in the side of the Plexiglass liner and readings are taken at one centimeter intervals to a depth of ten centimeters. The platinum electrode is etched in Zobel's solution for three minutes between readings.

REPORTED UNITS: millivolts (mV)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	50mV	July 1984-Present

REFERENCES:

- (1) **Twilley, Robert.** Pers. comm. University of Southern Louisiana, Lafayette, A 70504.

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FIELD METHOD NO.: *EHF12*

STUDY ELEMENTS: MINI-SONE Sediment Profile (MNSPRF<sub>xx</sub>)

COLLECTION DEVICE: An intact sediment core is obtained using a Bouma box corer. A special Plexiglass cylinder (7 cm diameter by 30 cm height) is used to extract a sub-core. This cylinder has holes drilled one centimeter apart in a straight line along its length. This special cylinder is removed containing an intact sediment sub-core and sealed, top and bottom, with rubber stoppers.

SAMPLE COLLECTION: After removal of the box corer, the level of sediment is adjusted so that the sediment surface is level with one of the holes in the liner. The calomel electrode is placed into, and remains in, the subcore's overlying water. This electrode is situated approximately 1.0 cm above the sediment surface. This electrode remains in this position throughout all of the measurements. The platinum electrode is inserted into the drilled holes to obtain measurements.

REFERENCES:

- (1) **Twilley, Robert.** Pers. comm. University of Southern Louisiana, Lafayette, LA 70504.

**A-8. EPC Parameter: Fluorescence**

EPC Abbreviation: **FLUOR**

STUDY ELEMENT: Continuous Surface Water Quality Mapping (DFslMDmmdyy;  
DFslCDyyyy)

FIELD METHOD NO.: FLURF01

COLLECTION DEVICE: Yellow Springs Instrument (YSI) 6025 Chlorophyll Probe

**SAMPLE COLLECTION:**

Blue excitation light (wavelength=455 nm) is directed onto a continuous flow of water. This excitation energy source is adsorbed by chlorophyll-a and re-emitted as red light (wavelength=685 nm). This red light is detected by a photodiode and the signal is transmitted directly to the data logger. The water sample is pumped from approximately 10 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a flow rate of at least 7 l m<sup>-1</sup>.

REPORTED UNITS: %FS (Full scale)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	100%	0%	May 2002

RESOLUTION: 0.1%

**REFERENCE:**

(1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

**A-9. EPC Parameter: Nitrite**

CBP/EPC ABBREVIATION: *NO2F*

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNNUTxx)  
MINI-SONE Core Data (MNCDATxx)  
SAV Water Column Nutrients (WCNTyyyy)

ANALYTICAL METHOD NO.: NO2FL01

METHOD SUMMARY: Nitrite in a filtered water sample is determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a reddish purple azo dye which is then measured colorimetrically at 520 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon TrAAcs-800 Nutrient Analyzer

REFERENCES:

- (1) **Technicon Industrial System.** 1987. Technicon Industrial Method No. 818-87T. Technicon Industrial Systems, Tarrytown, NY 10591. p.4. as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.14.

REPORTED UNITS: micromolar ( $\mu\text{M}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0003 $\mu\text{M}$	May 2002

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FIELD METHOD NO.: DISNF08

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx)  
SAV Water Column Nutrients (WCNTyyyy)

COLLECTION DEVICE :

**MINI-SONE Water Nutrients; and High Resolution and Bottom Water Nutrients:**  
Gould deep well submersible pump; flow rate is 40 liters per minute.

**SAV Water Column Nutrients:** Hand held boat pump

**SAMPLE COLLECTION:**

**MINI-SONE Water Nutrients:** A bottom water sample is collected 0.5 meters above bottom using a submersible pump.

**SAV Water Column Nutrients:** A surface water sample is collected approximately 0.5 meter below the surface.

Both samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

**FILTER TYPE/PORE SIZE:** Whatman GF/F 2.5 cm diameter, 0.7 $\mu$ m glass fiber filter pad.

**SAMPLE PRESEVATION:** Frozen -20 C

**REFERENCES:**

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

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**FIELD METHOD NO.:** CDNTF16

**STUDY ELEMENT:** MINI-SONE Core Data (MNCDATxx)

**COLLECTION DEVICE:** A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

**SAMPLE COLLECTION:** One intact sediment core is obtained at each MINI-SONE station using a modified Bouma box corer. After deployment and retrieval of the box corer, the Plexiglass liner containing the sediment sample is removed and visually inspected for disturbance. The sediment fills slightly more than half the volume of the chamber, the remaining top half being filled with *in-situ* bottom water. The top and bottom of the chambers are sealed and the chambers placed in a darkened water-filled holding incubator to maintain ambient temperature. Just prior to incubation the overlying core water is replaced by fresh bottom water to ensure that water quality conditions in the core closely approximate *in-situ* conditions.

The core is transferred to a circulating, temperature controlled water bath. Oxygen probes and sample tubes are inserted (Figure 3-2) and the cores are allowed to stabilize for about 10 minutes prior to sampling. Gentle circulation of water with no sediment resuspension is maintained in the core during the measurement period via the stirring devices attached to the Orbisphere oxygen probes. A total of four water samples are extracted from the core at 60 minute intervals during the 3 hour incubation period. Water samples are filtered through Whatman GF/F 2.5 cm diameter, 0.7 µm glass fiber filters and collected in Auto- Analyzer (AA) vials and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-10. EPC Parameter: Nitrite+Nitrate**

CBP/EPC ABBREVIATION: *NO23F*

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx)  
MINI-SONE Core Data (MNCDATxx)  
SAV Water Column Nutrients (WCNTyyyy)

ANALYTICAL METHOD NO.: NO23FL01

METHOD SUMMARY: Filtered samples are passed through a granulated copper cadmium column to reduce nitrate to nitrite. The nitrite (originally present plus reduced nitrate) is then determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a reddish purple azo dye which is then measured colorimetrically using the Auto-Analyzer II. Nitrate concentration is obtained by subtracting the corresponding nitrite value from NO<sub>2</sub> + NO<sub>3</sub> concentration.

INSTRUMENTATION: Technicon Auto Analyzer II

REFERENCES:

- (1) **Technicon Industrial System.** 1977. Nitrate and nitrite in water and seawater. Technicon Industrial Method No. 158-71W/A Tentative. Technicon Industrial Systems, Tarrytown, NY 10591. p.4.  
and: United States Environmental Protection Agency. 1979. Method No. 353.2 in Methods of chemical analysis of water and wastes. United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio. Report No. EPA-600/4-79-020. March 1979. 460pp.  
as modified by: **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.17.

REPORTED UNITS: micromolar (µM)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0007 µM	May 2002

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FIELD METHOD NO.: DISNF08

STUDY ELEMENTS: MINI-SONE Water Nutrients (MNHNUTxx)  
SAV Water Column Nutrients (WCNTyyyy)

COLLECTION DEVICE :

**MINI-SONE Water Nutrients:** Gould deep well submersible pump; flow rate is 40 liters per minute.

**SAV Water Column Nutrients:** Hand held boat pump

**SAMPLE COLLECTION:**

**MINI-SONE Water Nutrients:** A bottom water sample is collected 0.5 meters above bottom using a submersible pump.

**SAV Water Column Nutrients:** A surface water sample is collected approximately 0.5 meter below the surface.

Both samples are filtered through a 2.5 cm diameter GF/F filter pad. Approximately 15 ml is collected in 3 Auto-Analyzer (AA) vials, which are triple rinsed with sample water prior to filling with sample and immediately frozen.

**FILTER TYPE/PORE SIZE:** Whatman GF/F 2.5 cm diameter, 0.7mm glass fiber filter pad.

**SAMPLE PRESEVATION:** Frozen -20 C

**REFERENCES:**

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

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**FIELD METHOD NO.:** CDNTF16

**STUDY ELEMENT:** MINI-SONE Core Data (MNCDATxx)

**COLLECTION DEVICE:** A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

**SAMPLE COLLECTION:** One intact sediment core is obtained at each MINI-SONE station using a modified Bouma box corer. After deployment and retrieval of the box corer, the Plexiglass liner containing the sediment sample is removed and visually inspected for

disturbance. The sediment fills slightly more than half the volume of the chamber, the remaining top half being filled with *in-situ* bottom water. The top and bottom of the chambers are sealed and the chambers placed in a darkened water-filled holding incubator to maintain ambient temperature. Just prior to incubation the overlying core water is replaced by fresh bottom water to ensure that water quality conditions in the cores closely approximate *in-situ* conditions.

The core is transferred to a circulating, temperature controlled water bath. Oxygen probes and sample tubes are inserted (Figure 3-2) and the core is allowed to stabilize for 10 minutes prior to sampling. Gentle circulation of water with no sediment resuspension is maintained in the cores during the measurement period via the stirring devices attached to the Orbisphere oxygen probes. A total of four water samples are extracted from the core at 60 minute intervals during the 3 hour incubation period. Water samples are filtered through Whatman GF/F 2.5 cm diameter, 0.7 µm glass fiber filters and collected in Auto- Analyzer (AA) vials and immediately frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 2.5 cm diameter, 0.7µm glass fiber filter pad.

SAMPLE PRESERVATION: Frozen -20 C

#### REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-11. EPC Parameter: Phaeophytin**

CBP/EPC ABBREVIATION: *PHEO*

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)  
Continuous Surface Water Quality Mapping, Calibration Data  
(DFslCDyyyy)

ANALYTICAL METHOD NO.: PHEOL01

METHOD SUMMARY: Prior to analysis, the sample is thawed and chlorophyll-a extracted overnight in 40 ml of 90% acetone. The sample is read flourometrically. Two drops of 1N Hydrochloric Acid are added to the sample and it is read flourometrically once more.

LABORATORY INSTRUMENTATION: Turner Designs Model TD 700

REFERENCES:

- (3) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman. 1997.** Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038. p.64 Revised February 2002.

REPORTED UNITS: micrograms per liter ( $\mu\text{g l}^{-1}$ )

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.48 $\mu\text{g l}^{-1}$	September 1998 - Present

PRECISION:	N/A	Not available
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FIELD METHOD NO.: PPCHF10

STUDY ELEMENTS: SAV Water Column Nutrients (WCNTyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy)

COLLECTION DEVICE:

**SAV Water Column Nutrients:** Hand Held Boat Pump

**Continuous Surface Water Quality Mapping:** Water discharged from a short tube located immediately after the discharge from the surface mapping instrument is collected in a 1 liter beaker.

SAMPLE COLLECTION:

**SAV Water Column Nutrients:** A water sample is taken at approximately 0.5 meters below the surface.

**Continuous Surface Water Quality Mapping:** The beaker is rinsed several times in the discharge flow, then filled with water, noting the exact time of collection (to the second) from the Global Positioning System. This facilitates later matching of chlorophyll-*a* measurements with concurrent fluorescence readings from the instrument.

Both water samples are filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

**FILTER TYPE/PORE SIZE:** Whatman GF/F 4.7 cm diameter, 0.7 $\mu$ m glass fiber filter pad.

**SAMPLE PRESEVATION:** Frozen -20 C

Samples are placed in an ice-filled cooler onboard the research vessel and frozen upon reaching shore.

**REFERENCES:**

- (4) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (5) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.
- (6) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank.** 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

## A-12. EPC Parameter: Photosynthetically Active Radiation

CBP/EPC ABBREVIATION: *EPARD\_Z*

STUDY ELEMENTS: SAV Water Column Light Attenuation Measurements (WCLTyyyy)  
Continuous Surface Water Quality Mapping (DFslCDyyyy)

FIELD METHOD NO.: EPARD\_ZF01

### METHOD SUMMARY:

**SAV Water Column Light Attenuation Measurements:** The *Li-Cor* is lowered over board and measurements taken *in-situ*.

COLLECTION DEVICE: Li-Cor Li-192SA Underwater Quantum Sensor

### SAMPLE COLLECTION:

**SAV Water Column Light Attenuation Measurements:** The *Li-Cor* Li-192SA is used in-situ where it records measurements at three depths 0.1m, 0.5m and 1.0m. These values are used to calculate  $K_d$  the extinction coefficient.

**SAV Epiphyte Light Attenuation Measurements:** A single strip is placed in a PVC transport tube that is kept in a cooler in ice during the cruise and is transported back to the laboratory. The strip is analyzed immediately upon return to the laboratory, always within 6 hours of collection.

REPORTED UNITS:  $\mu\text{M m}^{-2} \text{sec}^{-1}$  or  $\mu\text{E}$  (microEinsteins)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	$0.0 \mu\text{M m}^{-2} \text{sec}^{-1}$	1997

### REFERENCES:

- (1) **LI-COR Inc.** 1990. LI-COR Underwater Radiation Sensors, Type SA Instruction Manual, Publication No. 8609-57. LI-COR, Inc., 4421 Superior Street, P.O. Box 4425, Lincoln, NE 68504.
- (2) **Burt, J.S., G.A. Kendrick, R.J. Masini and C.J. Simpson.** 1995. Light and *Posidonia sinuosa* seagrass meadows in the temperate coastal waters of Western Australia. II. Effects of epiphytic species assemblage and biomass on attenuating light to the leaf surface. Department of Environmental Protection, Perth Western Australia Technical Series 62.

**A-13. EPC Parameter: Salinity**

CBP/EPC ABBREVIATION: *SALIN/SALINITY*

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRFxx)  
SAV Water Column Profile (WCNDyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy)

FIELD METHOD NO.: SALINITYF04

COLLECTION DEVICE: Hydrolab 4000  
Hydrolab Surveyor II  
Yellow Springs Instrument (YSI) Model 33 - Conductivity Cell  
Beckman Induction Salinometer  
Yellow Springs Instrument (YSI) Model probe 6560

SAMPLE COLLECTION: Salinity is determined automatically by the probe, from sonde conductivity and temperature readings according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (1989).

REPORTED UNITS: parts per thousand (ppt)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	400 ppt	± 0.5 ppt	July 1984 - 1998
	70 ppt	0 ppt	1999 - Present

REFERENCES:

- (1) **Operation and Maintenance Instructions, Hydrolab 4000.** 1981. Hydrolab Corporation, Austin, TX 78727.
- (2) **Surveyor II Operating Manual (and Performance Manual).** 1985. Hydrolab Corporation, Austin, TX 78727.
- (3) **Instructions for YSI Model 33 and 33M S-C-T Meters.** 1983. Scientific Division, Yellow Springs Instrument Co., Inc. Yellow Springs, OH 45387.
- (4) **YSI 6-Series Environmental Monitoring Systems.** 1999. SA Instruction Manual, Publication No. 8609-57. LI-COR, inc., 4421 Superior Street, P.O. Box 4425, Lincoln, NE 68504; #069300.
- (5) **Clesceri, L.S., A.E. Greenberg and R.R. Trussell (Editors).** 1989. Standard methods for the examination of water and water water. Method 2520.D. Am. Public Health Assoc., Washington, DC. 1268p.

**A-14. EPC Parameter: Secchi Depth**

CBP/EPC ABBREVIATION: **SECCHI**

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRFxx)  
SAV Water Column Profile (WCNDyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy)

FIELD METHOD NO.: SECCIF01

COLLECTION DEVICE: Secchi Disk

SAMPLE COLLECTION: A secchi disk measuring 25.5 cm\* diameter is used. The upper surface is divided into four equal quadrants and are colored so that the two quadrants opposite each other are black and the intervening ones are white.

Readings with the secchi disk are made *in-situ* without the aid of sunglasses. The secchi disk is lowered into the water and the depth at which it is no longer visible is recorded.

For use in continuous surface water quality measurements, the secchi depth reading is taken near the stern of the vessel and the time at which the reading is taken is noted (to the second) from the Global Positioning System. This facilitates later matching of secchi depth readings with transmissometer data.

REPORTED UNITS: meters (m)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.1 m	July 1984-Present

REFERENCES:

- (1) **Tyler, John.** 1968. The secchi disk. *Limnol. Oceanogr.* 13(1): 1-6.

**\* Note: VIMS, ODU and DNR use a 20 cm Secchi disk.**

**A-15. EPC Parameter: Surficial Sediment Particulate Carbon**

EPC ABBREVIATION: *SED PC*

STUDY ELEMENT: MINI-SONE Sediment Profile (MNSPRFxx)

ANALYTICAL METHOD NO.: SEDPCL01

METHOD SUMMARY: A known weight of dried sediment (approximately 10 mg) is placed in an aluminum capsule. Combustion of the sample occurs in pure oxygen under static conditions in an excess of oxygen at about 950 C. Detection of carbon is by thermal conductivity using an Elemental Analyzer.

INSTRUMENTATION: Exeter Analytical, Inc. (EAI) CE-440 Elemental Analyzer

REFERENCES:

- (1) **Control Equipment Corporation.** 1986. Operating Manual for Model 240 Elemental Analyzer. Lowell, MA.
- (2) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688-0038, p.49.

REPORTED UNITS: grams carbon per 100 grams of dry sediment [% (wt)]

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.13%	Oct 1987-Present

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FIELD METHOD NO.: SEDPF13

STUDY ELEMENT: MINI-SONE Sediment Profile (MNSPRFxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

SAMPLE COLLECTION: An open-ended 60 ml syringe is very slowly inserted into the intact sediment column contained within the Plexiglass microcosm, to a depth of 5-6 cm. A stopper is placed on the open end and the sample extracted. The syringe plunger is then inserted in the bottom of the syringe, the stopper removed from the top and the sediment sample slowly extruded to the desired height. Presently sediments are sampled to a depth of one centimeter. The surficial sediment sample is placed in a centrifuge tube and frozen.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

## A-16. EPC Parameter: Surficial Sediment Particulate Nitrogen

EPC ABBREVIATION: *SED PN*

STUDY ELEMENT: MINI-SONE Sediment Profile (MNSPRFxx)

ANALYTICAL METHOD NO.: SEDPNL01

METHOD SUMMARY: A known weight of dried sediment (approximately 10 mg) is placed in an aluminum capsule. Combustion of the sample occurs in pure oxygen under static conditions. Detection of nitrogen is by thermal conductivity using an Elemental Analyzer.

INSTRUMENTATION: Exeter Analytical, Inc. (EAI) CE-440 Elemental Analyzer

### REFERENCES:

- (1) **Control Equipment Corporation.** 1986. Operating Manual for Model 240-XA Elemental Analyzer. Lowell, MA.
- (2) **D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K. V. Wood and C.F. Zimmerman.** 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures. Technical Report Series No. 158-97. Chesapeake Biological Laboratory (CBL), Box 38, Solomons, MD 20688. p.49.

REPORTED UNITS: grams nitrogen per 100 grams of dry sediment [% (wt)]

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0084%	Oct 1987-Present

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FIELD METHOD NO.: SEDPF13

STUDY ELEMENT: MINI-SONE Sediment Profile (MNSPRFxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

SAMPLE COLLECTION: An open-ended 60 ml syringe is very slowly inserted into the intact sediment column contained within a Plexiglass microcosm, to a depth of 5-6 cm. A stopper is placed on the open end and the sample extracted. The syringe plunger is then inserted in the bottom of the syringe, the stopper removed from the top and the sediment sample slowly extruded to the desired height. Presently sediments are sampled to a depth of one centimeter. The surficial sediment sample is placed in a centrifuge tube and frozen.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

## A-17. EPC Parameter: Surficial Sediment Particulate Phosphorus

EPC ABBREVIATION: *SED PP*

STUDY ELEMENT: MINI-SONE Sediment Profile (MNSPRFxx)

ANALYTICAL METHOD NO.: SEDPPL01

METHOD SUMMARY: A known weight of dried sediment (50-200 mg) is placed in a muffle furnace at 550 C for 1.5 hours. The sediment is ground in a crucible and phosphorus extracted using 1N HCl. After adding reagents the "phosphomolybdenum blue" complex is read colorimetrically at 880 nm using the Auto-Analyzer II.

INSTRUMENTATION: Technicon Auto Analyzer II with IBM compatible Labtronics Inc. DP500 Software data collection system.

### REFERENCES:

- (1) **Aspila, I., H. Agemian and A.S.Y. Chau.** 1976. A semi-automated method for the determination of inorganic, organic and total phosphate in sediments. *Analyst.* 101:187-197.

REPORTED UNITS: grams phosphorus per 100 grams of dry sediment [% (wt)]

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	0.0087%	Oct 1987-Present

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FIELD METHOD NO.: SEDPF13

STUDY ELEMENT: MINI-SONE Sediment Profile (MNSPRFxx)

COLLECTION DEVICE: A sediment core is obtained using a modified Bouma box corer. These cores are then transferred to a Plexiglass cylinder (15 cm diameter x 30 cm length) and inspected for disturbances from large macrofauna or cracks in the sediment surface. If a sample is satisfactory, the core is fitted with an O-ring sealed top containing various sampling ports, and a gasket sealed bottom (Figure 3-2).

SAMPLE COLLECTION: An open-ended 60 ml syringe is very slowly inserted into the intact sediment column contained within a Plexiglass microcosm, to a depth of 5-6 cm. A stopper is placed on the open end and the sample extracted. The syringe plunger is then inserted in the bottom of the syringe, the stopper removed from the top and the sediment sample slowly extruded to the desired height. Presently sediments are sampled to a depth of one centimeter. The surficial sediment sample is placed in a centrifuge tube and frozen.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

## A-18. EPC Parameter: Temperature

CBP/EPC ABBREVIATION: **WTEMP**

STUDY ELEMENTS: MINI-SONE Water Profile (MNHPRFxx)  
SAV Water Column Profile (WCNDyyyy)  
Continuous Surface Water Quality Mapping (DFslMDmmdyy)

FIELD METHOD NO.: WTEMPF01

### COLLECTION DEVICE:

Yellow Springs Instrument (YSI) Model 600R  
Yellow Springs Instrument (YSI) 6920

### SAMPLE COLLECTION:

**MINI-SONE:** Temperature probes are directly exposed to sample water which is supplied using a Gould deep well submersible pump with a flow rate of 40 liters per minute.

**SAV Water Column Profile:** Temperature measurements are made *in-situ*. 0.5 meters below surface.

REPORTED UNITS: centigrade (C)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	45 C	0.1 C	July 1984-Present

### REFERENCE:

- (1) **Instruction Manual, 600 Multi-Parameter Water Quality Monitor.** 1996. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.
- (2) **Instruction Manual and Service Manual, YSI 6920 Multi-Parameter Water Quality Monitor.** 1996. YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

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FIELD METHOD NO.: TEMPF05

STUDY ELEMENT: Continuous Surface Water Quality Mapping (DFslMDmmdyy)

COLLECTION DEVICE: YSI 6560 Conductivity/Temperature Probe

SAMPLE COLLECTION: Water is pumped from approximately 10 cm depth at the stern of the research vessel and passes directly through a series of in-line sensors at a flow rate of at least 7 l m<sup>-1</sup>. The temperature probe is located in-line and is directly exposed to a continuous flow of ambient water. Water temperature information is transmitted directly to 650 data logger.

REPORTED UNITS: degrees centigrade (C)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	>50 C	0.1 C	June 2001-Present

REFERENCE:

- (1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

## **A-19. EPC Parameter: Total Suspended Solids**

CBP/EPC ABBREVIATION: *TSS*

FIELD METHOD NO.: TSSL01

STUDY ELEMENT: Continuous Surface Water Quality Mapping (DFslMDmmdyy)

COLLECTION DEVICE: Water discharged from a short tube located immediately after the discharge from the surface mapping instrument is collected in a 1 liter beaker.

SAMPLE COLLECTION: The beaker is rinsed several times in the discharge flow, then filled with water, noting the exact time of collection (to the second) from the Global Positioning System. This facilitates later matching of total suspended solids measurements with concurrent transmissometer readings from the mapping instrument. A known volume is filtered in the laboratory on a pre-weighed 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and placed on ice.

SAMPLE PRESERVATION: Sample bottles are placed in an ice-filled cooler on the research vessel and filtered samples prepared in the laboratory are frozen (-20 C) and stored until analyzed.

### REFERENCES:

- (1) **Boynton, W. R., R. M. Stankelis, F. M. Rohland, J. D. Hagy III, and J. M. Frank.** 1999. Ecosystem Processes Component Level 1 Interpretive Report #16. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. Solomons, MD. [UMCES]CBL Ref. No. 99-0070.

**A-20. EPC Parameter: Total Volatile Solids**

EPC ABBREVIATION: *VOLSOL*

STUDY ELEMENTS: SAV Epiphyte Biomass Measurement (EVLRYyyy)  
SAV Water Column Nutrients (WCNTyyyy)

ANALYTICAL METHOD NO.: TSSA13

METHOD SUMMARY: A known volume of water or water that also contains epiphytic material is filtered through pre-weighed filter pads. Filter pads are dried overnight at 103-105 C and weighed. Filter pads are then combusted at 550 C for 90 minutes and then re-weighed. Volatile weight is determined by subtraction.

REFERENCES:

- (1) **Clesceri, L.S., A.E. Greenberg and R.R. Trussell (Editors).** 1989. Standard methods for the examination of water and water water. Method 2540.E. Am. Public Health Assoc., Washington, DC. 1268p.

REPORTED UNITS: milligrams (mg l<sup>-1</sup>)

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	N/A	1.98 mg l <sup>-1</sup>	

PRECISION:	N/A	Not determined
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FIELD METHOD NO.: TVSF11

STUDY ELEMENT: SAV Epiphyte Biomass Measurement (EVLRRmmyy)

COLLECTION DEVICE: Mylar<sup>®</sup> strip

SAMPLE COLLECTION: Epiphytic material is removed from Mylar<sup>®</sup> strips and filtered onto the preweighed glass fiber filter.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, dried, preweighed, 0.7 µm glass fiber filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

SAMPLE PRESERVATION: Frozen -20 C

REFERENCES:

- (1) **Boynnton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological

FIELD METHOD NO.: TVSF12

STUDY ELEMENT: SAV Water Column Nutrients (WCNTyyyy)

COLLECTION DEVICE: Hand held boat pump

SAMPLE COLLECTION: A water sample of surface (approximately 0.5 meter below surface) or bottom (approximately 0.5 meter above bottom) is collected using a hand pump.

The water sample is filtered through an untreated 4.7 cm diameter GF/F filter pad. The filter pad is folded in half inward, wrapped in aluminum foil and frozen.

FILTER TYPE/PORE SIZE: Whatman GF/F 4.7 cm diameter, 0.7 $\mu$ m glass fiber filter pad.

SAMPLE PRESEVATION: Frozen -20 C

REFERENCES:

- (1) **Garber, J.H., W.R. Boynton and W.M. Kemp.** 1987. Ecosystem processes component study plan and budget for FY-88. Maryland Office of Environmental Programs. Maryland Chesapeake Bay Water Quality Monitoring Program. Chesapeake Biological Laboratory (CBL), University of Maryland, Solomons, MD. [UMCEES]CBL Ref. No. 89-050. p.25.
- (2) **Boynton, W.R. and F.M. Rohland (editors); R.M. Stankelis, N.H. Burger, J.D. Hagy III, J.M. Frank, L.L. Matteson and M.M. Weir.** 1998. Ecosystem Processes Component Level 1 Interpretive Report No. 15. Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, Solomons, MD 20688-0038. Ref No. [UMCES] CBL 98-073a.

**A-21. EPC Parameter: Turbidity**

CBP/EPC Abbreviation: **TURB\_NTU**

STUDY ELEMENT: Continuous Surface Water Quality Mapping (DFslMDmmdyy)

FIELD METHOD NO.: TURB\_NTUL01

COLLECTION DEVICE: YSI 6026 Turbidity Probe.

**SAMPLE COLLECTION:**

A filtered, single wavelength light source is passed through a 10 cm column of continuously flowing seawater. A photodiode sensor converts returns a voltage proportional to the amount of transmitted light. This voltage is sensed and recorded by the datalogger. Volatages are converted nephelometric turbidity units (NTU) via a calibration curve established in the laboratory. The water sample is pumped from approximately 0.5 M depth at the stern of the research vessel directly through a series of in-line sensors at a flow rate of 4.5 l m<sup>-1</sup>.

REPORTED UNITS: nephelometric turbidity units (NTU).

DETECTION LIMITS:	Upper Limit	Lower Limit	Dates Valid
	200 NTU	0.1 NTU	June 2001-Present

**REFERENCE:**

- (1) **Environmental Monitoring Systems Operating Manual; YSI 6 series: 6600 Sonde.** YSI Incorporated, 1725 Brannum Lane, Yellow Springs, OH 45387.

# **APPENDIX B: SAMPLE DATA SHEETS**

**B-1. MINI-SONE Cruise, September 2001.**

**Cruise Plan: September 2001 - MINI-SONE**

**Crew:** B.Bean, H.Pine, B.Stankelis and J.Frank

**Date:** Wednesday, September 12, 2001

**Research Vessel:** Aquarius

**Sites:** 4 long-term sites in the Patuxent River,  
STLC, BRIS, MRPT and BUVA

**Tasks:** The usual taking of mud and water,  
Extra cores will be needed at STLC for an in-lab experiment.

**Tuesday September 11:** Load Aquarius.

**Wednesday September 12:** Depart at 0545 a.m.. Dead head to BUVA and work down river, four long term sites (BUVA, MRPT, BRIS and STLC). Unload and clean the Aquarius.

**Thursday September 13:** Alternate weather day.

Meals Requested: Breakfast and Lunch



**B-3. MINI-SONE: Sediment Oxygen and Nutrient Exchanges  
Sediment Profile Data Sheet**

SEDIMENT CORE Eh DETERMINATIONS			
CRUISE ID:			

STATION:	
DATE:	
START TIME:	
ZOBEL'S SOLN:	
(~191mv)	
DEPTH (cm)	Eh (+ or -) mv
OW +1	
0	
-1	
-2	
-3	XX
-4	XX
-5	
-6	XX
-7	XX
-8	XX
-9	XX
-10	XX
BW AA VIAL #	
END TIME:	
CREW:	

STATION:	
DATE:	
START TIME:	
ZOBEL'S SOLN:	
(~191mv)	
DEPTH (cm)	Eh (+ or -) mv
OW +1	
0	
-1	
-2	
-3	XX
-4	XX
-5	
-6	XX
-7	XX
-8	XX
-9	XX
-10	XX
BW AA VIAL #	
END TIME:	
CREW:	

STATION:	
DATE:	
START TIME:	
ZOBEL'S SOLN:	
(~191mv)	
DEPTH (cm)	Eh (+ or -) mv
OW +1	
0	
-1	
-2	
-3	XX
-4	XX
-5	
-6	XX
-7	XX
-8	XX
-9	XX
-10	XX
BW AA VIAL #	
END TIME:	
CREW:	

**B-4. MINI-SONE: Sediment Oxygen and Nutrient Exchanges  
Benthic Flux Data Sheet**

<b>STATION:</b>		<b>CORE #:</b>				
<b>DATE:</b>		<b>COLOR:</b>				
<b>VOLUME:</b>						
	<b>BOTTOM WATER</b>	<b>PRECAL.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>TIME</b>						
<b>DO</b>						
<b>TEMP</b>						
<b>AA#</b>						
<b>CREW</b>						

<b>STATION:</b>		<b>CORE #:</b>				
<b>DATE:</b>		<b>COLOR:</b>				
<b>VOLUME:</b>						
	<b>BOTTOM WATER</b>	<b>PRECAL.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>TIME</b>						
<b>DO</b>						
<b>TEMP</b>						
<b>AA#</b>						
<b>CREW</b>						

**B-5. SAV HABITAT EVALUATION: Water Column and SAV Field Data Sheet**

<b>Near Shore Water Quality Evaluation</b>						
Technician		<u>Light Attenuation</u>		PAR		
Station:		Depth 1:		PAR		
Date:		Depth 2:				
Time:		Depth 3:				
Latitude:		Secchi:				
Longitude:		<b>Dataflow/SAV Data</b>				
<b>Station Conditions</b>		Temperature:				
Depth:		Salinity:				
Air Temp:		Conductivity:				
Cloud Cover (~%):		DO %:				
Wind (direction/~speed)		DO:				
Wave Condition:		Transmissometer:				
<b>Filtering Data</b>		Chlorophyll:				
CHLA volume filtered:		Fluorometer:				
TVS pad numbers:		<b>Comments</b>				
TVS volume filtered:						
<b>E-TVS</b>	Pad #				Diluted Vol	Filtered Vol.

Technician		<u>Light Attenuation</u>		PAR		
Station:		Depth 1:		PAR		
Date:		Depth 2:				
Time:		Depth 3:				
Latitude:		Secchi:				
Longitude:		<b>Dataflow/SAV Data</b>				
<b>Station Conditions</b>		Temperature:				
Depth:		Salinity:				
Air Temp:		Conductivity:				
Cloud Cover (~%):		DO %:				
Wind (direction/~speed)		DO:				
Wave Condition:		Transmissometer:				
<b>Filtering Data</b>		Chlorophyll:				
CHLA volume filtered:		Fluorometer:				
TVS pad numbers:		<b>Comments</b>				
TVS volume filtered:						
<b>E-TVS</b>	Pad #				Diluted Vol	Filtered Vol.

## **B-6.1. DATAFLOW V Cruise Plan: Tangier Sound R/V Outrage**

**5/21/2001 - 5/24/2001**

**Area of Operations:** Tangier Sound north of 37° 57' and the following tributary rivers: Little Annemessex River to Crisfield, Big Annemessex River to Moon Bay, Manokin River to Locust Pt, Wicomico River to Halland Point (including Monie Bay), Nanticoke River to Runaway Pt. and Fishing Bay to Point No Point.

**Scientists:** *J. M. Lawrence, B.W. Bean.*

**Objectives:** Map water column properties relevant to light attenuation within the study area. Map any differences in water quality parameters that occur along inshore-offshore transects and depth gradients throughout the study region.

### **Cruise Schedule:**

#### *Monday:*

5/21/2001 Load batteries, pump and dabbler and all equipment into vehicle. Perform calibrations on dissolved oxygen, water temperature, and conductivity probes. Charge deep-cycle batteries.

#### *Tuesday:*

5/22/2001 0530 Prepare for departure.

600 Depart Solomons, to Little Deal Island towing R/V Outrage.

1000 Mapping in Upper Sound (1 calibration station), Monie Bay (1 calibration station), Wicomico (1 calibration station), Nanticoke (1 calibration station) Fishing Bay (2 calibration stations). 7 hours.  
20 minutes are spent at each calibration station.

1700 Back to Deal Island, back to Crisfield.

1800 Reach Crisfield, refuel.

1900 - 2200 Filter water samples.

#### *Wednesday:*

5/23/2001 0700 Launch at Janes Island State Park.

800 Mapping in the Little Annemessex (1 calibration station), Smith Island (2 calibration stations), South Marsh Island (3 calibration station), Manokin River (2 calibration stations) and Lower Sound (1 calibration station).

1600 Reach Janes Island, back to Crisfield.

1800 Reach Crisfield, refuel.

1900 - 2200 Filter water samples.

*Thursday:*

5/24/2001 0700 Launch at Janes Island State Park.

800 Mapping in the Big Annemessex River (2 calibration stations).

1100 Reach Janes Island. Drive back to Solomons, unload and clean,

1500 - 1600 Filter water samples.

### **Table of Tangier Sound Stop Stations Locations**

Stop Station Abbreviation	River	Latitude	Longitude
MRGC	Manokin	38° 08.830'	75° 50.344'
J11G	Big Annemessex	38° 01.642'	75° 50.506'
J12G	Little Annemessex	37° 58.194'	75° 52.493'
SIBT	Smith Island	37° 58.127'	75° 59.551'
SIBC	Smith Island	38° 02.025'	76° 00.650'
SMSP	South Marsh Island	38° 04.321'	76° 01.172'
ET9.1	Big Annemessex	38° 03.380'	75° 48.289'
TM03	Manokin	38° 05.071'	75° 53.874'
TM04	South Marsh Island	38° 06.694'	76° 00.867'
TM06	South Marsh Island	38° 07.015'	76° 04.030'
TM07	Fishing Bay	38° 16.852'	76° 00.872'
TM08	Fishing Bay	38° 20.013'	76° 00.228'
TM09	Nanticoke	38° 18.101'	75° 54.968'
TM10	Monie Bay	38° 11.980'	75° 53.001'
TM11	Wicomico	38° 14.932'	75° 50.427'
EE3.1	Upper Sound	38° 11.730'	75° 58.427'
ET8.1	Manokin	38° 08.234'	75° 48.208'
EE3.2	Lower Sound	37° 58.825'	75° 55.395'

**B-6.2. Continuous Surface Water Quality Measurements:  
Field Calibration Data Set: File DFslCDyyyy**

TABLE E-1.1. TANGIER SOUND, MAGOTHY AND SEVERN RIVERS CONTINUOUS SURFACE WATER QUALITY MEAUREMENTS DATAFLOW STATION AND CALIBRATION DATA 2001

VARIABLE	DEFINITION	UNITS
STATION	Calibration Station	
DATE	Sampling Date	YYYYMMDD Year-Month-Day
TIME	Time	hh:min:sec
LATITUDE	Location of calibration station	DD.DDDD Degrees North Latitude decimal degrees
LONGITUDE	Location of calibration station	DD.DDDD Degrees West Latitude decimal degrees
SECCHI DEPTH	Maximum visual depth	meters (m)
DEPTH	Meters	meters (m)
D1	Depth at first light flux measurement	meters (m)
D2	Depth at second light flux measurement	
D3	Depth at third light flux measurement	
Light Flux 1	PAR1 - photosynthetically active radiation at D1	micromol per meter square per second $\mu\text{M m}^{-2} \text{s}^{-1}$
Light Flux 2	PAR2 - photosynthetically active radiation at D2	micromol per meter square per second $\mu\text{M m}^{-2} \text{s}^{-1}$
Light Flux 3	PAR3 - photosynthetically active radiation at D3	micromol per meter square per second $\mu\text{M m}^{-2} \text{s}^{-1}$
Kd1	Light attenuation calculated between D1 and D2	$\text{m}^{-1}$
Kd2	Light attenuation calculated between D1 and D2	$\text{m}^{-1}$
Kd3	Mean Kd calculated from Kd2 and Kd3	$\text{m}^{-1}$
TRANSMISSOMETER*	Transmissometer sensor output	nephelometric turbidity units (NTU)
FLOUROMETER	Flourescence (% full scale)	%FS
CHLOROPHYLL	Calculated from florescence on YSI probe	$\mu\text{g l}^{-1}$
TSS	Total suspended solids	milligram per liter ( $\text{mg l}^{-1}$ )
TVS	Total volatile solids	milligram per liter (mg l)
CHLa-T	The total chlorophyll-a of a water sample is acidified and measured fluorometrically.	$\mu\text{g l}^{-1}$
PHAEOPHYTIN	Readings are taken before and after acidification of ground extract using 2 drops of 1 N HCl to fluorometrically measure phaeophytin.	$\mu\text{g l}^{-1}$
CHLa-A	The total chlorophyll-a of a water sample is acidified and measured fluorometrically. Active chlorophyll-a is then determined by subtracting the value obtained following acidification from the total chlorophyll-a value	$\mu\text{g l}^{-1}$

**NOTES:**

DATAFLOW parameters reported in 1999 and 2000 remain equivalent, however, several changes in parameter headings were made in 2000 to conform to other portions of the EPC monitoring program. These changes in parameter headings are as follows:

Z1, Z2 and Z3 will now be listed under the heading D1, D2, D3, PAR1, PAR2 and PAR3 will now be listed under the heading Light Flux 1, Light Flux 2 and Light Flux 3.

Units of transmissoter measurements taken in 1999 and 2000 were in volts (V).

### **B-6.3. Continuous Surface Water Quality Mapping: Calibration Stations.**

Approximately 20 stop stations are planned to obtain measurements for field calibrations of the fluorometer and transmissometer. At each stop station we will:

- (1) Record time of arrival from GPS.
- (2) Record approximate wind speed and direction.
- (3) Take Secchi Depth reading, noting exact time of reading from GPS.
- (4) Take series of PAR measurements (0.1, 0.5, 1.0 m).
- (5) Collect water to filter for chlorophyll-*a* and TSS analysis in the laboratory.

#### **Equipment Needed:**

##### Light Measurements:

1. Secchi Disk with Cable.
2. *Li-Cor* Light Meter.

##### Chlorophyll-*a* and TSS Samples (in laboratory):

1. 2 Glass flasks with electric Vacuum pump, 2 vacuum filtration columns.
2. 60 cc syringe for measuring water.
3. 250 ml graduated cylinder for measuring water for TSS.
4. 36 pre-weighed filter pads for TSS
5. 18 filter pads for chlorophyll-*a*.
6. Foil packets for filters.
7. Zip-lock bag for samples that are placed in the freezer.
8. Cooler for water samples.

##### DATAFLOW V

1. 1 battery charger to charge battery at night.

#### B-6.4. Location of Data Flow V Calibration Stations: Magothy and Severn Rivers 2001.

<b>Station</b>	<b>Latitude</b>	<b>Longitude</b>
<b><i>Magothy River</i></b>		
MG01	39° 03.482'	76° 26.105'
MG02	39° 03.189'	76° 26.934'
MG03	39° 04.037'	76° 28.661'
MG04	39° 04.588'	76° 30.211'
MG05	39° 05.194'	76° 31.495'
MG06	39° 05.189'	76° 28.870'
MG07	39° 05.321'	76° 26.048'
MG08	39° 04.683'	76° 27.349'
<b><i>Severn River</i></b>		
Station	Latitude	Longitude
SR01	38° 58.088'	76° 27.215'
SR02	39° 00.162'	76° 29.433'
SR03	39° 00.438'	76° 30.334'
SR04	39° 02.295'	76 32.148'
SR05	39° 03.089'	76° 32.995'
SR06	39° 03.777'	76° 34.211'
SR07	39° 02.253'	76° 34.151'
SR08	39° 01.232'	76° 31.593'

**B-6.5. DATAFLOW V Calibration Stations Data Sheet.**

<b>Near Shore Water Quality Evaluation</b>				
Technician		<u>Light Attenuation</u>		PAR
Station:		Depth 1:		PAR
Date:		Depth 2:		
Time:		Depth 3:		
Latitude:		Secchi:		
Longitude:		<b>Dataflow/SAV Data</b>		
<b>Station Conditions</b>		Temperature:		
Depth:		Salinity:		
Air Temp:		Conductivity:		
Cloud Cover (~%):		DO %:		
Wind (diection/~speed)		DO:		
Wave Condition:		Transmissometer:		
<b>Filtering Data</b>		Chlorophyll:		
CHLA volume filtered:		Flourometer:		
TVS pad numbers:		<b>Comments</b>		
TVS volume filtered:				
<b>E-TVS</b>	Pad #	Diluted Vol	Filtered Vol.	

Technician		<u>Light Attenuation</u>		PAR
Station:		Depth 1:		PAR
Date:		Depth 2:		
Time:		Depth 3:		
Latitude:		Secchi:		
Longitude:		<b>Dataflow/SAV Data</b>		
<b>Station Conditions</b>		Temperature:		
Depth:		Salinity:		
Air Temp:		Conductivity:		
Cloud Cover (~%):		DO %:		
Wind (diection/~speed)		DO:		
Wave Condition:		Transmissometer:		
<b>Filtering Data</b>		Chlorophyll:		
CHLA volume filtered:		Flourometer:		
TVS pad numbers:		<b>Comments</b>		
TVS volume filtered:				
<b>E-TVS</b>	Pad #	Diluted Vol	Filtered Vol.	

**B-6.6. DATAFLOW V Calibration Stations Data (Example).**

TABLE E-1.3. MAGOTHY RIVER CONTINUOUS SURFACE WATER MAPPING CALIBRATION DATA 2001

Kd1 calculated from PAR light flux measured at D1 and D2 (or D1 and D2T1)

Kd2 calculated from PAR light flux measured at D2 and D3 (or D2T2 and D3)

FILENAME: DFMRC2001

Calibration Station	Date	Latitude	Longitude	Secchi (m)	Depth No.	Depth (m)	Light flux (D1-D2) (D2-D3) $\mu\text{mol}/\text{m}^2/\text{s}$	Kd1	Kd2	MEAN Kd	Trans (NTU)	Flouro meter (Fs)	Chloro phyll ( $\mu\text{g l}^{-1}$ )	TSS ( $\text{mg l}^{-1}$ )	TVS ( $\text{mg l}^{-1}$ )	CHLa-T ( $\mu\text{g l}^{-1}$ )	PHAEO ( $\mu\text{g l}^{-1}$ )	CHLa-A ( $\mu\text{g l}^{-1}$ )		
MG01	20010418	39.0532	-76.4489	0.70	D1	0.10	952.40	1.95	1.86	1.90	16.3	2.2	9.4	15.20	4.20	18.59	4.73	16.25		
					D2	0.50	436.90													
					D3	1.00	172.50													
MG02	20010418	39.0673	-76.4777	0.90	D1	0.10	1441.00	1.56	1.68	1.62	7.3	3.1	13.9	11.20	4.40	29.61	5.42	26.93		
					D2	0.50	773.40													
					D3	1.00	334.20													
MG03	20010418	39.0765	-76.5035	1.20	D1	0.10	1447.10	1.23	SW	1.23	4.5	2.7	11.9	9.20	4.20	25.45	5.61	22.67		
					D2	0.50	886.10													
					D3	YY	YY													
MG04	20010418	39.0866	-76.5249	1.10	D1	0.10	1498.60	1.35	1.40	1.37	5.1	2.3	10.3	10.40	4.80	22.34	6.09	19.33		
					D2	0.50	875.00													
					D3	1.00	433.50													
MG05	20010418	39.0865	-76.4812	1.00	D1	0.10	1687.70	1.11	1.10	1.11	4.7	2.0	8.4	9.80	3.60	25.54	4.35	23.38		
					D2	0.50	1081.70													
					D3	1.00	623.10													
MG06	20010418	39.0887	-76.4341	0.90	D1	0.10	1831.00	1.25	1.50	1.38	9.0	1.8	7.6	11.60	3.40	17.91	3.86	16.00		
					D2	0.50	1112.00													
					D3	1.00	524.20													
MG07	20010418	39.0781	-76.4558	0.40	D1	0.10	1442.60	2.92	2.74	2.83	30.4	2.0	8.9	24.40	4.40	19.66	6.02	16.69		
					D2	0.50	449.40													
					D3	1.00	114.46													
MG08	20010418	39.0580	-76.4351	0.45	D1	0.10	374.60	2.74	3.04	2.89	30.9	2.6	11.3	24.00	4.80	16.28	5.78	13.42		
					D2	0.50	124.97													
					D3	1.00	27.27													

## **B-6.6. Continuous Surface Water Quality Measurements. DATAFLOW V Mapping Data**

### **FILE NAME: DfsIMDmmddy:**

Excel file, the name follows a 12 part descriptor, consisting of an identification of the data set, the location of the data, the data type and date: where DF = DATAFLOW V; MR = Magothy River, SR = Severn River, MD = Mapping data, mmddy - date, month, day, year.

### **MEASUREMENTS:**

Date, time, latitude, longitude for each record of water temperature, salinity, dissolved oxygen, total chlorophyll-*a*, fluorescence and transmissometer values. Due to the large quantity of data not hard copy will be provided.

### **PARAMETERS:**

DATE	YYYYMMDD, Year, Month, Day
TIME	HHMMSS, Hours, Minutes, Seconds
LATITUDE	DD.DDDD, Degrees North Latitude
LONGITUDE	DD.DDDD, Degrees West Longitude
TOTAL DEPTH	meters (m)
TEMPERATURE	degrees Celsius (C)
CONDUCTIVITY	millisiemens per centimeter (mS/cm)
SALINITY	parts per thousand (ppt)
DO %	percentage (%)
DO CONC	milligrams per liter (mg l <sup>-1</sup> )
TURBIDITY	nephelometric turbidity units (NTU)
TOTAL CHLOROPHYLL-A	micrograms per liter (µg l <sup>-1</sup> )
FLUORESCENCE	(%FS)

# APPENDIX C: SAMPLE DATA SHEETS (Hardcopy)

## Appendix C-1.1:

TABLE D-1.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 PATUXENT RIVER: MINI-SONE  
 WATER COLUMN PROFILES: Vertical profiles of temperature, salinity, dissolved oxygen  
 and other characteristics at MINI-SONE stations

MINI-SONE CRUISE: 21  
 FILENAME : MNHPRF21  
 REVISED : 20010618

STATION	DATE	TIME	TOTAL	SECCHI	GEAR	SAMPLE	TEMP	COND	SALIN	DO	DO SAT
			DEPTH	DEPTH	CODE	DEPTH					
			(m)	(m)			(°C)	(mmho cm <sup>-1</sup> )	(ppt)	(mg l <sup>-1</sup> )	(%)
BUVA	20010614	942	6.0	0.7	WP13	0.5	26.6	15.2	8.6	6.55	85.7
						3.0	24.3	17.8	10.3	1.59	20.1
						5.0	23.9	18.1	10.5	1.17	14.7
MRPT	20010614	825	7.0	0.9	WP13	0.5	26.7	18.6	10.8	8.61	114.2
						2.0	26.5	18.4	10.7	7.70	101.7
						4.0	23.6	18.9	11.0	0.31	3.9
						6.0	21.3	21.2	12.5	0.38	4.6
BRIS	20010614	727	16.0	1.7	WP13	0.5	26.1	20.0	11.7	8.70	114.8
						3.0	24.8	20.2	11.9	5.70	73.6
						5.0	21.9	21.3	12.6	0.35	4.3
						7.0	21.4	21.8	12.9	0.12	1.5
						9.0	21.3	22.3	13.3	0.31	3.8
						11.0	21.0	23.9	14.3	0.60	7.3
						13.0	20.8	24.6	14.8	0.66	8.0
15.0	20.3	25.9	15.7	0.48	5.8						
STLC	20010614	632	7.0	1.7	WP13	0.5	26.2	20.4	12.0	9.12	120.8
						2.0	24.9	20.4	12.0	7.07	91.5
						4.0	22.5	21.2	12.5	2.16	26.8
						6.0	21.7	22.1	13.1	0.78	9.6

**Appendix C-1.2:**

TABLE D-2.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 PATUXENT RIVER: MINI-SONE  
 WATER COLUMN NUTRIENTS: Dissolved and particulate nutrient concentrations  
 in bottom waters

MINI-SONE CRUISE: 21  
 FILENAME : MNHNUT21  
 REVISED : 20010808

STATION	DATE	TOTAL DEPTH (m)	SAMPLE DEPTH (m)	SAMPLE #	DISSOLVED NUTRIENTS						
					NH <sub>4</sub> <sup>+</sup> (μM)	NO <sub>2</sub> <sup>-</sup> (μM)	NO <sub>2</sub> <sup>-</sup> +NO <sub>3</sub> <sup>-</sup> (μM)	TDN (μM)	CORR DIP (μM)	TDP (μM)	SI(OH) <sub>4</sub> <sup>-</sup> (μM)
BUVA	20010614	6.0	5.5	116	0.4	0.26	0.10	UU	0.28	UU	UU
MRPT	20010614	7.0	6.5	111	11.0	0.06	0.44	UU	0.29	UU	UU
BRIS	20010614	16.0	15.5	106	18.1	0.31	0.10	UU	0.28	UU	UU
STLC	20010614	7.0	6.5	101	10.5	0.39	2.52	UU	0.10	UU	UU

### Appendix C-1.3:

TABLE D-3.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 PATUXENT RIVER: MINI-SONE  
 SEDIMENT PROFILES: Vertical sediment profiles of Eh and surficial  
 sediment characteristics at MINI-SONE stations

SEDCHL CRUISE: 21  
 FILENAME : MNSPRF12  
 REVISED : 20010808

STATION	DATE	TIME	CORE DEPTH (cm)	Eh MEAS (mV)	Eh CORR (mV)	SURFICIAL SEDIMENT PARTICULATES				
						SED PC %(wt)	SED PN %(wt)	SED PP %(wt)	SED CHLa TOTAL (mg m <sup>-2</sup> )	SED CHLa ACTIVE (mg m <sup>-2</sup> )
BUVA	20010614	927	1.0	140	384					
			0.0	156	400					
			-1.0	129	373	2.96	0.36	0.103	38.4	6.3 (1 cm)
			-2.0	146	390					
			-3.0	HH	HH					
			-4.0	HH	HH					
			-5.0	147	391					
			-6.0	HH	HH					
			-7.0	HH	HH					
			-8.0	HH	HH					
			-9.0	HH	HH					
			-10.0	HH	HH					
MRPT	20010614	820	1.0	163	407					
			0.0	-111	133					
			-1.0	-154	90	3.26	0.440	0.084	101.1	61.3 (1 cm)
			-2.0	-177	67					
			-3.0	HH	HH					
			-4.0	HH	HH					
			-5.0	-189	55					
			-6.0	HH	HH					
			-7.0	HH	HH					
			-8.0	HH	HH					
			-9.0	HH	HH					
			-10.0	HH	HH					

**Appendix C-1.4.:**

TABLE D-4.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 PATUXENT RIVER: MINI-SONE  
 CORE DATA: Dissolved nutrient and oxygen concentrations in MINI-SONE  
 sediment-water flux chambers

MINI-SONE CRUISE: 21  
 FILENAME : MNCDAT21  
 REVISED : 20020121

STATION	DATE	CORE NO	TIME OF SAMPLE		TIME DELTA (min)	TIME SUM (min)	DO (mg l <sup>-1</sup> )	AA		NO <sub>2</sub> <sup>-</sup> (μM)	NO <sub>2</sub> <sup>-</sup> +NO <sub>3</sub> <sup>-</sup> (μM)	DIP (μM)
			hr	min				VIAL NO	NH <sub>4</sub> <sup>+</sup> (μM)			
BUVA	20010614	1	11	10	0	0	1.33	117	1.30	0.08	0.15	0.36
			12	10	60	60	0.94	118	3.20	0.15	0.19	0.37
			13	10	60	120	0.60	119	5.10	0.12	0.31	0.43
			14	10	60	180	0.40	120	6.60	0.12	0.23	0.44
MRPT	20010614	1	9	55	0	0	0.29	112	11.70	0.07	0.21	0.38
			10	55	60	60	0.18	113	14.80	0.11	0.13	0.61
			11	55	60	120	0.14	114	18.10	0.43	0.28	0.79
			12	55	60	180	0.07	115	19.40	0.12	0.13	0.93
BRIS	20010614	1	8	50	0	0	0.62	107	19.00	0.29	1.53	0.18
			9	50	60	60	0.34	108	21.30	0.32	1.33	0.23
			10	50	60	120	0.20	109	22.50	0.26	1.51	0.27
			11	50	60	180	0.14	110	24.50	0.28	0.97	0.23
STLC	20010614	1	7	40	0	0	0.75	102	11.80	0.78	2.67	0.23
			8	35	55	55	0.47	103	13.20	0.38	2.07	0.13
			9	35	60	115	0.28	104	15.10	0.62	1.79	0.13
			10	35	60	175	0.18	105	16.30	0.38	1.58	0.16

## Appendix C-1.5:

TABLE D-5.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 SEDIMENT-WATER FLUX: Net sediment-water exchange rates of dissolved  
 oxygen [ $\text{gO}_2/(\text{m}^2.\text{day})$ ] and nutrients [ $\mu\text{MN}$ , P, Si and S/ $(\text{m}^2.\text{hr})$ ]

MINI-SONE CRUISE: 21  
 FILENAME : MNFLUX21  
 REVISED : 20020213

STATION	DATE	CORE H <sub>2</sub> O			DO	DO	NH <sub>4</sub> <sup>+</sup>	NH <sub>4</sub> <sup>+</sup>
		NO	VOL (ml)	DEPTH (m)	SLOPE [mg/(l.min)]	FLUX [gO <sub>2</sub> /(m <sup>2</sup> .day)]	SLOPE ( $\mu\text{MN}/\text{min}$ )	FLUX [ $\mu\text{MN}/(\text{m}^2.\text{hr})$ ]
BUVA	20010614	1	1700	0.122	-0.005217	-0.92	0.029667	217.7
MRPT	20010614	1	1660	0.119	-0.001167	-0.20	0.044000	315.3
BRIS	20010614	1	1600	0.115	-0.002633	-0.44	0.029500	203.7
STLC	20010614	1	1640	0.118	-0.003233	-0.55	0.026316	186.3

TABLE D-5.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 SEDIMENT-WATER FLUX: Net sediment-water exchange rates of dissolved  
 oxygen [ $\text{gO}_2/(\text{m}^2.\text{day})$ ] and nutrients [ $\mu\text{MN}$ , P, Si and S/ $(\text{m}^2.\text{hr})$ ]

MINI-SONE CRUISE: 21  
 FILENAME : MNFLUX21  
 REVISED : 20020213

STATION	DATE	CORE H <sub>2</sub> O			NO <sub>2</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup> + NO <sub>3</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup> + NO <sub>3</sub> <sup>-</sup>
		NO	VOL (ml)	DEPTH (m)	SLOPE [mg/(l.min)]	FLUX [ $\mu\text{MN}/(\text{m}^2.\text{hr})$ ]	SLOPE [ $\mu\text{MN}/(\text{l.min})$ ]	FLUX [ $\mu\text{MN}/(\text{m}^2.\text{hr})$ ]
BUVA	20010614	1	1700	0.122	0.000000	0.00	0.000429	3.15
MRPT	20010614	1	1660	0.119	0.000000	0.00	0.000000	0.00
BRIS	20010614	1	1600	0.115	0.000000	0.00	0.000000	0.00
STLC	20010614	1	1640	0.118	0.000000	0.00	-0.006034	-42.72

TABLE D-5.21. MARYLAND CHESAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
 ECOSYSTEM PROCESSES COMPONENT  
 SEDIMENT OXYGEN AND NUTRIENT EXCHANGES (SONE)  
 SEDIMENT-WATER FLUX: Net sediment-water exchange rates of dissolved  
 oxygen [ $\text{gO}_2/(\text{m}^2.\text{day})$ ] and nutrients [ $\mu\text{MN}$ , P, Si and S/ $(\text{m}^2.\text{hr})$ ]

MINI-SONE CRUISE: 21  
 FILENAME : MNFLUX21  
 REVISED : 20020213

STATION	DATE	NO	CORE H <sub>2</sub> O		DIP	DIP
			VOL (ml)	DEPTH (m)	SLOPE [ $\mu\text{MP}/(\text{l}.\text{min})$ ]	FLUX [ $\mu\text{MP}/(\text{m}^2.\text{hr})$ ]
BUVA	20010614	1	1700	0.122	0.000500	3.67
MRPT	20010614	1	1660	0.119	0.003050	21.85
BRIS	20010614	1	1600	0.115	0.000750	5.18
STLC	20010614	1	1640	0.118	0.000000	0.00

## Appendix C-2.1:

TABLE F-1.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
ECOSYSTEM PROCESSES COMPONENT  
PATUXENT RIVER AND TANGIER SOUND:  
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY  
WATER QUALITY CONDITIONS: Temperature, salinity, dissolved oxygen  
and other characteristics measured at  
0.5m below surface at SAV stations  
Note: Secchi depth reading noted with + symbol denotes max water  
column depth, true secchi depth actually greater than value listed

FILENAME: WCND2001  
REVISED : 20001103

STATION	DATE	STATION DEPTH (m)	SECCHI DEPTH (m)		TEMP (°C)	COND (mS)	SAL (ppt)	DO (mg l <sup>-1</sup> )	DO SAT (%)
SIBT	20010515	0.65	0.70	+	19.86	17.52	25.57	10.60	128.60
SIBC	20010515	0.80	0.80	+	20.38	16.32	24.24	12.32	150.10
SMSP	20010515	1.10	1.00	+	18.35	15.45	22.05	8.53	99.50
MRGC	20010515	1.20	1.20		19.26	16.57	23.97	7.64	91.40
JI1G	20010515	1.00	0.95		19.21	17.92	25.75	9.34	112.60
JI2G	20010515	0.95	0.90	+	19.38	18.74	26.94	11.32	137.50
SIBT	20010523	0.90	0.80		20.23	16.53	26.90	8.61	YY
SIBT	20010523	0.90	0.80		20.23	16.53	26.90	8.61	YY
SMSP	20010523	1.20	0.50		20.47	25.51	25.50	8.16	99.20
MRGC	20010523	1.20	0.95		22.21	15.44	25.30	8.70	109.20
JI1G	20010524	0.80	0.80	+	21.26	17.53	28.40	7.11	88.80
JI2G	20010523	1.00	0.90		19.80	17.59	28.46	7.83	95.20
SIBT	20010529	1.00	0.90		20.10	18.33	26.79	7.00	86.00
SIBC	20010529	0.90	0.90	+	20.22	17.94	26.34	7.00	86.00
SMSP	20010529	0.80	YY		20.35	15.97	23.75	7.83	95.10
MRGC	20010529	0.85	0.85	+	21.11	14.84	22.45	8.53	104.10
JI1G	20010529	0.90	0.90	+	21.72	17.90	27.14	7.54	95.50
JI2G	20010529	1.20	0.80		20.28	18.32	26.89	6.76	83.30

**Appendix C-2.2:**

TABLE F-2.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
ECOSYSTEM PROCESSES COMPONENT  
PATUXENT RIVER AND TANGIER SOUND:  
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY  
WATER COLUMN LIGHT ATTENUATION MEASUREMENTS:  
Kd1 = Light attenuation coefficient calculated from PAR @ D1 and D2,  
Kd2 = Light attenuation coefficient calculated from PAR @ D2 and D3.

FILENAME: WCLT2001  
REVISED : 20001103

STATION	DATE	DEPTH NO	DEPTH (m)	PAR $\mu\text{mol}/\text{m}^2/\text{s}$	Kd1 (D1-D2)	Kd2 (D2-D3)	MEAN Kd
SIBT	20010515	D1	0.10	1778.30			
		D2	0.50	1148.00			
		D3	SW	SW	1.09	SW	1.09
SIBC	20010515	D1	0.10	698.20			
		D2	0.50	535.60			
		D3	SW	SW	0.66	SW	0.66
SMSP	20010515	D1	0.10	854.40			
		D2	0.50	561.20			
		D3	0.80	400.60	1.05	1.12	1.09
MRGC	20010515	D1	0.10	1117.50			
		D2	0.50	724.70			
		D3	1.00	385.80	1.08	1.26	1.17
JI1G	20010515	D1	0.10	1607.00			
		D2	0.50	872.70			
		D3	0.80	650.30	1.53	NI	1.53
JI2G	20010515	D1	0.10	1529.80			
		D2	0.50	865.40			
		D3	SW	SW	1.42	SW	1.42
SIBT	20010523	D1	0.10	1530.70			
		D2	0.50	717.90			
		D3	0.70	380.30	1.89	NI	1.89
SIBC	20010523	D1	0.10	1589.20			
		D2	0.50	644.80			
		D3	0.80	259.70	NI	3.03	3.03
SMSP	20010523	D1	0.10	1473.60			
		D2	0.50	527.40			
		D3	0.80	153.39	2.57	NI	2.57
JI1G	20010524	D1	0.10	1265.00			
		D2	0.50	800.10			
		D3	0.70	693.20	1.15	0.72	0.93
JI2G	20010523	D1	0.10	524.70			
		D2	0.50	214.70			
		D3	0.80	149.87	NI	1.20	1.20

## Appendix C-2.3:

TABLE F3.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
ECOSYSTEM PROCESSES COMPONENT  
PATUXENT RIVER AND TANGIER SOUND:  
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY  
WATER COLUMN NUTRIENT DATA: Dissolved and particulate nutrients  
measured at 0.5m below surface at SAV stations  
U = uncorrected, no salinity measurement

FILENAME: WCNT2001

REVISED : 20020110

STATION	DATE	NH <sub>4</sub> <sup>+</sup> (μmol l <sup>-1</sup> )	NO <sub>2</sub> <sup>-</sup> (μmol l <sup>-1</sup> )	NO <sub>2</sub> <sup>-</sup> +NO <sub>3</sub> <sup>-</sup> (μmol l <sup>-1</sup> )	CORR DIP (μmol l <sup>-1</sup> )	CHLA-T (μg l <sup>-1</sup> )	CHLA-A (μg l <sup>-1</sup> )	TSS (mg l <sup>-1</sup> )	TVS (mg l <sup>-1</sup> )	PHAEO (mg l <sup>-1</sup> )
SIBT	20010515	1.50	0.14	0.92	0.10	3.27	2.78	13.60	1.70	1.00
SIBC	20010515	1.00	0.18	1.62	0.06	2.57	2.32	9.10	1.60	0.50
SMSP	20010515	1.80	0.42	7.62	0.06	5.36	4.84	10.10	2.10	1.05
MRGC	20010515	1.90	0.18	1.01	0.08	4.82	4.10	10.00	2.20	1.48
JI1G	20010515	1.00	0.05	0.64	0.11	7.25	6.46	7.70	1.70	1.60
JI2G	20010515	1.20	0.07	0.37	0.11	4.55	4.01	15.40	2.70	1.09
SIBT	20010523	1.80	0.12	0.81	0.09	4.75	3.57	21.90	3.40	2.42
SIBC	20010523	2.10	0.25	2.60	0.09	7.05	6.13	32.00	4.00	1.85
SMSP	20010523	1.60	0.36	5.34	0.10	9.45	7.98	85.00	6.40	2.98
MRGC	20010523	4.50	35.00	3.56	0.13	7.54	6.30	17.70	3.20	2.52
JI1G	20010524	2.20	1.60	1.04	0.13	3.88	3.28	17.00	2.60	1.21
JI2G	20010523	1.90	0.16	1.14	0.12	8.76	7.15	16.67	3.33	3.27
SIBT	20010529	2.30	0.21	0.71	0.05	7.94	6.86	24.00	2.80	2.20
SIBC	20010529	2.10	0.19	1.58	0.11	3.41	2.94	18.40	2.60	0.97
SMSP	20010529	1.90	0.39	6.05	0.10	11.19	9.94	31.20	3.20	2.54
MRGC	20010529	3.90	0.36	3.36	0.11	7.52	6.32	15.40	2.40	2.44
JI1G	20010529	2.60	0.28	1.93	0.06	0.16	0.00	16.20	2.40	0.00
JI2G	20010529	3.00	0.21	1.58	0.06	7.72	6.47	22.60	3.00	2.54
SV09	20010524	1.20	0.34	9.37	0.1(U)	YY	YY	YY	YY	YY

## Appendix C-2.4:

TABLE F-5.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
ECOSYSTEM PROCESSES COMPONENT  
PATUXENT RIVER AND TANGIER SOUND:  
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY  
EPIPHYTE CHLOROPHYLL-*a* ACCUMULATION: Raw data

FILENAME: ECHL2001

REVISED: 20001106

STATION	DATE	TOTAL TCHL- <i>a</i> ( $\mu\text{g}/\text{strip}$ )	ACTIVE ACHL- <i>a</i> ( $\mu\text{g}/\text{strip}$ )	STRIP AREA ( $\text{cm}^2$ )	TOTAL TCHL- <i>a</i> ( $\mu\text{g cm}^{-2}$ )	ACTIVE ACHL- <i>a</i> ( $\mu\text{g cm}^{-2}$ )	DAYS <i>In-situ</i>	EPIPHYTE ACCUMULATION RATES	
								TCHL- <i>a</i> ( $\mu\text{g}/\text{cm}^2/\text{day}$ )	ACHL- <i>a</i> ( $\mu\text{g}/\text{cm}^2/\text{day}$ )
SIBT	20010523	3.12	2.69	64.52	0.0483	0.0417	8	0.0060	0.0052
SIBC	20010523	1.32	1.22	64.52	0.0204	0.0188	8	0.0026	0.0024
SMSP	20010523	1.23	0.70	64.52	0.0191	0.0108	8	0.0024	0.0013
MRGC	20010523	88.30	75.79	64.52	1.3686	1.1746	8	0.1711	0.1468
JI1G	20010523	16.12	13.69	64.52	0.2498	0.2123	8	0.0312	0.0265
JI2G	20010523	6.63	5.77	64.52	0.1027	0.0894	8	0.0128	0.0112
SIBT	20010529	2.58	2.24	64.52	0.0399	0.0347	6	0.0067	0.0058
SIBT	20010529	4.68	4.03	64.52	0.0725	0.0624	6	0.0121	0.0104
SIBT	20010529	1.26	1.01	64.52	0.0195	0.0156	6	0.0032	0.0026
SIBC	20010529	1.34	1.20	64.52	0.0207	0.0186	6	0.0035	0.0031
SIBC	20010529	0.89	0.80	64.52	0.0138	0.0123	6	0.0023	0.0021
SIBC	20010529	0.88	0.79	64.52	0.0137	0.0123	6	0.0023	0.0020
SMSP	20010529	1.43	0.64	64.52	0.0221	0.0099	6	0.0037	0.0016
SMSP	20010529	1.08	0.60	64.52	0.0167	0.0092	6	0.0028	0.0015
SMSP	20010529	1.60	1.35	64.52	0.0248	0.0209	6	0.0041	0.0035
MRGC	20010529	54.41	48.73	64.52	0.8433	0.7553	6	0.1406	0.1259
MRGC	20010529	93.12	80.81	64.52	1.4432	1.2525	6	0.2405	0.2088
JI1G	20010529	1.63	1.48	64.52	0.0253	0.0229	5	0.0051	0.0046
JI1G	20010529	1.46	1.32	64.52	0.0227	0.0204	5	0.0045	0.0041
JI1G	20010529	2.43	2.22	64.52	0.0377	0.0343	5	0.0075	0.0069
JI2G	20010529	4.31	3.86	64.52	0.0668	0.0598	6	0.0111	0.0100
JI2G	20010529	5.74	5.09	64.52	0.0889	0.0788	6	0.0148	0.0131
JI2G	20010529	4.10	3.69	64.52	0.0635	0.0572	6	0.0106	0.0095

## Appendix C-2.5:

TABLE F-6.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
ECOSYSTEM PROCESSES COMPONENT  
PATUXENT RIVER SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY  
VOLATILE MEASUREMENTS: Inorganic Component of Epiphytes Nutrients: Raw Data

FILENAME: EVLR2001  
REVISED : 20001106

Station	Date	Total diluted		Dilution	Strip Area	Measured			Calculated		
		Volume	Filtered			TSS	Dry wt/strip	Dry Wt	Inorg wt	Inorg wt/strip	Inorg wt/strip
		(ml)	Volume	Factor	(cm <sup>2</sup> )	(mg l <sup>-1</sup> )	(mg/strip)	(mg cm <sup>-2</sup> )	(mg l <sup>-1</sup> )	(mg/strip)	(mg cm <sup>-2</sup> )
SIBT	20010523	250	100	2.50	64.52	31.5	7.9	0.1221	19.5	4.9	0.0756
SIBC	20010523	250	100	2.50	64.52	10.5	2.6	0.0407	4.0	1.0	0.0155
SMSP	20010523	250	125	2.00	64.52	10.0	2.5	0.0387	3.6	0.9	0.0139
MRGC	20010523	500	25	20.00	64.52	370.0	185.0	2.8673	312.0	156.0	2.4179
JI2G	20010523	250	100	2.50	64.52	32.5	8.1	0.1259	21.0	5.2	0.0814
JI1G	20010523	250	100	2.50	64.52	94.0	23.5	0.3642	78.0	19.5	0.3022
SIBT	20010529	250	100	2.50	64.52	31.0	7.8	0.1201	22.0	5.5	0.0852
SIBT	20010529	250	75	3.33	64.52	30.7	7.7	0.1188	17.3	4.3	0.0672
SIBT	20010529	250	75	3.33	64.52	12.7	3.2	0.0491	1.3	0.3	0.0052
SIBC	20010529	250	75	3.33	64.52	7.3	1.8	0.0284	<	<	<
SIBC	20010529	250	100	2.50	64.52	9.0	2.3	0.0349	4.0	1.0	0.0155
SIBC	20010529	250	75	3.33	64.52	8.0	2.0	0.0310	<	<	<
SMSP	20010529	250	100	2.50	64.52	35.5	8.9	0.1376	25.5	6.4	0.0988
SMSP	20010529	250	100	2.50	64.52	32.5	8.1	0.1259	21.5	5.4	0.0833
SMSP	20010529	250	100	2.50	64.52	104.5	26.1	0.4049	86.0	21.5	0.3332
MRGC	20010529	500	50	10.00	64.52	486.0	243.0	3.7663	433.0	216.5	3.3555
MRGC	20010529	500	25	20.00	64.52	314.0	157.0	2.4334	268.0	134.0	2.0769
MRGC	20010529	300	50	6.00	64.52	773.0	231.9	3.5942	674.0	202.2	3.1339
JI1G	20010529	250	75	3.33	64.52	12.7	3.2	0.0491	2.7	0.7	0.0103
JI1G	20010529	250	75	3.33	64.52	6.7	1.7	0.0258	<	<	<
JI1G	20010529	250	75	3.33	64.52	6.7	1.7	0.0258	<	<	<
JI2G	20010529	250	75	3.33	64.52	10.0	2.5	0.0387	0.7	0.2	0.0026
JI2G	20010529	250	75	3.33	64.52	14.7	3.7	0.0568	4.0	1.0	0.0155
JI2G	20010529	250	75	3.33	64.52	9.3	2.3	0.0362	0.0	0.0	0.0000

## Appendix C-2.6:

TABLE F-7.18. MARYLAND CHEAPEAKE BAY WATER QUALITY MONITORING PROGRAM  
ECOSYSTEM PROCESSES COMPONENT  
PATUXENT RIVER AND TANGIER SOUND:  
SUBMERGED AQUATIC VEGETATION (SAV) HABITAT STUDY  
EPIPHYTE VOLATILE MEASUREMENTS: Inorganic Component of Epiphyte Nutrients  
Mean Data

FILENAME: EVLM2001  
REVISED : 20020111

STATION	DATE	DRY WT	INORG WT	% INORG	DAYS	DRY WT	INORG WT
		AREA	AREA	MATERIAL		AREA DAY	AREA DAY
		(mg/cm <sup>2</sup> )	(mg/cm <sup>2</sup> )	(%)	<i>In-situ</i>	(mg/cm <sup>2</sup> /day)	(mg/cm <sup>2</sup> /day)
SIBT	20010523	0.1221	0.0756	38	8	0.0153	0.0094
SIBC	20010523	0.0407	0.0155	62	8	0.0051	0.0019
SMSP	20010523	0.0387	0.0139	64	8	0.0048	0.0017
MRGC	20010523	2.8673	2.4179	16	8	0.3584	0.3022
JI1G	20010524	0.3642	0.3022	17	8	0.0455	0.0378
JI2G	20010523	0.1259	0.0814	35	8	0.0157	0.0102
SIBT	20010529	0.1201	0.0852	29	6	0.0200	0.0142
SIBT	20010529	0.1188	0.0672	43	6	0.0198	0.0112
SIBT	20010529	0.0491	0.0052	89	6	0.0082	0.0009
SIBC	20010529	0.0349	0.0155	56	6	0.0058	0.0026
SIBC	20010529	0.0310	<	<	6	0.0052	<
SIBC	20010529	0.0284	<	<	6	0.0047	<
SMSP	20010529	0.1376	0.0988	28	6	0.0229	0.0165
SMSP	20010529	0.1259	0.0833	34	6	0.0210	0.0139
SMSP	20010529	0.4049	0.3332	18	6	0.0675	0.0555
MRGC	20010529	3.7663	3.3555	11	6	0.6277	0.5593
MRGC	20010529	2.4334	2.0769	15	6	0.4056	0.3461
MRGC	20010529	3.5942	3.1339	13	6	0.5990	0.5223
JI1G	20010529	0.0491	0.0103	79	5	0.0098	0.0021
JI1G	20010529	0.0258	<	<	5	0.0052	<
JI1G	20010529	0.0258	<	<	5	0.0052	<
JI2G	20010529	0.0387	0.0026	93	6	0.0065	0.0004
JI2G	20010529	0.0568	0.0155	73	6	0.0095	0.0026
JI2G	20010529	0.0362	0.0000	100	6	0.0060	0.0000