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Guide to Using Chesapeake Bay Program Water Quality Monitoring Data

Chesapeake Bay Program

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GUIDE TO USING CHESAPEAKE BAY PROGRAM WATER QUALITY MONITORING DATA

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I. OVERVIEW

A. The Guide

This document describes the Chesapeake Bay Mainstem Water Quality Monitoring Program in general and provides detailed information about the existing Program data base. The two main purposes of this document are to assist those who wish to obtain monitoring data, and to provide information to data analysts about the data base.

This chapter, highlighted in blue, provides an overview of the Guide and emphasizes particular elements that should help the potential data user formulate a data request tailored to his or her needs. It serves as a common starting point for communication between the user and the data provider at the CBP Computer Center. Potential data users should read this chapter, and fill out and submit the data request form at the end of the chapter, prior to any communication with CBPCC staff.

Some of the information in this document is essential for properly manipulating (sorting, subsetting) the data. Other facts are important in designing, implementing and interpreting data analyses. Some topics are interrelated and may be discussed in more than one place in the Guide. Users should review the table of contents, list of tables and this overview to gain information on how this document can be used.

It should be kept in mind that this is a "living" document. As the Program continues and as the data are used and examined, the contents will certainly change and be expanded. To that end, we ask that such knowledge gained by all who work with the data be passed back to the Chesapeake Bay Program Office (CBPO) to be shared with others and included in the Guide.

B. The Water Quality Monitoring Program

The Chesapeake Bay Program, a cooperative effort between the federal government and the state and local governments in the Chesapeake Bay watershed, provides funds to the states of Maryland and Virginia for the routine monitoring of 19 directly measured water quality parameters at 49 stations in the mainstem Bay. The Water Quality Monitoring Program began in June 1984 with stations sampled once each month during the colder late fall and winter months and twice each month in the warmer months. The three collecting organizations coordinate the sampling times of their respective stations, so that data for each sampling event, or "cruise", represent a synoptic picture of the Bay at that point in time. The sampling frequency has been changed since the beginning, and cruises have occasionally been disrupted partially or completely due to weather or mechanical difficulties. Some stations have been dropped from the Program, others added. Station maps (Figures 1 and 2) and a list of stations (Table 1) show the station locations.

Monitoring Program sampling locations (see Figures 1 & 2) are identified in the data base by station name and by latitude and longitude. For some

applications, it may be useful to group stations into geographic regions. The CBP segmentation scheme (Figures 1 & 2 and Table 2) was based primarily on long-term salinity data and circulation patterns. A segment identifier is associated with each data record.

At each station, a hydrographic profile is made (including water temperature, salinity, and dissolved oxygen) at approximately 1- to 2-meter intervals. Water samples for chemical analysis (e.g., nutrients and chlorophyll) are collected at surface and bottom, and at two additional depths depending on the existence and location of a pycnocline (region(s) of density discontinuity in the water column). Correlative data on sea state and climate are also collected, and in some cases additional optional parameters are available. Some of the monitored chemical parameters have changed over time, and some of the analytical methods and limits of detection have also changed since the beginning of the Program. The water quality parameters monitored routinely by participating agencies are listed in Table 3.

C. The Data Base

Complete and accurate data and program documentation is of the greatest importance in providing a data base of known quality. Participating agencies are required to submit a documentation file with every data submission. This file provides such information as changes made since last submission, sampling dates, information on method and detection limit changes, and notes from cruise and laboratory logs. Copies of these files are available upon request. Also, documentation of major issues affecting CBP data analysis is collected and stored through the Data Analysis Issues Tracking System (DAITS). See Chapter III, sections A and G for more information.

Data in the primary data base consist of all directly measured parameters. For user applications, however, calculated values, such as total nitrogen and total phosphorus, are provided if the requisite components are available (see Table 4 in Chapter III, section E for more information).

Each parameter may have associated with it a set of coded variables. One indicates the particular analytical method (parameter_M), another flags analytical problems (parameter_A), if any, and another indicates whether the value is above or below the limit of analytical detection (parameter_D). In the primary data sets, parameters that are at or below detection are given the value of the detection limit. See Table 5 for a list of lower detection limits. However, other options for handling detection limits are available at the direction of the user: values below detection can be set to missing or to one-half the detection limit.

Variables that uniquely identify data are STATION, DATE (or CRUISE), SDEPTH, LAYER, and REP_NUM (Table 3). These variables are required to discriminate among data records. Since each station is sampled only once per date or cruise, TIME is not used as an identifier variable.

The data base includes several types of quality assurance (QA) data, which estimate the precision and accuracy of the monitoring data. Refer to Chapter II, section D, and Chapter IV for more information on QA data.

Again, the above information is only a brief introduction to using the data base. Everyone who uses these data is encouraged to read the rest of the Guide for greater detail about the Monitoring Program and the water quality parameters.

For the benefit of those who wish to search for specific information without reading all sections, some frequently used acronyms include:

AMQAW	Analytical Methods and Quality Assurance Workgroup
CBL	Chesapeake Biological Laboratory
CRL	Central Regional Laboratory
DAWG	Data Analysis Workgroup
DCLS	Virginia Division of Consolidated Laboratory Services
DMAW	Data Management and Acquisition Workgroup
DMP	Data Management Plan
DAITS	Data Analysis Issues Tracking System
MDE	Maryland Department of the Environment
MDHMH	Maryland Department of Health and Mental Hygiene
ODU	Old Dominion University
VIMS	Virginia Institute of Marine Science
VWCB	Virginia Water Control Board

Users of the monitoring data base may contact the CBPO at (800) 523-2281 for additional information.

A "Data Request Form" follows the figures and tables in this chapter. This should be used for all requests for CBP Water Quality Monitoring data.

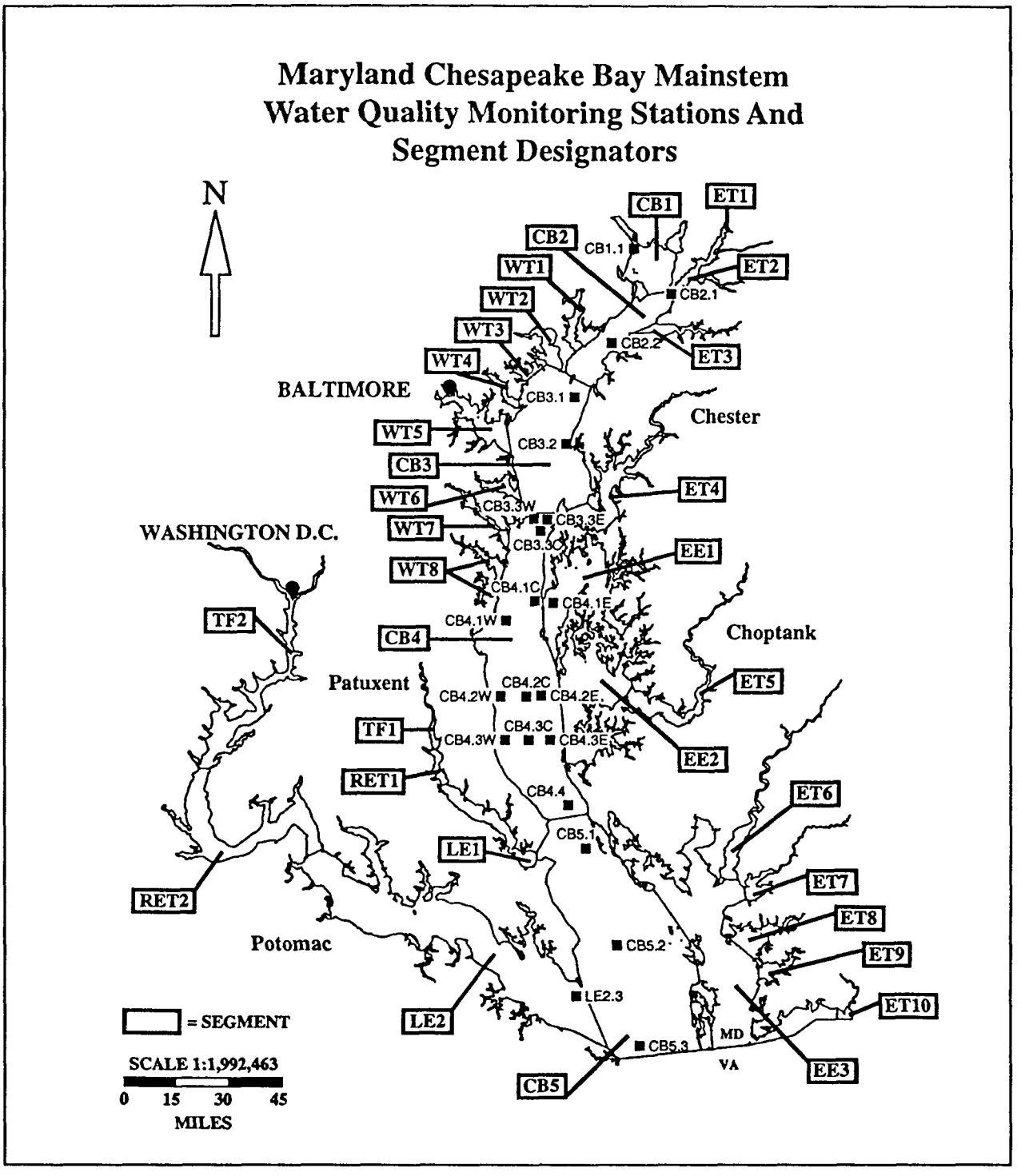

Figure 1. Maryland portion of the Chesapeake Bay, showing Chesapeake Bay Monitoring Program stations and segments.

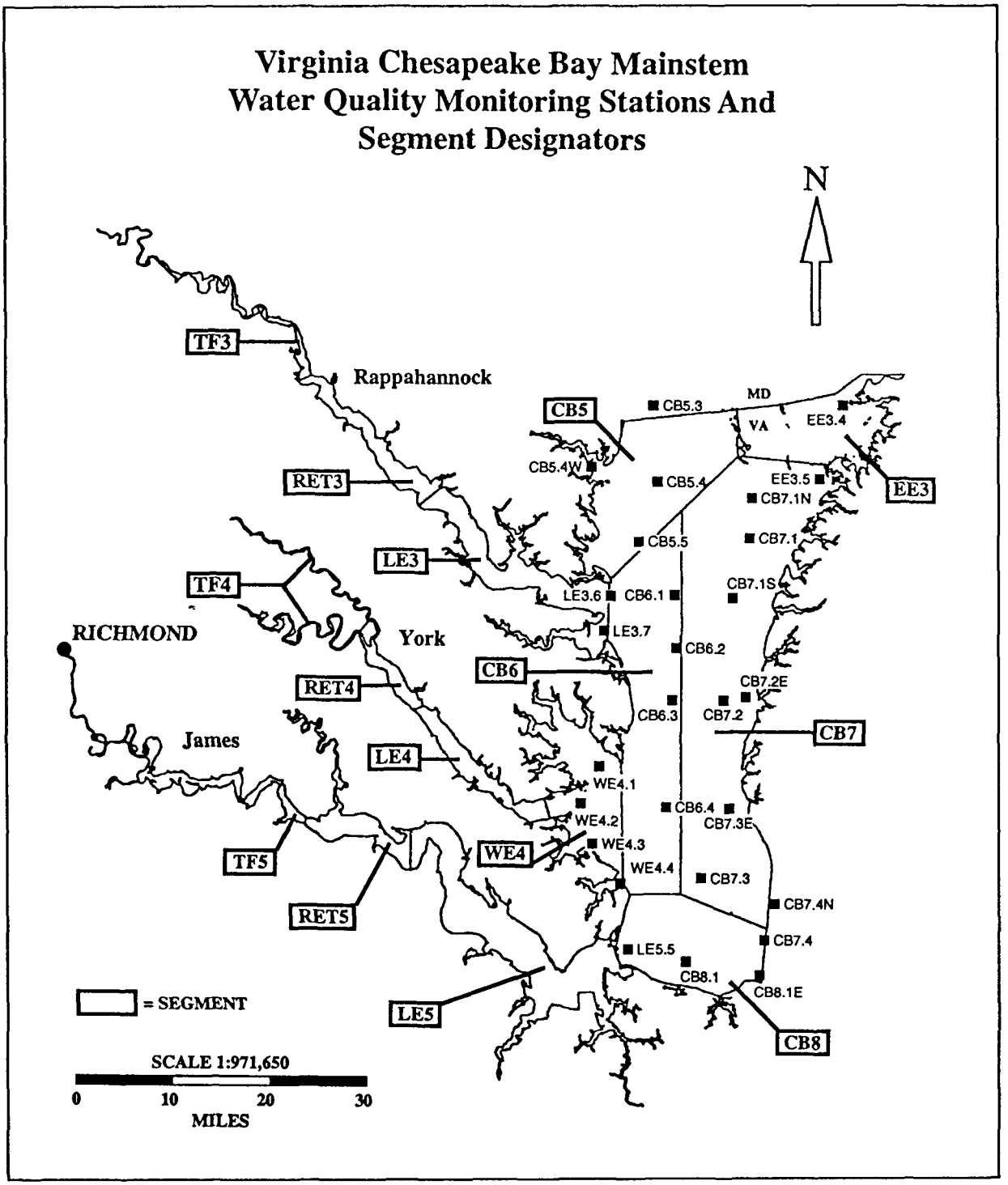

Figure 2. Virginia portion of the Chesapeake Bay, showing Chesapeake Bay Monitoring Program stations and segments.

Table 1. Mainstem Water Quality Monitoring Stations.

CBP STATION	CBP SEGMENT	AGENCY	LATITUDE DD MM SS	LONGITUDE DD MM SS	MEAN DEPTH[1]	NUMBER SAMPLES[2]	NOTES
		(Stations located in the Chesapeake Bay mainstem)					
CB1.1	CB1	MD/MDE	39 32 48	76 04 54	6.2	2	
CB2.1	CB2	MD/MDE	39 26 24	76 01 30	6.2	2	
CB2.2	CB2	MD/MDE	39 20 54	76 10 30	12.0	4	
CB3.1	CB3	MD/MDE	39 15 00	76 14 24	12.5	4	
CB3.2	CB3	MD/MDE	39 09 54	76 18 30	11.6	4	
CB3.3C	CB4	MD/MDE	38 59 45	76 21 36	23.5	4	
CB3.3E	CB4	MD/MDE	39 00 12	76 20 48	8.4	2	3,4
CB3.3W	CB4	MD/MDE	39 00 12	76 23 18	9.1	2	3,4
CB4.1C	CB4	MD/MDE	38 49 36	76 24 00	31.8	4	
CB4.1W	CB4	MD/MDE	38 48 51	76 27 54	9.3	2	3,4
CB4.2C	CB4	MD/MDE	38 38 48	76 25 06	27.0	4	
CB4.2E	CB4	MD/MDE	38 38 42	76 24 06	9.4	2	3,4
CB4.2W	CB4	MD/MDE	38 38 36	76 30 06	9.4	2	3,4
CB4.3C	CB4	MD/MDE	38 33 24	76 26 12	26.2	4	
CB4.3E	CB4	MD/MDE	38 33 24	76 23 30	22.3	4	
CB4.3W	CB4	MD/MDE	38 33 27	76 29 36	9.7	2	3,4
CB4.4	CB4	MD/MDE	38 24 48	76 20 36	29.6	4	
CB5.1	CB5	MD/MDE	38 19 06	76 17 36	33.9	4	
CB5.2	CB5	MD/MDE	38 08 12	76 13 45	30.2	4	
CB5.3	CB5	MD/MDE	37 54 42	76 10 06	26.5	4	5
CB5.4	CB5	VA/VIMS	37 48 00	76 10 30	32.4	4	6
CB5.4W	CB5	VA/VIMS	37 48 48	76 17 42	5.5	2	
CB5.5	CB5	VA/VIMS	37 41 30	76 11 24	18.8	4	6
CB6.1	CB6	VA/VIMS	37 35 18	76 09 45	13.2	4	6
CB6.2	CB6	VA/VIMS	37 29 12	76 09 24	11.2	4	6
CB6.3	CB6	VA/VIMS	37 24 41	76 09 36	12.8	4	6
CB6.4	CB6	VA/ODU	37 14 11	76 12 30	10.6	4	7
LE3.6	CB6	VA/VIMS	37 35 48	76 17 06	10.0	2	
CB7.1	CB7	VA/VIMS	37 41 00	75 59 24	25.3	2	
CB7.1N	CB7	VA/VIMS	37 46 30	75 58 30	31.7	2	
CB7.1S	CB7	VA/VIMS	37 34 52	76 03 30	16.0	2	
CB7.2	CB7	VA/VIMS	37 24 41	76 04 48	21.8	2	
CB7.2E	CB7	VA/VIMS	37 24 41	76 01 30	13.4	2	
CB7.3	CB7	VA/ODU	37 07 00	76 07 32	13.6	4	7
CB7.3E	CB7	VA/ODU	37 13 43	76 03 15	17.9	2	
CB7.4N	CB7	VA/ODU	37 03 29	75 58 23	12.9	2	
EE3.5	CB7	VA/VIMS	37 47 33	75 50 37	27.0	2	
CB7.4	CB8	VA/ODU	36 59 36	76 00 38	14.0	4	8
CB8.1	CB8	VA/ODU	36 59 15	76 10 05	10.6	2	
CB8.1E	CB8	VA/ODU	36 56 42	76 01 30	19.5	2	
LE5.5	CB8	VA/ODU	36 59 48	76 18 12	22.1	2	

Table 1 (continued). Mainstem Water Quality Monitoring Stations.

CBP STATION	CBP SEGMENT	AGENCY	LATITUDE DD MM SS	LONGITUDE DD MM SS	MEAN DEPTH[1]	NUMBER SAMPLES[2]	NOTES
		(Mainstem stations located in tributary segments)					
CB4.1E	EE1	MD/MDE	38 49 00	76 22 18	23.1	4	3
EE3.4	EE3	VA/VIMS	37 54 30	75 47 30	4.8	2	
LE2.3	LE2	MD/MDE	38 01 18	76 21 00	20.0	4	
LE3.7	LE3	VA/VIMS	37 31 50	76 18 25	7.3	2	
WE4.1	WE4	VA/VIMS	37 18 42	76 20 48	6.2	2	
WE4.2	WE4	VA/VIMS	37 14 30	76 23 12	13.9	2	
WE4.3	WE4	VA/VIMS	37 10 36	76 22 24	5.8	2	
WE4.4	WE4	VA/VIMS	37 06 36	76 17 36	7.5	2	
		(Stations sampled as part of special projects)					
CB4.0C	CB4	MD/MDE	38 55 37	76 23 41	31.3	4	9
CB4.0E	CB4	MD/MDE	38 55 37	76 23 14	8.4	0	9
CB4.0W	CB4	MD/MDE	38 55 38	76 25 59	9.0	0	9
CB5.3	CB5	VA/VIMS	37 54 42	76 10 00	26.5	4	5

1 The "Mean Depth" (meters) was computed from total depth using June, 1984 through December 1990 water quality data.

2 The "Number Samples" represents the number of nutrient samples which are collected during each cruise at that station. Some stations are considered "pycnocline stations" and have four samples collected (S,AP,BP,B), others have only two samples collected (S,B). The pycnocline is the region of the water column where density changes rapidly due to salinity and temperature differences.

3 Stations not sampled during "Winter." This is generally the November through the first March cruise beginning with BAY075, March, 1988.

4 CB3.3E, CB3.3W, CB4.1W, CB4.2E, CB4.2W, and CB4.3W had four nutrient samples collected until cruise BAY075.

5 Station CB5.3 was also sampled by VIMS from the start of the program in June, 1984 through April, 1990. The VIMS data for station CB5.3 was removed from the database to avoid confusion due to duplicate samples. It is available upon request.

6 CB5.4, CB5.5, CB6.1, CB6.2, and CB6.3 had only two nutrient samples collected until cruise BAY013.

7 CB6.4 and CB7.3 had only two nutrient samples collected until BAY021.

8 CB7.4 had only two nutrient samples collected until cruise BAY019. From then until BAY050, four samples were collected when a pycnocline was detected. After cruise BAY050 four samples were always collected.

9 Stations CB4.0C, CB4.0E, and CB4.0W were sampled from June through October, 1990 as part of a study funded by the Baltimore Port Authority to determine the feasibility of using the trough to dump dredging spoils. Stations CB4.0E and CB4.0W were only sampled for physical profile parameters and had no nutrient samples collected.

Table 2. Chesapeake Bay Program segments containing the 49 Mainstem Monitoring Program stations.

SEG. CODE	SEGMENT NAME	MAINSTEM MONITORING PROGRAM STATIONS
CB1	Northern Chesapeake Bay	CB1.1
CB2	Upper Chesapeake Bay	CB2.1, CB2.2
CB3	Upper Central Chesapeake Bay	CB3.1, CB3.2
CB4	Middle Central Chesapeake Bay	CB3.3W, CB3.3C, CB3.3E, CB4.1W, CB4.1C, CB4.2W, CB4.2C, CB4.2E, CB4.3W, CB4.3C, CB4.3E, CB4.4 (PLUS CB4.0W, CB4.0C, CB4.0E in deep trench)
CB5	Lower Chesapeake Bay	CB5.1, CB5.2, CB5.3, CB5.4W, CB5.4, CB5.5 (PLUS tributary station CB5.1W*)
CB6	Western Lower Chesapeake Bay	CB6.1, CB6.2, CB6.3, CB6.4, LE3.6
CB7	Eastern Lower Chesapeake Bay	CB7.1, CB7.1N, CB7.1S, CB7.2, CB7.2E, CB7.3, CB7.3E, CB7.4N, EE3.5
CB8	Mouth of the Chesapeake Bay	CB8.1, CB8.1E, CB7.4, LE5.5
EE1	Eastern Bay	CB4.1E (PLUS tributary station EE1.1*)
EE3	Tangier/Pocomoke Sounds	EE3.4 (PLUS tributary stations EE3.0, EE3.1, EE3.2, and EE3.3*)
LE2	Lower Potomac River	LE2.3 (PLUS tributary station LE2.2*)
LE3	Lower Rappahannock River	LE3.7 (PLUS tributary stations LE3.1, LE3.2, LE3.3, and LE3.4*)
WE4	Mobjack Bay	WE4.1, WE4.2, WE4.3, WE4.4

* These stations are sampled as part of the Tributary Monitoring Program, and are included here to show all the stations that are in these segments.

Table 3. Parameter Titles and Variable Names by Data Category.

PHOSPHORUS:	Total Phosphorus	TP
	Total Dissolved Phosphorus	TDP
	Particulate Phosphorus	PHOSP
	Orthophosphate	PO4F
	Dissolved Inorganic Phosphorus	DIP
	Dissolved Organic Phosphorus	DOP
NITROGEN:	Total Nitrogen	TN
	Total Dissolved Nitrogen	TDN
	Particulate Organic Nitrogen and Particulate Nitro-gen	PON
	Total Kjeldahl Nitrogen, Whole/Filtered	TKNW,TKNF
	Nitrite + Nitrate, Filtered	NO23
	Nitrite, Filtered	NO2
	Nitrate, Filtered	NO3
	Ammonium, Filtered	NH4
	Dissolved Inorganic Nitrogen	DIN
	Dissolved Organic Nitrogen	DON
	Total Organic Nitrogen	TON
CARBON:	Total Organic Carbon	TOC
	Dissolved Organic Carbon	DOC
	Particulate Organic Carbon and Particulate Carbon	POC
OTHER LAB PARAMETERS:	Silica, Filtered	SI
	Total Suspended Solids	TSS
	Chlorophyll a and Phaeophytin, Spectrophotometric	CHLA, PHEA
FIELD PARAMETERS:	Dissolved Oxygen	DISOXY
	Dissolved Oxygen Saturation	DO_SAT
	pH	PH
	Salinity	SALIN
	Secchi Disk Depth	SECCHI
	Specific Conductivity	COND
	Water Temperature	WTEMP
	Air Temperature	ATEMP
	Cloud Cover	CLOUD
	Tidal Stage	TIDE
	Wave Height	WAVHGT
	Wind Direction	WINDIR
	Wind Speed	WINDSPD
	Specific Gravity	SIG_T
	Chlorophyll a, Fluorometric	CHLAF

Table 3 (continued). Parameter Titles and Variable Names by Data Category.

SAMPLE IDENTIFIER VARIABLES:	CBP Segment	SEGMENT
	Cruise Identifier	CRUISE
	Date of Sample Collection	DATE
	Period of Sampling	PERIOD
	Pycnocline, Lower Depth	PDEPTHL
	Pycnocline, Upper Depth	PDEPTHU
	Replicate Number	REP_NUM
	Sample Depth	SDEPTH
	Total Depth	TDEPTH
	Sample Layer	LAYER
	Sampling Station Identifier	STATION
	Latitude	LAT
	Longitude	LONG
	Basin Name	BASIN
	River Code	RIVER
	Sampling Time	TIME
	Source Agency	SOURCE

D. Data Request Form

Chesapeake Bay Program mainstem water quality monitoring data are available by request from the Chesapeake Bay Program Office (CBPO). The purpose of the Request Form is to provide for a clear and concise statement of the scope of each request for CBP Water Quality data.

Responsibilities for fulfilling data requests are divided between CBPO program management staff and the computer center staff. The program management staff normally handle the initial contact with a data requestor, including distribution of the "Guide," which contains this form, to be used when requesting data. After receiving a data request, the program management staff approve and then prioritize the data request. They may coordinate with the data originator, as required, to determine appropriate uses of the data. The program management staff also review data output before releasing it to the requestor. The computer center staff normally complete the data base retrieval and output portions of the data request.

The data user should read Chapter I of the "Guide" before filling out the request form.

Please return the completed Request Form to:

U.S. EPA Chesapeake Bay Program
Information Center
410 Severn Ave, Suite 109
Annapolis, MD 21403

1. REQUESTOR INFORMATION

Name: _____ Organization: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone: (Voice) _____ (FAX) _____

2. INTENDED USE

Please describe the intended use of the data. Please be specific, and attach additional pages if needed.

3. TIME PERIOD

The CBP Mainstem Water Quality Monitoring Program began in June or July 1984, depending on stations of interest. The most recent data available are usually several months behind the current calendar month. Time Period may be indicated by choosing a range of dates, specific months, specific years, a range of cruises, or specific cruises.

Range:

Month/Year: _____ to _____

or

Cruise: _____ to _____

Specific: (Please indicate clearly)

4. GEOGRAPHIC LOCATION

Please list either CBP segment codes or CBP station names. Copies of the monitoring station maps (Figures 1 & 2), with the stations of interest indicated clearly, may be substituted here.

Segments:

Stations:

5. VARIABLES

Please choose the variables of interest by placing an 'X' in the space provided. The five required identifier variables have already been marked.
(_D: detection limit flag, _M: method code)

- X STATION
- X DATE
- __ TIME
- X SDEPTH
- X REP_NUM

- X LAYER
- __ SOURCE

- __ CRUISE
- __ PERIOD

- __ SEGMENT
- __ LAT
- __ LONG
- __ BASIN
- __ RIVER

- __ PDEPTHU
- __ PDEPTHL
- __ TDEPTH
- __ SECCHI
- __ SECCHI_D
- __ SECCHI_M

- __ PH
- __ PH_D
- __ PH_M
- __ COND
- __ COND_D
- __ COND_M
- __ SALIN
- __ SALIN_D
- __ SALIN_M
- __ WTEMP
- __ WTEMP_D
- __ WTEMP_M
- __ DISOXY
- __ DISOXY_D
- __ DISOXY_M
- __ DO_SAT
- __ SIG_T

- __ TSS
- __ TSS_D
- __ TSS_M
- __ SI
- __ SI_D
- __ SI_M
- __ TOC
- __ TOC_D
- __ TOC_M
- __ DOC
- __ DOC_D
- __ DOC_M
- __ POC
- __ POC_D
- __ POC_M

- __ ATEMP
- __ ATEMP_D
- __ ATEMP_M
- __ CLOUD
- __ TIDE
- __ WAVHGT
- __ WINDIR
- __ WINDSPD

- __ TDN
- __ TDN_D
- __ TDN_M
- __ PON
- __ PON_D
- __ PON_M
- __ NO23
- __ NO23_D
- __ NO23_M
- __ NH4
- __ NH4_D
- __ NH4_M
- __ NO2
- __ NO2_D
- __ NO2_M

- __ TN
- __ TN_D
- __ TN_M
- __ DIN
- __ DIN_D
- __ DIN_M
- __ DON
- __ DON_D
- __ DON_M
- __ NO3
- __ NO3_D
- __ NO3_M
- __ TON
- __ TON_D
- __ TON_M

- __ TKNF
- __ TKNF_D
- __ TKNF_M
- __ TKNW
- __ TKNW_D
- __ TKNW_M

- __ CHLA
- __ CHLA_D
- __ CHLA_M
- __ PHEA
- __ PHEA_D
- __ PHEA_M
- __ CHLAF

- __ TP
- __ TP_D
- __ TP_M
- __ TDP
- __ TDP_D
- __ TDP_M
- __ PHOSP
- __ PHOSP_D
- __ PHOSP_M
- __ PO4F
- __ PO4F_D
- __ PO4F_M
- __ DOP
- __ DOP_D
- __ DOP_M

6. OUTPUT FORMAT

Please indicate the desired transfer format for the data output. (Printed output may be available for small requests.)

Choose one option for Transfer Media, and one option from each side of either the SAS Data Set box or the ASCII File box.

Transfer Media
__ 9 track tape __ 8 mm tape __ 3.5" High Density IBM diskette

SAS Data Set	
__ VAX format __ SAS Transport format	__ Version 5 __ Version 6.06 __ Version 6.07

- or -

ASCII File	
__ column delimited __ tab delimited	__ wide file, with one observation per line __ 80 column file, multiple lines per obs. __ 132 column file, multiple lines per obs.

II. GENERAL DESCRIPTION

A. Monitoring Program Design

The design of the current monitoring program was laid out in Appendix F of CBP (1983b), "Chesapeake Bay: A Framework for Action." This design built on previous Chesapeake Bay monitoring programs, avoiding their weaknesses while addressing monitoring, research, and management needs in an integrated fashion. The authors proposed a "Water Quality Baseline Monitoring" design (CBP 1983b, Appendix F, Attachment 6) that was largely followed in the current CBP monitoring program. A fundamental part of the design was sampling for nutrients above and below the pycnocline at stratified stations, in addition to surface and bottom samples. The pycnocline is the region of the water column where density changes rapidly due to salinity and temperature differences. Previous monitoring had used fixed-depth sampling, which did not always characterize the upper and lower water masses at stratified stations. The authors also stressed the need for "built-in flexibility," which is an important part of the current program. This flexibility is illustrated by the changes that have occurred in the CBP monitoring program since 1984.

The Chesapeake Bay Mainstem Water Quality Monitoring Program is documented in CBP (1989), "Chesapeake Bay Basin Monitoring Program Atlas." It began in June 1984 with 50 stations (currently 49 are sampled): 22 in Maryland and 28 in Virginia, sampled once each month during the late fall and winter months and twice each month in the warmer months. Surface and bottom samples are collected for nutrient analysis at all stations, and two mid-water samples, from above and below the pycnocline, are added where the water column is stratified. The three collecting organizations, Maryland Department of the Environment (MDE), Old Dominion University (ODU), and Virginia Institute of Marine Science (VIMS), attempt to sample their respective stations over the same three-day time period, so that the data for each sampling period or "cruise" as it is named in the data base, represent a synoptic picture of the Bay at that point in time (CBP 1985).

The sampling frequency has been changed since the beginning of the program, and cruises have occasionally been disrupted partially or completely due to weather or mechanical difficulties. In the beginning of the program (1984) water quality data were collected once in November, December, January, and February, and twice in all other months. Beginning in 1988, to reduce program costs, the Virginia institutions eliminated one of the March collections; Maryland continued the original schedule. Through 1991, data from cruises BAY075, BAY095, BAY115, and BAY135 (the second of the March cruises for 1988 through 1991 respectively) cover Maryland stations only. Beginning in 1989, VIMS and ODU began sampling only once in October, therefore, cruises BAY109 and BAY129 (the second October cruise for years 1989 and 1990 contain only Maryland data. While Maryland continued with two March and two October collections, sampling the lateral stations during the winter season was discontinued. One station has been dropped from the program (VIMS sampling of CB5.3 in May

1990) and others temporarily added for dredge spoil sampling beginning with cruise BAY120 (CB4.0E, CB4.0C, CB4.0W June through October, 1990).

Table 1 lists the CBP mainstem station name, CBP segment, the agency which samples that station, latitude, longitude, mean total depth in meters, and the number of nutrient samples collected during each cruise. The stations are grouped in three sections: 1) stations located in the mainstem, 2) stations located in tributary segments, sampled as part of the mainstem monitoring program, and 3) stations sampled as part of special projects. Refer to the table notes for additional information. Table 2 lists the CBP segments that include the 49 mainstem monitoring program stations, for data users that want to request the data from all stations in a particular segment. Note that the station name prefix does not always correspond to the segment name. The reader is also referred to Chapter III, Identifier Variables - SEGMENT, and to CBP (1989), "Chesapeake Bay Basin Monitoring Program Atlas," and CBP (1990), "Chesapeake Bay Segmentation Scheme."

In months when two cruises are scheduled, the first cruise is typically planned between the 1st and 15th of the month, and the second cruise between the 16th and the last day of the month. In months when only one cruise is planned, the cruise may take place at any time and usually depends on weather conditions. In general, Maryland requires three days to cover its stations, VIMS requires two days, and ODU requires one to two days.

The several collecting institutions attempt to sample over the same time period and visit stations in the same order at approximately the same time of day on each cruise. Deviations from this schedule exist with sampling dates varying between collecting institutions by more than a week. In general, with respect to order and time of day, Maryland stations have been sampled most consistently. VIMS stations have been sampled least consistently primarily because of time constraints, distance between stations, and weather.

B. Sample Collection and Water Quality Parameters

At each station, a hydrographic (physiochemical) profile is made and water samples for chemical analysis are collected at the surface and the bottom layers, and (for deeper stations) at two additional mid-water depths depending on the existence and location of a pycnocline. The pycnocline is the region of the water column where density changes rapidly due to salinity and temperature differences. Generally, samples have been collected via pumping system rather than a discrete sample collection device. The chemical parameters include suites of phosphorus, nitrogen, and carbon species; silica; photosynthetic pigments; and suspended solids. Refer to Table 3 for a list of parameter titles and corresponding data base names. This list includes chemistry profile parameters for phosphorus, nitrogen, and carbon species, field profile parameters, and sample identifier variables. Additional discussion on these variables follows in Chapter III, sections B and C.

A few of the specific parameters have changed over time, and some of the analytical methods and limits of detection also have changed since the beginning of the program, with some inconsistency among data collecting organizations and analytical laboratories (see Table 4, "Measured and Calculated Laboratory Parameters," and Table 5, "Lower Detection Limits of Water Quality Parameters"). There have been inconsistencies among collecting laboratories in the depth - relative to the pycnocline - at which samples and measurements were collected (see Chapter III, section B, "Sample Layer and Sample Depth" and CBP 1985, "Monitoring 1984," p. 15).

C. Data Base

Electronic data files from the monitoring cruises are sent to the CBPO by the participating agencies. These files contain concentrations from the 19 sampled parameters, along with cruise information such as station, sample date, time, cruise number, sample depth, replicate number, latitude, longitude, sea state, and weather. Data are required to be submitted to the CBPO within 60 days of the end of the month in which the sample was collected along with the appropriate documentation for that data submittal.

After QA and verification procedures are completed at CBPO, the data submitter is asked to review and comment or correct any errors or out of range data that are flagged by the verification programs (refer to lists of outliers in CSC 1991 and CBP 1992b). After signoff by the data submitter, the data are available upon request.

Two levels of the monitoring data base, now containing well over 120,000 observations, are supported at the CBPO. The first level consists of all directly measured parameters (no derived or calculated parameters with the exception of chlorophyll_a and phaeophytin). See Chapter III, section C, Water Quality Parameters. Each parameter has with it a set of coded variables. One indicates the particular analytical method, another flags analytical problems, if any, and another indicates whether the value is above or below the limit of analytical detection. In the first level data sets, parameters that are below the level of detection are given the value of the detection limit and the detection limit flag is set to "<". The analytical problem codes have been used and interpreted inconsistently among agencies (MDE and VIMS use CBPO codes and ODU currently notes problems in their data set documentation). Refer to the Data Management Plan (CBP 1992a) for valid analytical problem codes and their definitions.

Second-level data sets are generated via a menu-driven data selection program for general user requests. The data sets may include primary and documentary data variables, and alternative options for handling detection limit values may be selected (e.g., set to missing, set to one-half the detection limit value). The method codes should be viewed as a general description of the method; each laboratory may interpret the method slightly differently or make small modifications over time. Analytical

problem codes are not currently available in routine retrievals from this second-level data base.

Certain useful parameters which are not measured directly but which can be calculated are also available (e.g., total nitrogen may be obtained by summing specific directly measured nitrogen species). Users should be aware that calculated values may be derived from constituents below detection limit, and this may have an effect on user applications.

In addition to these calculated variables, other identifier variables have been added to the second-level data base to facilitate grouping data in space and time (i.e., BASIN, equal to "Chesapeake" in the mainstem data, RIVER equal to tributary name, and PERIOD equal to the range of dates covered in one "cruise").

The structure of the CBPO Monitoring Program data sets is based both on the sampling design and on the requirements of the data management software (SAS). The water quality data sets are stored and manipulated as SAS data sets, which consist of a series of similarly structured records, each of which contains all the variables of the data set, whether assigned a value or not. A header record carries information about the station which is not associated with any particular sample or sample depth, e.g., Secchi depth, station depth, pycnocline depth, weather and sea state. Sample depth in the header record is always equal to 0, and the sample depth for water quality data records is always greater than 0; surface is usually 0.5 or 1 meter. At the minimum, all valid records should carry non-missing values for participating agency, cruise number, station, date, sample depth, latitude, and longitude.

Documentation of any problems with data quality is also an important part of a monitoring program. Documentation of major issues affecting CBP data analysis and data quality is collected and stored through the Data Analysis Issues Tracking System (DAITS). This system is used to solicit information and track the resolution of analytical method and data analysis issues that arise. See Chapter III, Table 6 for more details and a listing of issues.

D. Quality Assurance (QA)

The goal of quality assurance is to provide the data user with data of known and high quality. The first stage of quality assurance is quality control (QC), which is performed by personnel at the analysis laboratory to ensure that data leaving the laboratory meet quality standards (Taylor 1987). In the second stage, data users employ the same data in slightly different ways to assess the quality of the data being analyzed. Since the intended audience of this document is data users, the focus here is on this second stage, assessing the quality of data being analyzed.

Quality assurance data for chemical analyses measure two quantities, precision and accuracy. Precision is the repeatability of measurements,

and accuracy is the closeness of analytical measurements to a "true" value. CBP QA data include precision and accuracy comparisons within the same organization, and among results from different organizations.

To assess within-organization precision and accuracy, approximately 10% of the chemical analyses for each parameter are analyzed in duplicate and spiked in the laboratories. Laboratory replicate and spike data are submitted to CBPO separately from monitoring data and are maintained in separate QA data sets. At some stations, field replicates are also generated, and these are reported with the regular monitoring data. Within-organization QA data are described and summarized in detail in Chapter IV.

Inter-organization precision and accuracy are assessed by the Coordinated Split Sample Program (CSSP), which includes comparisons of the results from field split samples analyzed by different laboratories. CSSP results also include another measure of accuracy, from Standard Reference Material (SRM) analyses. CSSP data are described in detail in Chapter IV.

Another aspect of quality assurance is detection limits. The minimum detection limit (MDL) is the lowest concentration of a parameter that the measurement system can detect reliably. At CBP laboratories, the MDL is currently determined from 3 times the standard deviation of seven replicates of a low-level ambient water sample. In the CBP data base, when measurements are below the MDL, the value of the variable is set to the detection limit and the detection limit flag, variable_D, is set to "<". Detection limits for many parameters have been lowered over the life of the program. See Table 5, "Lower Detection Limits of Water Quality Parameters" for a detailed listing. Some parameters also have upper detection limits, but since most parameters can be diluted and re-analyzed when these are encountered, they rarely result in censored values in the data base.

Water quality values may be removed from CBP data sets (set to missing and flagged with the analytical problem code, variable _A) for a variety of quality control reasons. The "rules" by which data are removed and flagged with a code have evolved over the life of the program (see DAITS #1 for details).

E. Program Sponsor

U.S. Environmental Protection Agency
Chesapeake Bay Program Office (CBPO)
410 Severn Avenue
Annapolis, MD 21403

(410) 267-0061
(800) 523-2281

F. Participating Agencies

Maryland Grantee:

Maryland Department of the Environment (MDE)
Chesapeake Bay and Watershed Management Administration
Chesapeake Bay and Special Projects Program
2500 Broening Highway
Baltimore, MD 21224

(Originally Office of Environmental Programs [OEP], Department of Health and Mental Hygiene, Baltimore, MD through 1986)

Maryland Laboratories:

EPA Central Regional Laboratory (CRL)
839 Bestgate Road
Annapolis, MD 21401
(6/84-5/15/85, analyses done by OEP staff)

Maryland Department of Health and Mental Hygiene (MDHMH)
Lab Administration
P.O. Box 2355
Baltimore, MD 21201
(tributaries, and mainstem chlorophyll)

University of Maryland Chesapeake Biological Laboratory (CBL)
P.O. Box 38
Solomons, MD 20688
(5/16/85-present)

Maryland Field Operations:

Maryland Department of the Environment (MDE)
416 Chinquapin Round Rd.
Annapolis, MD 21401

Virginia Grantee:

Virginia Water Control Board (VWCB)
Chesapeake Bay Office
P.O. Box 11143
Richmond, VA 23230-1143

Virginia Subcontractors (Field and Lab Operations):

Old Dominion University (ODU)
Applied Marine Research Laboratory
College of Sciences
Norfolk, VA 23529-0456

Virginia Institute of Marine Science (VIMS)
College of William and Mary
Gloucester Point, VA 23062

See Table 1 for a complete list of the stations sampled by each organization.

III. DATA BASE INFORMATION

This chapter provides specific information on the data base in the following sections:

A: Data Documentation, used to store information about sample collection and analysis, and specific information about that sampling cruise;

B: Identifier variables, used to uniquely identify each observation;

C: Water quality parameters, including physical profile parameters analyzed in the field and laboratory parameters;

D: Other parameters, including information on sampling conditions such as weather and sea state;

E: Measured and Calculated Laboratory Parameters, a table of which parameters were directly measured, and what other parameters were calculated from them, during different time periods at each laboratory;

F: Lower Detection Limits of Laboratory Parameters, a table of the lower Method Detection Limits (MDLs) for each directly measured and calculated water quality parameter, organized by parameter and laboratory; and

G: Data Analysis Issues Tracking System (DAITS), an explanation of this documentation system with a table of the issues.

A. Data Documentation

Complete and accurate data and program documentation is considered to be of the highest importance. This serves as the basis for providing a data base of known quality. Participating agencies are required to submit a data set documentation (DSDOC) file with every data submission. This file provides such information as:

- changes made since last submission;
- sampling dates and cruise number;
- information on method and method detection limit (MDL) changes;
- parameter methods table, and;
- notes from cruise and laboratory logs.

The DSDOC is supposed to serve as "living" documentation and should include any information that would assist in the analysis and interpretation of the data in the future. The SAS program that is used to convert the data set to CBP format and add required CBP variables is appended to the DSDOC supplied by the data submitter. Any changes to the data made during the conversion process or subsequently should be recorded there, and the results of the routine CBPO range-checking procedure is

also included. These files are available to the user upon request. Refer to the Data Management Plan (CBP 1992a) to see the complete DSDOC form.

Project documentation is also requested for each grant year and is intended to provide an overview of the entire project. At this time, these are out of date. The complete form is available in the Data Management Plan (CBP 1992a). Some of the questions the form contains are:

- project title;
- project beginning and ending date, and sampling schedule;
- EPA QA/QC officer, EPA project officer, and EPA project number;
- principal investigator, project manager, QA/QC manager, and data manager;
- administrative organization, collecting organization, and analytical laboratory;
- project summary;
- parameter list;
- station table and station description; and,
- data entry and verification methods.

Quarterly reports are submitted to the CBPO and provide some additional information such as the reason why some stations were not sampled and changes in methods or procedures. Quarterly reports are generally not available to the user, but information from these reports has been added to the water quality parameter descriptions in Chapter III.
The CBP Monitoring Cruise Summary is also requested with each data submission. This form summarizes the sample collection activities during the entire cruise. The summary contains questions on:

- field sample collection; and,
- electronic instrument calibration.

A field summary sheet for each day of the cruise is attached to the cruise summary. This lists specific information and measurements relative to each station such as:

- field observations and comments;
- weather;
- station arrival and departure time;
- refrigerator and freezer temperatures; and,
- meter calibration information for dissolved oxygen, temperature, and pH.

A third form, Chesapeake Bay Monitoring Program Procedure Modification Tracking Form, should be completed for cases where major changes occur in sampling or analytical procedures. This form is used to request approval for modifications and to document approved modifications made to CBPO procedures or methods. This form asks for information on:

- type of procedure;
- duration of method change;
- method description;
- justification for modification;
- analytical parameters that may be affected by this change;
- affected QA plans; and,
- affected cruises.

This information is available upon request. The complete forms are included in the "Recommended Guidelines for Sampling and Analysis in the Chesapeake Bay Monitoring Program" (AMQAW, in draft).

B. Identifier Variables

When using the CBP water quality monitoring data, it is important to become aware of how the data are organized in the data base, and of the issues associated with individual variables. The following section on identifier variables pertains to those variables in the data base that describe sampling location, depth in the water column, and time and date of the sample. The variables are organized alphabetically by title, and each variable description includes the parameter name, units of measure, associated CBP method codes, description of the general method, description of method changes, DAITS and other issues pertaining to that variable, and references to other documentation.

Identifier variables used to uniquely locate data observations are STATION, DATE, LAYER, SDEPTH, and REP_NUM. These parameters provide the key to use in sorting data accurately. Additional parameters, SOURCE, CRUISE, TIME, TDEPTH, PDEPTHU, PDEPTHL, SEGMENT, LAT, LONG, BASIN, RIVER, and PERIOD provide important information about the sample but are not used to identify unique observations. The SOURCE variable contains the participating agency code. CRUISE allows the user to separate bay-wide sampling events. Since each agency samples a station only once per cruise, the variable TIME is not required to discriminate among samples. The parameters TDEPTH, PDEPTHU, and PDEPTHL are coded only on the observation with SDEPTH = 0. This is the first observation in the logical record for one station and is often referred to as the header record. SEGMENT is useful when it is necessary to group stations together by geographic region. LAT and LONG are the latitude and longitude of the sampling station, in degrees and decimal degrees. BASIN and RIVER indicate geographic area codes that are listed in the "Chesapeake Bay Program Data management Plan" (CBP 1992a). PERIOD allows the user to label data reports and graphics by a range of dates.
The identifier variables in the CBP data base are described on the following pages.

TITLE: **CBP SEGMENT DESIGNATION**
PARAMETER NAME: **SEGMENT**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHOD:

The Chesapeake Bay segments are geographical units to be used in the analysis of water quality data. They are based on the circulation and salinity properties of different areas of the Bay. The following text describes all of the segments in the CBP segmentation scheme, including those in the tributaries, based on CBP (1983a), "Chesapeake Bay: A profile of environmental change." These descriptions, and the CBP segmentation scheme itself, were based on monitoring data from 1949-1980, and may not necessarily reflect current conditions. Salinities mentioned are "long-term summer mean salinity" (CBP 1983a), but it was not stated if this was surface or bottom salinity, or some combination of the two. Their original names had a hyphen, but this was dropped when the SEGMENT variable was created in the data base.

MAIN BAY SEGMENTS:

Segment CB1 is the uppermost segment of the mainstem of Chesapeake Bay encompassing the Susquehanna Flats. It is characterized as a tidal freshwater region and is dominated by freshwater inflow. This area is resident habitat for freshwater fish and the spawning area for anadromous and semi-anadromous fish.

Segment CB2 is in the upper portion of the Chesapeake Bay mainstem. This segment is a transition zone between freshwater and marine habitats. The salinity is this segment generally ranges from 3 to 9 ppt. This zone is the region of maximum turbidity due to suspended sediments which cause light limitation to phytoplankton production most of the year. The transition zone generally found in this segment is characterized partially as a sediment trap concentrating suspended sediments including adsorbed toxic chemicals.

Segment CB3 is the uppermost reach for the estuarine zone in the mainstem of the Chesapeake Bay. It is characterized by moderate salinity (7 to 13 ppt) and has two-layer estuarine circulation driven by freshwater inflow. This segment is generally the upstream limit for deep-water anoxia.

Segment CB4 is considered to be in the upper portion of the central Chesapeake Bay mainstem. Salinity ranges from 9 to 14 ppt, and the water is rich in nutrients. During the summer months this segment generally experiences oxygen depletion at depths greater than 9.2 meters creating an anoxic habitat for benthic animals.

CBP SEGMENT DESIGNATION continued:

Segment CB5 is located in the central portion of the mainstem of the Chesapeake Bay. It is influenced by flow from both the Potomac River and the Patuxent River, and its waters are generally high in nutrients. The salinity in this segment ranges from about 10 to 17 ppt. This segment contains most of the Bay's deepest waters and is subject to deep water anoxia in the summer months.

Segment CB6 is located in the lower west-central portion of the mainstem of Chesapeake Bay. It is characterized by a net southward flow and by salinities ranging from about 14 to 21 ppt. This segment is influenced greatly by the major western tributaries.

Segment CB7 is located in the lower east-central portion of the mainstem. This segment is characterized by a net northerly flow pattern and by salinities of about 19 to 24 ppt. This segment is influenced by incoming Atlantic Ocean tidal waters.

Segment CB8 is the southern-most segment of the Bay. This segment is characterized by a net southerly flow due to its proximity to the mouth of the Chesapeake Bay. Salinity ranges from 18 to 23 ppt.

EASTERN SHORE EMBAYMENTS:

EE1	Eastern Bay, Miles River, and Wye River
EE2	Choptank River, west of Castle Haven, including Tred Avon River, Broad Creek, Harris Creek, and the Little Choptank River
EE3	Tangier and Pocomoke Sounds

These three segments are characterized by salinity patterns similar to the adjacent waters of the Chesapeake Bay. The water in these areas is generally shallow enough to permit light penetration for submerged aquatic vegetation growth and is strongly influenced by wind patterns.

EASTERN SHORE TIDAL TRIBUTARIES:

ET1	Northeast River
ET2	Elk River and Bohemia River
ET3	Sassafras River
ET4	Chester River
ET5	Choptank River
ET6	Nanticoke River
ET7	Wicomico River
ET8	Manokin River
ET9	Big Annemessex River
ET10	Pocomoke River

CBP SEGMENT DESIGNATION continued:

The ten segments in this group encompass the estuarine, or tidal, reaches of the major Eastern Shore tributaries. They are characterized by weak estuarine circulation patterns and limited flushing capacities. Water quality in these segments is controlled by the density structure of the mainstem Bay waters that are adjacent to the tributaries mouths.

MAJOR TIDAL TRIBUTARIES OF THE WESTERN SHORE:

Patuxent River	TF1	Tidal freshwater segment
	RET1	Riverine-estuarine transition zone
	LE1	Lower estuarine segment
Potomac River	TF2	Tidal freshwater segment
	RET2	Riverine-estuarine transition zone
	LE2	Lower estuarine segment
Rappahannock River	TF3	Tidal freshwater segment
	RET3	Riverine-estuarine transition zone
	LE3	Lower estuarine segment
York River	TF4	Tidal freshwater segment
	RET4	Riverine-estuarine transition zone
	LE4	Lower estuarine segment
James River	TF5	Tidal freshwater segment
	RET5	Riverine-estuarine segment
	LE5	Lower estuarine segment
Mobjack Bay	WE4	
Elizabeth River	ELIZA	

The five major tidal tributaries along the middle to lower western shore of the Chesapeake share common hydrodynamic and water quality features.

The TF, or tidal freshwater, segments are located in the upper tidal reaches of the tributaries where the water remains fresh year-round because these areas are dominated by freshwater inflow. These areas are the resident habitats of freshwater fish and are prime spawning areas for anadromous and semi-anadromous fish.

The RET, or riverine-estuarine transition, segments are located in the mid sections of these five tributaries. The freshwater inflow mixes with the saltier Bay water brought in with the tide, and a transition zone between freshwater and marine habitats is the result. Salinities range from about 3 to 9 ppt. This zone is the region of maximum turbidity due to suspended sediments which, for most of the year, reduce the amount of light available for phytoplankton. The transition zone tends to concentrate and trap suspended particulate matter, some of which may contain toxic chemicals which are adsorbed onto the sediment particles.

CBP SEGMENT DESIGNATION continued:

The LE, or lower estuarine, segments are located between the RET segments and the mainstem of the Chesapeake. They are characterized by moderate salinity (7 to 13 ppt) and have two-layer estuarine circulation driven by freshwater inflow. These segments are usually the upstream limit of deep-water anoxia in the tributaries.

Segment WE4, Mobjack Bay, is located north of the mouth of the York River. This segment is characterized by salinity patterns similar to the adjacent waters of the Chesapeake Bay. The water in this segment is generally shallow enough to permit light penetration for submerged aquatic vegetation growth and is strongly influenced by wind patterns.

The Elizabeth River, segment ELIZA, is a tributary of the James River. Its physical characteristics are similar to those of the LE segments. This segment was separated from the James River LE5 segment due to highly degraded water quality which skews statistical data for the LE5 segment.

TIDAL TRIBUTARIES OF THE UPPER WESTERN SHORE:

WT1 Bush River
WT2 Gunpowder River
WT3 Middle River and Seneca Creek
WT4 Back River
WT5 Patapsco River
WT6 Magothy River
WT7 Severn River
WT8 South, Rhode, and West rivers

The WT, or western tributary, segments encompass the tidal reaches of the small tributaries along the western shore of the Chesapeake Bay north of the Patuxent River. These segments are characterized by weak estuarine circulation patterns and limited flushing capacities. Water quality in these segments is controlled by the density structure of the mainstem of the Bay at the mouths of the tributaries.

METHOD CHANGES:

None

CBP SEGMENT DESIGNATION continued:

DAITS ISSUES:

None

OTHER ISSUES:

Other segmentation schemes have been developed for special applications such as the Submerged Aquatic Vegetation (SAV) aerial survey, the 3D model segments, and the Watershed Model segments. Data presented in these special-purpose segments are converted to the CBP segments before being added to the CBP data base.

OTHER DOCUMENTATION:

CBP 1983a, "Chesapeake Bay: A profile of environmental change," for descriptions of each segment. Appendix A, Section 2, has the most complete description.

CBP 1990, "The Chesapeake Bay Segmentation Scheme," for geographic boundaries of the segments.

TITLE: **CRUISE IDENTIFIER**
PARAMETER NAME: **CRUISE**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHOD:

The data for a CRUISE is intended to denote a bay-wide synoptic view of the Bay at one time. This parameter is useful for grouping data collected over a range of sampling dates within the mainstem. Cruises are numbered sequentially and begin with the letters "BAY," e.g. "BAY001" (June 1984).

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

There may be gaps in the cruise sequence for individual stations and/or agencies. These may be due to several reasons: stations are sampled only during certain seasons; cruise(s) dropped by one agency, but not by others; a cruise was displaced because of weather.

In the tributary data sets, CRUISE contains the value most closely related temporally to a mainstem cruise and also begins with the letters "BAY." Since tributary and mainstem sampling dates often vary by more than a week, the user should remember that combining these data sets by CRUISE number will not necessarily produce the same synoptic view as one would expect when using bay-wide data sets for the same CRUISE.

OTHER DOCUMENTATION:

Refer to Chapter V, "Related Documentation."

TITLE: DATE OF SAMPLE COLLECTION
PARAMETER NAME: DATE
UNITS OF MEASURE: None
METHOD CODES: None

GENERAL METHOD:

DATE in the water quality data base is the date of sample collection and is stored in SAS date format.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

DATE is a "key" sorting field when searching for a particular observation in the data base. The parameter PERIOD could be used when locating data temporally.

OTHER DOCUMENTATION:

Refer to "Identifier Variables - CRUISE and PERIOD," and to the "Data Management Plan" (CBP 1992a).

TITLE: **SAMPLE LAYER**
PARAMETER NAME: **LAYER**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHOD:

Physical/chemical profiling of the water column is done at generally regular depth intervals. Samples for water chemistry analyses are collected at surface and bottom, and at stratified stations, at two mid-water depths based on the presence and location of a pycnocline (see "Pycnocline, Lower Depth" for a definition). LAYER codes (S=surface, AP=above the pycnocline, BP=below the pycnocline, and B=bottom) identify these samples. If samples are collected at 1/3 and 2/3 of the total depth, LAYER is coded as AP and BP respectively. This is done to facilitate data retrieval by layer.

MD/MDE: During cruise BAY001 4 grab samples were collected at each station. Since then, shallow stations are sampled only at surface and bottom layers. Elsewhere, where a pycnocline exists, the above pycnocline sample is collected 1.5 meters above the pycnocline, the below pycnocline sample is collected 1.5 meters below the pycnocline, and the bottom sample is collected 1-1.5 meters from the bottom (see Table 1, "Mainstem Water Quality Monitoring Stations"). Where both an upper and lower pycnocline exist, then the above pycnocline sample is collected above the upper pycnocline and the below pycnocline sample is collected below the lower pycnocline. No sample is collected from the intermediate zone. If no pycnocline exists, then samples are collected at surface and bottom layers, and at 1/3 and 2/3 total depth.

VA/VIMS: Specific stations are identified as "pycnocline" stations and surface, above pycnocline, below pycnocline, and bottom water chemistry samples are collected only at these stations. At other stations, water chemistry samples are collected only from the surface and bottom layers. There is no indication of presence or depth of a pycnocline at other stations.

ODU: ODU has specified pycnocline stations where four water chemistry samples are collected. During the early cruises, ODU did not identify a lower pycnocline. Beginning with CRUISE BAY113, both upper and lower pycnocline depths are always coded.

SAMPLE LAYER continued:

METHOD CHANGES:

MD/MDE: In the first year of the program (June through December 1984), the water chemistry samples were collected from whatever depth was indicated by the pycnocline computation, regardless of whether there had been physical/chemical measurements collected at that depth. In MDE data from this period, if you retrieve the data only from the data records containing the water chemistry analyses, where LAYER is not blank, then data for dissolved oxygen, salinity, water temperature, etc. may have been linearly interpolated between the readings from above and below that depth. Starting in 1985, the sampling protocol was changed so that water chemistry samples are always associated with profile measurements.

VA/VIMS: Above pycnocline and below pycnocline samples were not necessarily collected relative to the pycnocline depth as defined by CBP methods (see "Pycnocline, Lower Depth," below). Also, early VIMS data did not include layer codes, and these were assigned by CBPCC staff using PDEPTHU values. In early VIMS data, therefore, there may be more than one sample per layer code for a given station and date (albeit at different depths); i.e., two above pycnocline samples and no below pycnocline sample, or two below pycnocline samples and no bottom sample. The variable SDEPTH must be included to sort these records correctly (refer to DAITS #25).

VA/ODU: ODU has varied their sampling at 1/3, 2/3 and pycnocline stations over the length of the program. During the early cruises they did not sample above and below the pycnocline or sample at 1/3 or 2/3 of total depth. Later they took four samples only if there was a pycnocline. Currently at three specified pycnocline stations, they look for a pycnocline and sample above and below it if one exists; if a pycnocline does not exist, they sample at 1/3 and 2/3 total depth.

DAITS ISSUES:

DAITS #25: There are differences in the way in which the various collecting agencies determine pycnocline depth upper (PDEPTHU) and pycnocline depth lower (PDEPTHL). The determination of these depths affects the depth at which AP and BP will be sampled.

SAMPLE LAYER continued:

OTHER ISSUES:

Depending on the stratification characteristics of the water column, S and AP, or B and BP samples (each collected separately) can occur at the same sampling depth. This occurs mostly in the Maryland portion of the Bay and at Virginia stations CB6.4, CB7.3, and CB7.4. From June 1984 to December 1990, 164 observations had S and AP at the same depth and 180 observations had B and BP at the same depth. To sort records, sort by STATION, DATE, SDEPTH, LAYER, and REP_NUM.

The user must examine the conductivity profile in the data base to see where no pycnocline exists but 1/3 and 2/3 samples were collected. These 1/3, 2/3 samples will have LAYER coded as "AP" and "BP" and PDEPTHU and PDEPTHL will be set to missing.

OTHER DOCUMENTATION:

Refer to "Identifier Variables - SDEPTH," and Chapter V, "Related Documentation."

TITLE: **PERIOD OF SAMPLING**
PARAMETER NAME: **PERIOD**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHOD:

PERIOD is a parameter created in second-level data retrieval software. It is a character parameter containing the first and last dates for a cruise. For example, if MDE sampled between 8/12/92-8/14/92, ODU sampled on 8/11/92 and VIMS sampled between 8/11/92-8/12/92, PERIOD would contain the value "8/11/92-8/14/92." PERIOD is selected from the menu when running the retrieval software and is used in report or graphics titles to show the actual range of dates for a particular cruise.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: PYCNOCLINE, LOWER DEPTH
PARAMETER NAME: PDEPTHL
UNITS OF MEASURE: Meters
METHOD CODES: None

GENERAL METHOD:

The monitoring program requires that at certain stations, two mid-water nutrient samples be collected relative to the pycnocline. These are listed in Table 1 with a "4" in the "Number Samples" column. The pycnocline is the region of the water column where density changes rapidly due to salinity and temperature differences. Since the pycnocline is often a region of mixing of water masses, the goal is to sample above and below this layer to characterize the separate upper and lower water masses. The top and bottom of the pycnocline region is identified in the CBP data base by PDEPTHU and PDEPTHL (pycnocline depth upper and lower). Identifying these depths enables determination of the sampling depth for nutrients at above and below the pycnocline (AP and BP).

The presence and location of a pycnocline is determined from the conductivity profile. A computed threshold value (CTV) is calculated from 2 times the mean change in conductivity per meter between the surface and bottom. If the CTV exceeds 500 micromhos/cm per meter, a pycnocline is assumed to exist, and the lower pycnocline depth is usually defined at the first depth interval from the bottom (or from the surface for the upper pycnocline depth) with a change in conductivity that exceeds the CTV. See below for details of the method used by each collecting organization.

Where a pycnocline exists, the above pycnocline (AP) sample is usually collected 1.5 meters above the upper pycnocline depth, and the below pycnocline (BP) sample is usually collected 1.5 meters below the lower pycnocline depth.

MD/MDE: MDE averages the two sample depths in which the difference in conductivity exceeds the computed threshold value (CTV). For PDEPTHU these values are the first pair from the surface and for PDEPTHL the first pair from the bottom that exceed the CTV.

VA/ODU: ODU assigns the value of PDEPTHU to the shallower of the two sample depths that exceed the CTV (not the average). ODU sets the value of PDEPTHL similar to MDE, except the value is the deeper of the two sample depths.

VA/VIMS: VIMS assigns the value of PDEPTHU to the shallower of the two sample depths that exceed the CTV (not the average). Because they use a different method to define the pycnocline, in VIMS data PDEPTHL is equal to PDEPTHU.

PYCNOCLINE, LOWER DEPTH continued:

METHOD CHANGES:

Refer to "Identifier Variables - LAYER."

DAITS ISSUES:

DAITS #25: There are differences in the way in which the various collecting agencies determine pycnocline depth upper (PDEPTHU) and pycnocline depth lower (PDEPTHL). The determination of these depths affects the depth at which AP and BP will be sampled.

OTHER ISSUES:

Refer to "Identifier Variables - LAYER."

If no pycnocline was indicated and sampling occurred at 1/3 and 2/3 of total depth, PDEPTHU and PDEPTHL are set to missing in the data base. The LAYER parameter is coded AP and BP, to facilitate data retrieval by layer.

OTHER DOCUMENTATION:

See "Identifier Variables - SDEPTH and LAYER," Chapter V, "Related Documentation," and the "Data Management Plan" (CBP 1992a).

TITLE: **PYCNOCLINE, UPPER DEPTH**
PARAMETER NAME: **PDEPTHU**
UNITS OF MEASURE: **Meters**
METHOD CODES: **None**

GENERAL METHOD:

Refer to "Identifier Variables - PDEPTHL."

METHOD CHANGES:

Refer to "Identifier Variables - LAYER."

DAITS ISSUES:

DAITS #25: There are differences in the way in which the various collecting agencies determine pycnocline depth upper (PDEPTHU) and pycnocline depth lower (PDEPTHL). The determination of these depths affects the depth at which AP and BP will be sampled.

OTHER ISSUES:

Refer to "Identifier Variables - LAYER."

If no pycnocline was indicated and sampling occurred at 1/3 and 2/3 of total depth, PDEPTHU and PDEPTHL are set to missing in the data base. The LAYER parameter is coded AP and BP, to facilitate data retrieval by layer.

OTHER DOCUMENTATION:

See "Identifier Variables - PDEPTHL, SDEPTH, and LAYER," Chapter V, "Related Documentation," and the "Data Management Plan" (CBP 1992a).

TITLE: REPLICATE NUMBER
PARAMETER NAME: REP_NUM
UNITS OF MEASURE: None
METHOD CODES: None

GENERAL METHOD:

REP_NUM in monitoring data sets represents the field replicate number. These may represent field splits from a single sample (MDE and VIMS) or true field replicates (two successive grab samples, ODU).

MD/MDE: Ten percent of water samples collected in the field are split for duplicate analysis (the whole suite of laboratory analyses are duplicated). Specific stations and layers with field replicates are: CB1.1-B, CB2.2-S, CB3.3C - B, CB4.1W - S, CB4.2E - B, CB4.3C - AP, CB4.4 - B, and CB5.2 - S. See DAITS #3 for more details. Both split sample results are reported in the regular monitoring data base (REP_NUM=1 or 2).

VA/ODU: Field replicates from station CB7.3 or CB7.4N, collected as two successive grab samples, have been submitted since June 1984 and are coded in regular monitoring data as REP_NUM=1 or 2.

VA/VIMS: The means of two field splits, but not the two separate values, are included in the monitoring data base beginning with Cruise 96 (the first cruise in April 1989). Thus, the variable REP_NUM is always set to 1 in VIMS monitoring data. The concentration of one of the field splits, and their standard deviation, are in the QA data set, identified by REP_TYPE = "FLD". Data users can calculate the concentration of the other split sample using this value and the mean in the monitoring data set.

METHOD CHANGES:

None

DAITS ISSUES:

DAITS #3: See this issue for more details on field replicate methods.

OTHER ISSUES:

None

OTHER DOCUMENTATION:

Refer to Chapter IV, "Quality Assurance (QA) Data."

TITLE: **SAMPLE DEPTH**
PARAMETER NAME: **SDEPTH**
UNITS OF MEASURE: **Meters**
METHOD CODES: **None**

GENERAL METHOD:

MD/MDE: At the beginning of the program (June 1984 through April 1986), physical/chemical profiles were collected at every meter, beginning with 0.5 meter, and continuing until there was little change in temperature, salinity, or dissolved oxygen. Thereafter physical/chemical measurements were collected every 3 meters to the bottom.

VA/ODU: ODU takes profile samples at 1-meter intervals, beginning with 1 meter up to 15 meters and then every 2 meters to the bottom.

VA/VIMS: During the first cruise, June 1984, the physical/ chemical profile began at 2 meters and measurements were collected every 2 meters to the bottom.

METHOD CHANGES:

MD/MDE: The protocol was modified in May 1986 and measurements were recorded at 0.5, 1, and 3 meters and thereafter at 2-meter intervals. If dissolved oxygen concentration changed more than 1 mg/l over the interval, or conductivity changed more than 1000 umhos/cm, then readings were taken at 1-meter intervals.

VA/VIMS: From July 1984-July 1986, the surface layer sample was at 1 meter and successive samples were taken at 2-meter intervals. From August 1986-June 14, 1987, the surface was at 1 meter, then samples were taken every 1 meter down to 15 meters, and every 2 meters below that. Starting June 15, 1987, a profiling CTD took readings for all parameters except DO every 1 meter from 1 meter depth to the bottom; the protocol for DO did not change, since VIMS staff measure DO with a YSI meter.

DAITS ISSUES:
None

OTHER ISSUES:

SDEPTH = 0 in the data base header record is reserved for station information such as secchi depth readings, tide stage, weather, air temperature, etc., at the time the station is sampled.

OTHER DOCUMENTATION:

Refer to "Identifier Variables - Layer," Chapter V, "Related Documentation," and the "Data Management Plan" (CBP 1992a).

TITLE: **TOTAL DEPTH**
PARAMETER NAME: **TDEPTH**
UNITS OF MEASURE: **Meters**
METHOD CODES: **None**

GENERAL METHOD:

Total Depth represents the measured water depth at the station. It should be greater than any sample depths, since the "bottom" sample is always taken slightly above the actual bottom. Total Depth will vary slightly at the same station over time because of changes in tidal stage and exact sampling location.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: **SAMPLING STATION IDENTIFIER**
PARAMETER NAME: **STATION**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHOD:

All of the mainstem data submitters locate their stations using Loran-C. MDE holds the station by anchor if required by weather or currents, VIMS holds the station by anchor, and ODU positions the vessel to drift through the station area.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

The submitter's station name is not kept in the data base. If needed, the user should refer to the "Chesapeake Bay Basin Monitoring Program Atlas" (CBP 1989) for lists of the submitter's station names.

The shallow stations in the uppermost part of the Bay (Stations CB1.1 and CB2.1) may be ice-covered during some part of the winter. Data gaps are common during those months.

As a cost-saving measure, beginning in fall 1988, the lateral stations in the MD portion of the Bay (CB3.3E, CB3.3W, CB4.1E, CB4.1W, CB4.2E, CB4.2W, CB4.3E, and CB4.3W) are not sampled from November through the first cruise in March.

To monitor the effect of dumping dredge spoil in the deep trench, the Maryland Port Authority funded an additional transect of stations (CB4.0E, CB4.0C, and CB4.0W) within the Monitoring Program sampling design. These stations were sampled from June through September 1990. CB4.0C is the only station where nutrient samples were collected.

VIMS and MDE both sampled CB5.3 until April 1990. Due to the frequency of sampling variations, this was discontinued and VIMS no longer samples this station. To avoid confusion caused by having the same station duplicated, the VIMS data were removed from the data base, but is available upon request.

SAMPLING STATION IDENTIFIER continued:

OTHER DOCUMENTATION:

Refer to Table 1, "Mainstem Water Quality Monitoring Stations" and the "Chesapeake Bay Monitoring Program Atlas" (CBP 1989).

TITLE: **SOURCE AGENCY**
VARIABLE NAME: **SOURCE**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHOD:

Valid codes for SOURCE in the mainstem data sets are "MD/MDE" (was "MD/OEP" till 1987), "VA/ODU", and "VA/VIMS".

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

SOURCE does not identify the analysis laboratories. In Maryland, Central Regional Laboratory (CRL), Chesapeake Biological Laboratory (CBL), and Maryland Department of Health and Mental Hygiene (MDHMH) all have the same source. It usually identifies the field sampling agency, although it may not in some tributary data.

OTHER DOCUMENTATION:

Refer to the "Data Management Plan" (CBP 1992a).

TITLE: SAMPLING TIME
PARAMETER NAME: TIME
UNITS OF MEASURE: HHMM
METHOD CODES: None

GENERAL METHOD:

Sampling time is coded using the 2400 clock, and should be Eastern Standard Time (EST), according to the Data Management Plan (CBP 1992a). In the CBP data base, it is a numeric variable ranging from 0 to 2400. VIMS submits TIME as EST, but MDE and ODU submit it as local time (EST or EDT depending on the date).

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

Refer to the "Data Management Plan" (CBP 1992a).

C. Water Quality Parameters

This summary of general information about each parameter measured or calculated is intended to make data analysts aware of special problems they may encounter when analyzing each parameter. These include method changes, Data Analysis Issues Tracking System (DAITS) issues, and problems with inter-organization agreement.

Laboratory methods are indicated by method codes carried either as variables in the data set (parameter_M) or in the data set documentation. A detailed description of the methods and any slight variations of the methods used by the Program participants is available on line in CHESSEE (CHESSEE, DOcumentation, MEthods), although this information is not currently up to date (as of August 1992).

Variable names for monitored parameters usually imply similar analytical methods and units of measure. However, some variables have been named to correspond to variable names in the historical water quality data base. For example, particulate carbon is called POC, not PC; and particulate nitrogen is called PON, not PN. The results of particulate carbon and nitrogen analyses using an elemental analyzer may contain some inorganic carbon or nitrogen, but the results are called POC and PON to agree with the name of the previous mainstem methods.

The Data Analysis Issues Tracking System (DAITS) is used to collect information and achieve consensus on analytical and other issues affecting data analysis. Brief summaries of completed issues are listed here. Contact CBP computer center (CBPCC) staff for more information.

See Chapter V, "Related Documentation" for other documentation.

TITLE: PHYSICAL PROFILE SAMPLING METHODS
PARAMETER NAME: None
(applied to COND, DISOXY, PH, SALIN, and WTEMP)
UNITS OF MEASURE: None
METHOD CODES: None

GENERAL METHOD:

MD/MDE and VA/ODU: Both agencies currently use a Hydrolab probe attached to the sampling pump. The probe is lowered in discrete increments and the suite of readings is copied by hand to field sheets.

VA/VIMS: VIMS currently uses a CTD for conductivity (COND) and water temperature (WTEMP) and a YSI meter for dissolved oxygen (DISOXY). The CTD and YSI assembly is lowered at a constant rate and both are attached to the sampling pump. Measurements from the CTD are captured electronically every two seconds. Values reported to the CBPO are averages of the values (typically 3 to 4) which fall within that meter. The value reported at an SDEPTH of 1.0 represents the readings from 0.5 to 1.5 meters. Values have been reported on the station information record (SDEPTH = 0). These values are the average of the measurements recorded from the time the probe hits the water to 0.5 meters. Measurements from the YSI are hand written on field sheets at discrete sample depths. Later the dissolved oxygen values are corrected for water temperature and conductivity. VIMS does not measure pH as part of the vertical profile, it is measured only from the nutrient samples on board the research vessel.

METHOD CHANGES:

VIMS currently uses an Applied Microsystems CTD, and previously used an Interoceans CTD. They have always used a YSI meter for dissolved oxygen.

Originally, MDE and ODU lowered the Hydrolab separately from the sample collection pump. MDE started attaching the Hydrolab probe to the sampling pump and lowering them together on 1/1/89, and ODU made this change on 8/21/91. MDE also lowered the probe and pump separately for several months starting in 1/90 when faulty electrical wiring in the pump interfered with operation of the Hydrolab. Once the wiring was repaired, they were lowered together again.

DAITS ISSUES:

None

PHYSICAL PROFILE SAMPLING METHODS continued:

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: DISSOLVED OXYGEN
PARAMETER NAME: DISOXY
UNITS OF MEASURE: mg/l
METHOD CODES: See CHESSEE list

GENERAL METHOD:

MD/MDE: MDE validates the Hydrolab's dissolved oxygen measurements by performing Winkler dissolved oxygen titrations on three samples pulled from a bucket with the Hydrolab. This is done once each day during the cruise. The Winkler validation numbers are recorded on the field sheets but are not submitted to the CBPO as separate parameters. Meter results should be within 0.5 mg/l of Winkler results, and a different Hydrolab is used if they can't be brought closer.

VA/ODU: ODU submits two dissolved oxygen variables, DISOXY and DISOX2, with the water quality data. The variable DISOXY contains the Hydrolab's measurement. The variable DISOX2 contains the Winkler titrated value. DISOXY values are maintained in both levels of the data base, and DISOX2 is available upon request.

VA/VIMS: VIMS reports three dissolved oxygen variables with the water quality data, DISOXY, DISOX2, and DISOX3. The variable DISOX2 contains the 'raw' YSI reading, and DISOXY contains the YSI reading corrected for water temperature and conductivity. The variable DISOX3 has the Winkler titrated value, which is done at each sample depth that has a nutrient sample (2 or 4 samples depending on the station). The variables DISOX2 and DISOX3 are available upon request.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: DISSOLVED OXYGEN SATURATION
PARAMETER NAME: DO_SAT
UNITS OF MEASURE: mg/l
METHOD CODES: See CHESSEE list

GENERAL METHOD:

DO_SAT is a calculated value representing the dissolved oxygen concentration at saturation for that water temperature and salinity. This is calculated from an equation provided by Hydroqual:

```
DO_SAT = 14.6244 - 0.367134*WTEMP + 0.0044972*WTEMP*WTEMP
   - 0.0966*SALIN + 0.00205*SALIN*WTEMP + 0.0002739*SALIN*SALIN;
```

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: **PH**
PARAMETER NAME: **PH**
UNITS OF MEASURE: **Standard units**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Refer to "Dissolved Oxygen" for physical profile methods.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

VIMS does not measure pH as part of the vertical profile. They collect aliquots of the nutrient samples and measure pH onboard the research vessel with a pH meter.

OTHER DOCUMENTATION:

None

TITLE: **SALINITY**
PARAMETER NAME: **SALIN**
UNITS OF MEASURE: **ppt**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Refer to "Dissolved Oxygen" for physical profile methods.

The salinity value is either computed from conductivity (COND) and water temperature (WTEMP) when using a CTD, or read directly when using a Hydrolab.

VA/VIMS: VIMS compares its CTD salinity measurements with a Beckman Salinometer and submits these values as the variable SALIN2. VIMS uses the UNESCO equation for calculating the CTD measured salinity. SALIN2 is available upon request.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: **SECCHI DISK DEPTH**
PARAMETER NAME: **SECCHI**
UNITS OF MEASURE: **Meters**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

A black-and-white Secchi disk attached to a ruled line is lowered into the water. The depth at which the disk disappears is averaged with the depth at which it reappears; this measurement (in meters) is the Secchi depth (SECCHI).

METHOD CHANGES:

The disk may be either 20 or 30 cm wide.

DAITS ISSUES:

DAITS #7: Secchi variability and time of sampling are discussed.

OTHER ISSUES:

SECCHI_D may be ">" if the disk is lowered to the bottom without disappearing from view.

The value for SECCHI is sometimes missing due to the time of day the station was sampled (see DAITS #7 for details). SECCHI is only taken within 1/2 hour before to 1/2 hour after sunrise and sunset respectively.

SECCHI should only be reported on the station information record where SDEPTH = 0.

OTHER DOCUMENTATION:

None

TITLE: **SPECIFIC CONDUCTIVITY**
PARAMETER NAME: **COND**
UNITS OF MEASURE: **umhos/cm**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Refer to "Dissolved Oxygen" for physical profile methods.

METHOD CHANGES:

ODU submitted COND as mmhos/cm until March 1992, when they started sending it as umhos/cm.

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: **WATER TEMPERATURE**
PARAMETER NAME: **WTEMP**
UNITS OF MEASURE: **degrees Celsius**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Refer to "Dissolved Oxygen" for physical profile methods. A thermistor is used, in a Hydrolab (MDE and ODU) or CTD (VIMS). It cannot be calibrated in the Hydrolab; the unit must be sent in for service if out of calibration. MDE and ODU check the temperature calibration of the Hydrolab thermistor against a NIST calibrated thermometer at least twice a year.

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: SPECIFIC GRAVITY
PARAMETER NAME: SIG_T
UNITS OF MEASURE: none
METHOD CODES: See CHESSEE list

GENERAL METHOD:

Specific gravity is calculated from:

```
sigo=-0.069+((1.47808*((salin-0.03)/1.805))
     -(0.00157*(((salin-0.03)/1.805)**2))
     +(0.0000398*(((salin-0.03)/1.805)**3)));
tsum=(-1*(((wtemp-3.98)**2)/503.57))*((wtemp+283)/(wtemp+67.26));
sa=((10**-3)*wtemp)*(4.7867-(0.098185*wtemp)+(0.0010843*
(wtemp**2)));
sb=((10**-6)*wtemp)*(18.030-(0.8164*wtemp)+(0.01667*(wtemp**2)));

SIG_T = tsum+((sigo+0.1324)*(1-sa+sb*(sigo-0.1324)));
```

METHOD CHANGES:

None

DAITS ISSUES:

None

OTHER ISSUES:

None

OTHER DOCUMENTATION:

None

TITLE: **FIELD FILTRATION METHODS**
PARAMETER NAME: **None (affects all dissolved and particulate parameters)**
UNITS OF MEASURE: **None**
METHOD CODES: **None**

GENERAL METHODS:

All dissolved parameters are analyzed from water filtered in the field, to minimize changes in the sample caused by biological activity after sample collection. All parameters are filtered using a vacuum pump, except DOC/POC/PON filtration at ODU used positive pressure filtration with a syringe until 1992. Whether or not the filter was rinsed after filtration also varied: TSS/PHOSP filters are always rinsed with deionized (DI) water, because the salt prevents accurate TSS determination if the filter is unrinsed. POC/PON filters were rinsed by VIMS with DI water until 1992, but were never rinsed by ODU or MDE field crews. CHLA filters have magnesium carbonate added at all mainstem laboratories.

The filtrate used for dissolved nutrient analysis varies: MDE/CBL uses the POC/PON filtrate, while ODU and VIMS use the TSS/PHOSP filtrate, removing it from the filter apparatus before the TSS/PHOSP filter is rinsed with DI water. The filtrate used for DOC also varies: CBL and ODU use the POC/PON filtrate for DOC analyses, while VIMS uses the TSS/PHOSP filtrate for DOC.

METHOD CHANGES:

MDE and VIMS field crews used 0.45 micron membrane filters at the start of the program in June 1984. ODU field crews have used 0.7 micron glass fiber filters (Whatman GF/F, except for CHLA and POC/PON) since the start of the program. VIMS changed to 0.7 micron glass fiber filters in June 1985, and MDE crews made this change on May 15, 1985. A study by Magnien (1986) showed there were no statistically significant differences in any dissolved parameters filtered by the two methods, except for small differences in silica concentrations.

The change in filter type was made for two reasons: membrane filters tend to clog when TSS is high, and there are possible contamination problems with nutrients released by the membrane filter.

VIMS previously used the POC/PON filtrate for DOC, but switched to using the TSS/PHOSP filtrate when they had contamination problems.

DAITS ISSUES:

DAITS #23: Effects of filter rinsing on POC/PON results are discussed. Results pending, data being collected by VIMS. Contact Betty Salley for more information.

FIELD FILTRATION METHODS continued:

OTHER ISSUES:

VIMS and ODU used Gelman AE glass fiber filters for their POC/PON determinations, because Whatman GF/F were not available in the diameter they needed. Both now use Whatman GF/F.

ODU used Whatman GF/C filters for CHLA filtration until 1992, when they switched to Whatman GF/F. GF/C has slightly larger pore size (1.0 micron). ODU ground CHLA filters on the boat, unless seas were too rough; ODU started grinding in the laboratory in 1992. MDE and VIMS grind CHLA filters in the laboratory.

OTHER DOCUMENTATION:

"A comparison of estuarine water chemistry analysis on the filtrate from two types of filters" (Magnien 1986).

"Estuarine nutrient analyses: A comparison of sample handling techniques and analyses of carbon, nitrogen, phosphorus, and chlorophyll a" (Zimmermann 1991).

TITLE: **TOTAL PHOSPHORUS**
PARAMETER NAME: **TP**
UNITS OF MEASURE: **mg/l as P**
METHOD CODES: **See CHESSEE list**

GENERAL METHODS:

Direct: An unfiltered water sample is digested in acid and persulfate to convert all forms of phosphorus to orthophosphate. Then orthophosphate is determined with the autoanalyzer.

Calculated: TDP + PHOSP (see those parameters for details).

METHOD CHANGES:

Major method changes have occurred. See Table 4, "Measured and Calculated Laboratory Parameters" in Chapter III for dates that each method was used at each laboratory. The change to TP calculated was made to eliminate any parameters calculated by subtraction, since calculations by subtraction were shown to be less accurate and can yield negative values (see D'Elia et al. 1987). No step trends have been identified associated with these method changes.

DAITS ISSUES:

DAITS #10: Summarizes method comparison data available to document comparability of old and new TP methods.

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories is high, based on CSSP data (AMQAW 1992).

OTHER DOCUMENTATION:

"Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991" (AMQAW 1992).

"Trends in Phosphorus in the Chesapeake Bay (1984-1990)" (CSC 1991).

"Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring" (D'Elia et al. 1987).

TITLE: TOTAL DISSOLVED PHOSPHORUS
PARAMETER NAME: TDP
UNITS OF MEASURE: mg/l as P
METHOD CODES: See CHESSEE list

GENERAL METHOD:

All laboratories digest a filtered sample to convert all forms of dissolved phosphorus to inorganic phosphorus (PO4F), which is analyzed using with the same autoanalyzer manifold as PO4F. ODU calibrates by the method of standard additions, using standards diluted in a composite of water from several samples.

METHOD CHANGES:

No major method changes. Minor changes occurred in the digestion method used (acid or alkaline persulfate). See Table 4, "Measured and Calculated Laboratory Parameters" for dates that each method was used at each laboratory. Comparisons between results from the two digestion methods showed slightly higher results with acid persulfate, but the magnitude of the differences was fairly small (about 0.005 mg/l, see Figure 15 in D'Elia et al. 1987).

DAITS ISSUES:
None

OTHER ISSUES:

Inter-laboratory agreement among the three mainstem laboratories (CBL, VIMS, and ODU) is high for TDP, based on Coordinated Split Sample Program (CSSP) data (AMQAW 1992).

Sometimes TDP results are less than PO4F results, even though theoretically they should be equal to or grater than PO4F. The discrepancy may have two causes: TDP involves a digestion and PO4F does not, and material may be lost during digestion; TDP also involves an internal dilution, and PO4F does not. When TDP < PO4F, laboratories should use analytical problem code 'QQ' and leave both values in the data base if the discrepancy is less than the analytical precision, usually estimated by the sum of both MDLs. If the discrepancy is larger than the summed MDLs, one or both values may be deleted.

OTHER DOCUMENTATION:

"Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991" (AMQAW 1992).

"Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring" (D'Elia et al. 1987).

TITLE: **PARTICULATE PHOSPHORUS**
PARAMETER NAME: **PHOSP**
UNITS OF MEASURE: **mg/l as P**
METHOD CODES: **See CHESSEE list**

GENERAL METHODS:

Calculated: From TP - TDP.

Direct: The same filter weighed for TSS determination is used in direct determination of PHOSP. After weighing, the filter is placed in a crucible and heated in a muffle furnace at 550 C. The combustion breaks down organically bound phosphorus to inorganic phosphorus (orthophosphate), which is extracted with hydrochloric acid and determined with an autoanalyzer. The method is from Aspila et al. (1976).

METHOD CHANGES:

Major method changes have occurred. See Table 4, "Measured and Calculated Laboratory Parameters" for dates that each method was used at each laboratory. The change to PHOSP measured directly was made to avoid having to calculate any parameters by subtraction, since calculations by subtraction were shown to be less accurate and can yield negative values (see D'Elia et al. 1987). No step trends have been identified associated with these method changes.

DAITS ISSUES:

DAITS #10: Summarizes method comparison data available to document comparability of old and new PHOSP methods.

DAITS #16: If Maryland mainstem data is being combined with Maryland tributary data for PHOSP, the differences found in TP and TDP results from Maryland mainstem and Maryland tributary monitoring programs probably also affected PHOSP. See TP or TDP for details.

OTHER ISSUES:

PHOSP may show a positive correlation with TSS, since it is contained in plankton and it may adhere to soil particles. These parameters can be compared when examining possible outliers in the data.

Inter-organization agreement among mainstem laboratories is high, based on CSSP data (AMQAW 1992).

PARTICULATE PHOSPHORUS continued:

OTHER DOCUMENTATION:

"Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991" (AMQAW 1992).

"Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring" (D'Elia et al. 1987).

"A semi-automated method for the determination of inorganic, organic, and total phosphate in sediments" (Aspila, I. et al. 1976).

TITLE: **ORTHOPHOSPHATE (FILTERED) AND DISSOLVED INORGANIC PHOSPHORUS**
PARAMETER NAME: **PO4F and DIP**
UNITS OF MEASURE: **mg/l as P**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

All laboratories use variants of EPA method 365, ascorbic acid reduction, with an autoanalyzer, except ODU used a manual method until 1992. ODU calibrates by the method of standard additions, using standards diluted in a composite of sample water. CBL and VIMS use a double reagent method (ascorbic acid as a separate reagent); see Zimmermann (1991).

METHOD CHANGES:

ODU changed from manual to autoanalyzer method in 1992.

DAITS ISSUES:

DAITS #15: CBL revised their PO4F data with a salinity correction in 1992. Correcting the CBP data base is pending, 7/31/92. This did not affect other phosphorus parameters, although they are analyzed as PO4F after digestion, because the additional reagents used for TP, TDP, and PHOSP change the refractive index of the solution and eliminate the need for the correction.

OTHER ISSUES:

Orthophosphate (filtered) is considered equivalent to dissolved inorganic phosphorus (DIP). PO4F may include a small amount of organic P, and it does not include one form of inorganic P, called "hydrolyzable phosphate." The magnitude of these two components in Bay PO4F samples is unknown, but both are assumed to be small. Hydrolyzable phosphate is mainly found in detergents, and its use is now banned in most detergents. Hydrolyzable phosphate should be included in TDP and TP determinations, however. PO4F is exactly equivalent to Soluble Reactive Phosphorus (SRP) used in oceanographic research.

Orthophosphate (filtered) is released (mineralized) from sediments under anoxic conditions, which usually occur in the summer. Thus, maximum values are often found in summer bottom samples.

A habitat requirement for Submerged Aquatic Vegetation (SAV) growth has been established for DIP. April-October median surface values should be less than 0.01 mg/l in lower salinity regions, and less than 0.02 mg/l in higher salinity regions (>18 ppt). See Batiuk et al. (1992) for details.

ORTHOPHOSPHATE (FILTERED) AND DISSOLVED INORGANIC PHOSPHORUS continued:

Orthophosphate (filtered) values are sometimes below the detection limit, complicating trend analyses. Orthophosphate (filtered) values may exceed TDP values; see TDP for more information.

In some historical Chesapeake Bay data (before 1984), PO4F may have been reported as mg/l PO4 instead of as mg/l P. All concentrations should have been converted, but if high results are found for a particular time period, they may have been reported as PO4.

Inter-organization agreement among mainstem laboratories is high, based on CSSP data (AMQAW 1992).

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

CSC. 1991. Trends in Phosphorus in the Chesapeake Bay (1984-1990). CBP/TRS 67/91, Chesapeake Bay Program, Annapolis, MD.

Batiuk et al. 1992. Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Goals: A Technical Synthesis. CBP/TRS 52/92, Chesapeake Bay Program, Annapolis, MD.

Zimmermann, C. 1991. Estuarine nutrient analyses: A comparison of sample handling techniques and analyses of carbon, nitrogen, phosphorus, and chlorophyll a. Report submitted to EPA through Technology Applications, Inc. by Chesapeake Biological Laboratory, Solomons, MD.

TITLE: DISSOLVED ORGANIC PHOSPHORUS
PARAMETER NAME: DOP
UNITS OF MEASURE: mg/l as P
METHOD CODES: See CHESSEE list

GENERAL METHOD:

Calculated from TDP - PO4F for all laboratories and time periods, assuming PO4F = DIP.

METHOD CHANGES:

No major method changes.

DAITS ISSUES:

None

OTHER ISSUES:

Because Orthophosphate (filtered) (PO4F) may include a small amount of organic P, the calculation method used may underestimate DOP slightly. However, DOP calculated by this method may be slightly overestimated if hydrolyzable phosphate is present.

DOP can be negative, since PO4F sometimes exceeds TDP. It should be set to 0 when negative.

OTHER DOCUMENTATION:

None

TITLE: **TOTAL NITROGEN**
PARAMETER NAME: **TN**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Total nitrogen is always calculated, from either TKNW + NO23 or TDN + PON.

METHOD CHANGES:

Major method changes have occurred. See Table 4, "Measured and Calculated Laboratory Parameters" for dates that each method was used at each laboratory. The change to TN = TDN + PON was made to avoid having to calculate any parameters by subtraction, since calculations by subtraction were shown to be less accurate and often yield negative values (see D'Elia et al. 1987). Two step trends have been identified associated with these method changes (see DAITS issues); TN data in the CBP data base have been adjusted to correct for both step trends.

DAITS ISSUES:

DAITS #2: Adjusting helix Kjeldahl nitrogen data (see Bergstrom 1992). Used method comparison data to correct a low bias in early TKNW and TKNF data from OEP/CRL, and thus TN and TDN data.

DAITS #10: Summarizes method comparison data available to document comparability of old and new TN methods.

DAITS #20: Adjustment for ODU TN Kjeldahl data. Used dummy variables from TN regression to adjust ODU TN data; no adjustment made to TKNW data.

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories was fairly low, based on CSSP data (AMQAW 1992). The difference was probably due to the difference in PON results, since it followed the same pattern; see PON for details.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

TOTAL NITROGEN continued:

Bergstrom, P. 1992. Adjusting helix Kjeldahl nitrogen results: Maryland Chesapeake Bay Mainstem Water Quality Monitoring Program, 1984-1985. CBP/TRS 44/92, Chesapeake Bay Program, Annapolis, MD.

Chesapeake Bay Program (CBP). 1992. Trends in Nitrogen in the Chesapeake Bay (1984-1990). CBP/TRS 68/92, Chesapeake Bay Program, Annapolis, MD.

D'Elia, C. et al. 1987. Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring. CBP/TRS 7/87, Chesapeake Bay Program, Annapolis, MD.

TITLE: **TOTAL DISSOLVED NITROGEN**
PARAMETER NAME: **TDN**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Calculated: from TDN = TKNF + NO23.

Direct: All laboratories digest a filtered sample with alkaline persulfate to convert all forms of dissolved nitrogen to nitrite + nitrate (NO23), which is analyzed with the same autoanalyzer manifold as NO23. See D'Elia et al. (1987).

METHOD CHANGES:

Major method changes have occurred. See Table 4, "Measured and Calculated Laboratory Parameters" for dates that each method was used at each laboratory. The change to TDN direct was made to avoid having to calculate any parameters by subtraction, since calculations by subtraction were shown to be less accurate and could yield negative values (see D'Elia et al. 1987). Two step trends have been identified associated with these method changes (see DAITS issues); TDN data in the CBP data base have been adjusted to correct for one step trend (see DAITS issues and Bergstrom 1992).

DAITS ISSUES:

DAITS #2: Adjusting helix Kjeldahl nitrogen data (see Bergstrom 1992). Used method comparison data to correct a low bias in early TKNW and TKNF data from OEP/CRL, and thus TDN data.

DAITS #10: Summarizes method comparison data available to document comparability of old and new TDN methods.

DAITS #20: Adjustment for ODU TN Kjeldahl data. Used dummy variables from TN regression to adjust ODU TN data; no adjustment done to TKNF or TDN data.

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories is generally high, based on CSSP data (AMQAW 1992).

TOTAL DISSOLVED NITROGEN continued:

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Bergstrom, P. 1992. Adjusting helix Kjeldahl nitrogen results: Maryland Chesapeake Bay Mainstem Water Quality Monitoring Program, 1984-1985. CBP/TRS 44/92, Chesapeake Bay Program, Annapolis, MD.

D'Elia, C. et al. 1987. Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring. CBP/TRS 7/87, Chesapeake Bay Program, Annapolis, MD.

TITLE: **PARTICULATE ORGANIC NITROGEN and PARTICULATE NITROGEN**
PARAMETER NAME: **PON**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Calculated: from PON = TKNW - TKNF.

Direct: All laboratories determine from a separate filter that is combusted at 975-1050 C using an elemental analyzer. The results may include some inorganic nitrogen, but the parameter is still called PON in the CBP data base, not PN, to agree with the name for the calculated method. See D'Elia et al. (1987).

METHOD CHANGES:

Major method changes have occurred. See Table 4, "Measured and Calculated Laboratory Parameters" for dates that each method was used at each laboratory. The change to PON direct was made to avoid having to calculate any parameters by subtraction, since calculations by subtraction were shown to be less accurate and could yield negative values (see D'Elia et al. 1987). Two step trends have been identified associated with these method changes (see DAITS issues); PON data in the CBP data base have been adjusted to correct for one step trend (see below).

DAITS ISSUES:

DAITS #2: Adjusting helix Kjeldahl nitrogen data (see Bergstrom 1992). Used method comparison data to correct a low bias in early TKNW and TKNF data from OEP/CRL, and thus PON data.

DAITS #10: Summarizes method comparison data available to document comparability of old and new PON methods.

DAITS #20: Adjustment for ODU TN Kjeldahl data. Used dummy variables from TN regression to adjust ODU TN data; no adjustment done to PON data.

DAITS #23: Effects of filter rinsing on POC/PON results. Results pending, data being collected by VIMS. Contact Betty Salley for more information.

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories was low, based on CSSP data (AMQAW 1992). Results were significantly higher from CBL than at VIMS or ODU. This was apparently due to filter rinsing at VIMS, which caused loss of PON, and positive pressure filtration at ODU. In 1992, VIMS stopped rinsing, and

PARTICULATE ORGANIC NITROGEN and PARTICULATE NITROGEN continued:

ODU switched to vacuum filtration in 1992, which should increase agreement. Also, VIMS and ODU use a different elemental analyzer from CBL.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Bergstrom, P. 1992. Adjusting helix Kjeldahl nitrogen results: Maryland Chesapeake Bay Mainstem Water Quality Monitoring Program, 1984-1985. CBP/TRS 44/92, Chesapeake Bay Program, Annapolis, MD.

D'Elia, C. et al. 1987. Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring. CBP/TRS 7/87, Chesapeake Bay Program, Annapolis, MD.

TITLE: **TOTAL KJELDAHL NITROGEN, WHOLE AND FILTERED**
PARAMETER NAME: **TKNW and TKNF**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Kjeldahl nitrogen includes all organic nitrogen, plus part of the inorganic nitrogen (ammonium or NH4). Nitrate + Nitrite (NO23) is not included. The whole or filtered sample is digested, usually in acid, which converts organic nitrogen to ammonium. The sample is analyzed on the autoanalyzer as ammonium. See Table 4, "Measured and Calculated Laboratory Parameters" for dates that TKNW & TKNF were used at each laboratory. The main method differences are in the heating method during digestion (see next section).

METHOD CHANGES:

There were two minor method changes, although there were three different digestion methods. See Table 4, "Measured and Calculated Laboratory Parameters" and Bergstrom 1992 for details.
Two step trends have been identified associated with method changes when the Kjeldahl methods were stopped (see DAITS issues); TKNW and TKNF data in the CBP data base have been adjusted to correct for only one of the step trends, in Maryland data (see Bergstrom 1992 and DAITS #20).

DAITS ISSUES:

DAITS #2: Adjusting helix Kjeldahl nitrogen data (see Bergstrom 1992). Used method comparison data to correct a low bias in early TKNW and TKNF data using the helix method from OEP/CRL.

DAITS #10: Summarizes method comparison data available to document comparability of old and new TKNW and TKNF methods.

DAITS #20: Adjustment for ODU TN Kjeldahl data. Used dummy variables from TN regression to adjust ODU TN data; no adjustment was done to TKNW data, since regressions were done on TN data only.

OTHER ISSUES:

TKNF was not analyzed in bottom samples by VIMS or ODU. This included samples with LAYER = 'B' (bottom) and also LAYER = 'BP' (below pycnocline). This also affected parameters calculated from TKNF: TDN, PON, and Dissolved Organic Nitrogen (DON). MDE laboratories analyzed TKNF in all samples, and TKNW was analyzed in all samples at all laboratories.

TOTAL KJELDAHL NITROGEN, WHOLE AND FILTERED continued:

Inter-organization agreement among mainstem laboratories could not be assessed with CSSP data because Kjeldahl methods were stopped right after the program started. Earlier two-way split sample data between VIMS and ODU showed significant inter-organization differences for TKNW (Bergstrom 1989). These differences could be a cause of the ODU step trend in TN (see DAITS #20), since ODU TKNW results were usually higher than VIMS results. TKNF was not analyzed because the samples used were bottom samples.

OTHER DOCUMENTATION:

Bergstrom, P. 1989. Split sample water quality results from laboratories participating in the Chesapeake Bay Program: 1985-1989. CBP/CSSP Report Series #1, Chesapeake Bay Program, Annapolis, MD.

Bergstrom, P. 1992. Adjusting helix Kjeldahl nitrogen results: Maryland Chesapeake Bay Mainstem Water Quality Monitoring Program, 1984-1985. CBP/TRS 44/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **NITRITE + NITRATE, FILTERED AND NITRATE, FILTERED**
PARAMETER NAME: **NO23 and NO3**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Cadmium reduces NO3 to NO2; then the sum of NO3 and NO2 are determined as NO2 by the diazo method with an autoanalyzer (EPA method 353.2). Calculate NO3 = NO23 - NO2.

METHOD CHANGES:

No major method changes. ODU originally reported NO23 as "NO3" but this was later corrected in the CBP data base. NO3 has never been measured directly.

DAITS ISSUES:

None

OTHER ISSUES:

Unfiltered NO23 results have been reported in some tributary monitoring programs, and may have been used in historical mainstem data. In the Potomac component of the CSSP, unfiltered NO23 results were slightly higher than filtered results (see AMQAW 1992). Filtered samples were used starting in October, 1990, which eliminated the difference (AMQAW 1992).

Inter-organization agreement among mainstem laboratories is high, based on CSSP data (AMQAW 1992).

NO3 is highly soluble in water, and can be present in runoff and ground water in high concentrations (10-15 mg/l in some tributaries). NO3 concentrations may be related to river flow, especially in or near major rivers.

Phytoplankton prefer to use NH4 as a nitrogen source, since it contains more energy, but will use NO23 when NH4 is in short supply. See CBP 1992 for details. Some wastewater treatment plants convert NH4 to NO23 (nitrification) to make it less attractive to phytoplankton, raising the NO23 concentration downstream.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Chesapeake Bay Program (CBP). 1992. Trends in Nitrogen in the Chesapeake Bay (1984-1990). CBP/TRS 68/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **NITRITE, FILTERED**
PARAMETER NAME: **NO2**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Determined directly by the automated sulfanilamide method with an autoanalyzer (EPA method 354.1), except ODU determines the concentration manually with a spectrophotometer.

METHOD CHANGES:

No major method changes.

DAITS ISSUES:

None

OTHER ISSUES:

NO2 may be below the MDL, complicating analyses of this parameter.

NO2 concentrations are usually less than NO3 or NH4 concentrations. It is produced as an intermediate product in nitrification: NH4 is oxidized to NO2, then NO2 is oxidized to NO3.

Inter-organization agreement among mainstem laboratories is high, based on CSSP data (AMQAW 1992).

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **AMMONIUM, FILTERED**
PARAMETER NAME: **NH4**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Determined directly with an autoanalyzer, using the automated alkaline phenol hypochlorite method (EPA 350.1 or equivalent).

METHOD CHANGES:

No major method changes.

DAITS ISSUES:

None

OTHER ISSUES:

NH4 is released (mineralized) by anoxic bottom sediments, usually in the summer. Thus, annual peaks usually occur in summer bottom samples.

Phytoplankton prefer to use NH4 as a nitrogen source, since it contains more energy, but will use NO23 when NH4 is in short supply. See CBP 1992 for details. Some wastewater treatment plants convert NH4 to NO23 to make it less attractive to phytoplankton (nitrification), lowering the NH4 concentration downstream.

Inter-organization agreement among mainstem laboratories is high, based on CSSP data (AMQAW 1992).

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Chesapeake Bay Program (CBP). 1992. Trends in Nitrogen in the Chesapeake Bay (1984-1990). CBP/TRS 68/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **DISSOLVED INORGANIC NITROGEN**
PARAMETER NAME: **DIN**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Always calculated, from DIN = NO23 + NH4.

METHOD CHANGES:

No major method changes.

DAITS ISSUES:

None

OTHER ISSUES:

A habitat requirement for Submerged Aquatic Vegetation (SAV) growth has been established for DIN. April-October median surface values should be less than 0.15 mg/l in higher salinity regions (>5 ppt). See Batiuk et al. (1992) for details.

OTHER DOCUMENTATION:

Batiuk et al. 1992. Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Goals: A Technical Synthesis. CBP/TRS 52/92.

Chesapeake Bay Program (CBP). 1992. Trends in Nitrogen in the Chesapeake Bay (1984-1990). CBP/TRS 68/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **DISSOLVED ORGANIC NITROGEN and TOTAL ORGANIC NITROGEN**
PARAMETER NAME: **DON and TON**
UNITS OF MEASURE: **mg/l as N**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Calculated as follows:

DON = TKNF - NH4 or TDN - NH4 - NO23;

TON = TKNW - NH4 or TN - NH4 - NO23.

See Table 4, "Measured and Calculated Laboratory Parameters" for details.

METHOD CHANGES:

No major method changes.

DAITS ISSUES:

None

OTHER ISSUES:

DON can be negative, if NH4 exceeds TKNF or (NH4 + NO23) exceeds TDN. TON can be negative, if NH4 exceeds TKNW or (NH4 + NO23) exceeds TN. If either is negative, it should be set to 0.

OTHER DOCUMENTATION:

None

TITLE: **TOTAL ORGANIC CARBON**
PARAMETER NAME: **TOC**
UNITS OF MEASURE: **mg/l as C**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Direct: The three mainstem laboratories used the same method, persulfate oxidation at 100 C, with two different instruments. CBL used an Oceanographic Instruments (OI) ampule instrument, and later an OI injection instrument; ODU uses an OI ampule instrument. VIMS never did TOC analyses; ODU analyzed samples from all VIMS stations.

Calculated: From TOC = DOC + POC.

METHOD CHANGES:

In Maryland, CRL used manual injection methods which were unreliable, and the data should be used with caution before 5/15/85 (see DAITS #18). CBL changed from OI ampule to OI injection on 3/1/87. See Table 4 for details.

In Virginia, ODU did DOC (and TOC direct until 12/87) for all ODU and VIMS stations until 7/90, when VIMS started DOC analyses for VIMS stations.

DAITS ISSUES:

DAITS #10: Summarizes method comparison data available to document comparability of old and new TOC methods.

DAITS #18: Manual injection carbon data. CRL used a manual injection method where the results depended on how forcefully the sample was injected. Analytical Methods and Quality Assurance Workgroup (AMQAW) members recommended against using any TOC or DOC results for Maryland mainstem stations before 5/15/85.

DAITS #21: Dissolved organic carbon method comparisons. Salley et al. (1992) summarizes comparisons at VIMS stations; other comparisons at a wider range of salinities are ongoing.

DAITS #23: Effects of filter rinsing on POC/PON results. Results pending, data being collected by VIMS. Contact Betty Salley for more information.

TOTAL ORGANIC CARBON continued:

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories for TOC calculated was high, based on CSSP data (AMQAW 1992). Even though both DOC and POC had low agreement, when added together the differences apparently disappeared.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **DISSOLVED ORGANIC CARBON**
PARAMETER NAME: **DOC**
UNITS OF MEASURE: **mg/l as C**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

The three mainstem laboratories currently use two different methods, using three different instruments. CBL and ODU use persulfate oxidation at 100 C, and do not preserve the samples in the field. CBL does the analysis with an Oceanographic Instruments (OI) injection instrument, and ODU uses an OI ampule instrument. VIMS uses a Shimadzu high-temperature catalyst method, and preserves the sample in the field with hydrochloric acid.

METHOD CHANGES:

In Maryland, CRL used manual injection methods which were unreliable, and the data should not be used (See DAITS #18). CBL changed from OI ampule to OI injection on 3/1/87.

In Virginia, ODU analyzed DOC (and TOC until 12/87) for all ODU and VIMS stations until 7/90, when VIMS started DOC analyses for VIMS stations. The lab at ODU that analyzed DOC changed for VIMS stations in 1/88, and for ODU stations in 9/88, from Dr. Wolfinbarger's lab to Steve Sokolowski's lab (AMRL). There was no method change, but percent recoveries became much less variable. Before the lab change, DOC recoveries ranged from 50-186%, and their standard deviation was 24%. After the change, DOC recoveries ranged from 79-122%, and their standard deviation was only 8%.

DAITS ISSUES:

DAITS #18: Manual injection carbon data. CRL used a manual injection method where the results depended on how forcefully the sample was injected. Analytical Methods and Quality Assurance Workgroup (AMQAW) members recommended against using any TOC or DOC results for Maryland mainstem stations before 5/15/85.

DAITS #21: Dissolved organic carbon method comparisons. Salley et al. (1992) summarizes comparisons at VIMS stations; other comparisons at a wider range of salinities are ongoing.

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories was low, based on CSSP data (AMQAW 1992). Results were significantly higher from VIMS; the Shimadzu method apparently recovers more DOC than other methods.

DISSOLVED ORGANIC CARBON continued:

OTHER DOCUMENTATION:

AMQAW. 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Salley, B., et al. 1992. A comparison of two methods of measuring dissolved organic carbon. Special Scientific Report #128, Virginia Institute of Marine Science (VIMS), Gloucester Point, VA.

TITLE: **PARTICULATE ORGANIC CARBON and PARTICULATE CARBON**
PARAMETER NAME: **POC**
UNITS OF MEASURE: **mg/l as C**
METHOD CODES: **See CHESSER list**

GENERAL METHOD:

Calculated: from POC = TOC - DOC.

Direct: All mainstem laboratories determine from a filter combusted at 975-1050 C using an elemental analyzer. The results may include some inorganic carbon, but the parameter is still called POC in the CBP data base, not PC, to agree with the name for the calculated method.

METHOD CHANGES:

Major method changes have occurred. See Table 4, "Measured and Calculated Laboratory Parameters" for dates that each method was used at each laboratory. The change to POC direct was made to avoid having to calculate any parameters by subtraction, since calculations by subtraction were shown to be less accurate and often yield negative values (see D'Elia et al. 1987, although it does not discuss carbon methods).

DAITS ISSUES:

DAITS #10: Summarizes method comparison data available to document comparability of old and new POC methods.

DAITS #23: Effects of filter rinsing on POC/PON results. Results pending, data being collected by VIMS. Contact Betty Salley for more information.

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories was low, based on CSSP data (AMQAW 1992). Results were significantly higher from CBL than at VIMS or ODU. This was apparently due to filter rinsing at VIMS, which caused loss of POC, and positive pressure filtration at ODU. In 1992, VIMS stopped rinsing, and ODU switched to vacuum filtration, which should increase agreement. VIMs and ODU also use a different elemental analyzer from the one used by CBL.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

PARTICULATE ORGANIC CARBON and PARTICULATE CARBON continued:

D'Elia, C. et al. 1987. Nitrogen and phosphorus determinations in estuarine waters: a comparison of methods used in Chesapeake Bay Monitoring. CBP/TRS 7/87, Chesapeake Bay Program, Annapolis, MD.

TITLE: **SILICA, FILTERED**
PARAMETER NAME: **SI**
UNITS OF MEASURE: **mg/l as SI**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Determined with autoanalyzer using reduction of silicomolybdate to molybdenum blue with ascorbic acid.

METHOD CHANGES:

No major method changes.

DAITS ISSUES:

None

OTHER ISSUES:

Silica is reported as SIO2 (silicate, the soluble form) by the Virginia tributary laboratory (DCLS); this should be converted to mg/l as SI by dividing by 2.14. SI may also have been reported this way in some mainstem historical monitoring data.

Inter-organization agreement was fairly low at mainstem laboratories, based on CSSP data (AMQAW 1992). CBL had significantly lower results than VIMS or ODU; the differences were larger than the analytical precision in 5 of 9 cruises analyzed. Possible causes of these differences are under investigation.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

TITLE: **TOTAL SUSPENDED SOLIDS**
PARAMETER NAME: **TSS**
UNITS OF MEASURE: **mg/l**
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

A known volume of sample is filtered through a pre-weighed filter. The filter is dried at 103-105 C, re-weighed, and the dry weight of TSS is calculated by subtraction (EPA method 160.2). This is converted to mg/l TSS by multiplying by the volume of water filtered.

METHOD CHANGES:

No major method changes. All mainstem laboratories use the same method.

DAITS ISSUES:

DAITS #1: Data censoring criteria. High TSS values in bottom samples are sometimes used as an indicator that the sample pump had hit the bottom, which stirred up bottom sediments. MDE mainstem data sometimes include the Analysis Problem Code "TS" or "SS" to indicate TSS data deleted for this reason; particulate nutrient parameters (PHOSP, POC, PON) may also be deleted.

OTHER ISSUES:

Inter-organization agreement was fairly low at mainstem laboratories, based on CSSP data (AMQAW 1992). CBL had significantly lower results than VIMS or ODU; the differences were larger than the analytical precision in 4 of 7 cruises analyzed. Possible causes of these differences are under investigation.

A habitat requirement for Submerged Aquatic Vegetation (SAV) growth has been established for TSS. April-October median surface values should be less than 15 mg/l baywide. See Batiuk et al. (1992) for details.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Batiuk et al. 1992. Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Goals: A Technical Synthesis. CBP/TRS 52/92.

TITLE: **CHLOROPHYLL A AND PHAEOPHYTIN, SPECTROPHOTOMETRIC**
PARAMETER NAME: **CHLA and PHEA**
UNITS OF MEASURE: **ug/l**
METHOD CODES: **See CHESSER list**

GENERAL METHOD:

Both are determined spectrophotometrically, using acetone extraction from a ground filter, and calculated from Optical Density (OD) readings at several wavelengths. See Table 4, "Measured and Calculated Laboratory Parameters" for details.

Chlorophyll in the Chesapeake Bay is also determined via fluorometry (see next page) and remote sensing, but remote sensing results are not currently included in the CBP data base.

METHOD CHANGES:

Optical density wavelengths and calculation methods changed; see Table 4, "Measured and Calculated Laboratory Parameters" for details.

DAITS ISSUES:

None

OTHER ISSUES:

Inter-organization agreement among mainstem laboratories was high for both CHLA and PHEA, based on CSSP data (AMQAW 1992).

A habitat requirement for Submerged Aquatic Vegetation (SAV) growth has been established for CHLA. April-October median surface values should be less than 15 ug/l baywide. See Batiuk et al. (1992) for details.

OTHER DOCUMENTATION:

Analytical Methods and Quality Assurance Workgroup (AMQAW). 1992. Chesapeake Bay Coordinated Split Sample Program Annual Report, 1990-1991. CBP/TRS 76/92, Chesapeake Bay Program, Annapolis, MD.

Batiuk et al. 1992. Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Goals: A Technical Synthesis. CBP/TRS 52/92.

D'Elia et al. 1986. Methodological comparisons for nitrogen and chlorophyll determinations in estuarine water samples. University of Maryland, Center for Estuarine and Environmental Studies, Publication UMCEES-CBL-86-55.

TITLE: **CHLOROPHYLL A AND PHAEOPHYTIN, FLUOROMETRIC**
PARAMETER NAME: **CHLAF and PHEAF**
UNITS OF MEASURE: ug/l
METHOD CODES: **See CHESSEE list**

GENERAL METHOD:

Both are determined with a fluorometer, either in the field (CHLAF only) or from a filter in the laboratory (CHLAF and PHEAF). Currently, only CHLAF is reported in CBP data, measured directly in the field from water passing through the instrument, without filtration. This is performed both during the vertical profile at each station, and in near-surface samples collected with a hull pump while the boat is underway (horizontal profiles). The fluorometer is calibrated against spectrophotometric chlorophyll results.

METHOD CHANGES:

None

DAITS ISSUES:

DAITS #27, "Fluorometric chlorophyll data structure." The best way to store the vertical and horizontal profiles of CHLAF in the CBP data base is being developed.

OTHER ISSUES:

A habitat requirement for Submerged Aquatic Vegetation (SAV) growth has been established for CHLA, and could also be used for CHLAF. April-October median surface values should be less than 15 ug/l baywide. See Batiuk et al. (1992) for details.

CHLAF and PHEAF are not reported in CSSP data, so no data are available to assess inter-organization agreement.

OTHER DOCUMENTATION:

Batiuk et al. 1992. Chesapeake Bay Submerged Aquatic Vegetation Habitat Requirements and Restoration Goals: A Technical Synthesis. CBP/TRS 52/92.

D'Elia et al. 1986. Methodological comparisons for nitrogen and chlorophyll determinations in estuarine water samples. University of Maryland, Center for Estuarine and Environmental Studies, Publication UMCEES-CBL-86-55.

D. Other Parameters

Several other parameters record the weather and sea state during sampling. These are:

Air Temperature (ATEMP)

Cloud Cover (CLOUD)

Tidal stage (TIDE)

Wave Height (WAVHGT)

Wind Direction (WINDIR)

Wind Speed (WINDSPD)

Except for ATEMP, which is degrees Celsius, these are all character variables. Their allowable values are defined in the applicable sections of CBP (1992a), "Chesapeake Bay Program Data Management Plan." Their use may vary among different sampling organizations and at different times.

E. Measured and Calculated Laboratory Parameters

Table 4 shows which laboratory parameters were measured, and which were calculated, for each mainstem laboratory and time period. Field parameters are not included. Some major method differences are noted (including digestion methods for some parameters) but space prevented any detailed listing of methods. See Chapter III, section C, Water Quality Parameters, for more information about specific parameters. See Table 3, "Parameter Titles and Variable Names by Data Category," for definitions of variable names.

This table is designed to present an overview of how the measured parameters changed during the monitoring program, and when overlap data are available for method comparisons. Unlike some monitoring programs, the CBP does not currently require specific analytical methods, and method changes are allowed as long as they will improve data quality, and they are documented with method comparison data.

The major method change that was made in CBP mainstem monitoring involved a change from EPA standard methods to oceanographic methods for nutrients and carbon. In EPA standard methods, total (whole water) and dissolved (filtered sample) nutrients (nitrogen and phosphorus) and carbon are measured directly, and particulate nutrients and carbon are calculated by subtraction, total - dissolved fractions. In oceanographic methods, dissolved and particulate nutrients and carbon are measured directly, and total nutrients and carbon are calculated from dissolved + particulate fractions. In estuarine samples, the EPA methods could produce negative values for the calculated particulate fractions, and the nitrogen method (Kjeldahl) does not perform well. D'Elia et al. (1987) discussed these problems and showed that higher data quality could be achieved with the oceanographic methods. Oceanographic methods have been used since October 1987 for all mainstem CBP data; data from Maryland stations also used these methods during 1985-1986 (see Table 4 for details).

Table 4. Measured and Calculated Laboratory Parameters.

Maryland Office of Environmental Programs (MD/OEP) / Maryland Department of the Environment (MD/MDE)

PARAMETERS MEASURED DIRECTLY	OEP staff at CRL* Cruises 1 - 18 6/17/84-5/15/85	CBL* Cruises 19-47 5/16/85-9/86
Carbon species:	TOC, DOC	PC(=POC), DOC
Nitrogen species:	NO23, NO2, NH4, TKNW**, TKNF**	NO23, NO2, NH4 TDN, PON
Phosphorus species:	TP***, TDP***, PO4F	TDP, PO4F, PHOSP
Other:	TSS, SI	TSS, SI
Pigment/OD species:	CHLA, PHEA (calc. at CRL)	OD630B,645B, 663A,B, 665A, 750A,B (June)**** (analyzed by MDHMH)
COMPUTED VARIABLES		
Monochromatic active chlorophyll_a :		26.73*[(OD663B-OD750B) -(OD665A-OD750A)])*K
Monochromatic phaeophytin : where (K=extract vol/sample volume*light path)		26.73*[1.7(OD665A-OD750A) -(OD663B-OD750B)]*K
Carbon spp: POC:	TOC - DOC	(direct)
TOC:	(direct)	POC + DOC
Nitrogen spp: NO3:	NO23 - NO2	NO23 - NO2
TDN:	TKNF** + NO23	(direct)
PON:	TKNW** - TKNF**	(direct)
DON:	TKNF** - NH4	TDN - NH4 - NO23
TON:	TKNW** - NH4	TN - NH4 - NO23
DIN:	NO23 + NH4	NO23 + NH4
TN:	TKNW** + NO23	PON + TDN
Phos. spp: DOP:	TDP - PO4F	TDP - PO4F
PHOSP:	TP - TDP	(direct)
TP:	(direct)	TDP + PHOSP

* Analyses by OEP staff at EPA Central Regional Laboratory, Annapolis. Later analyses done at Chesapeake Biological Laboratory, Solomons, by CBL staff, except CHLA & PHEA were analyzed at MD Dept. Health & Mental Hygiene (MDHMH) Laboratory, Baltimore.

** Using helix digestion; data were later adjusted to correct low bias.

*** Acid persulfate digestion; other TP & TDP used alkaline persulfate.

**** For Cruise 33 (2/86) OEP submitted the same OD data as on the next page.

Table 4 (continued). Measured and Calculated Laboratory Parameters.

Maryland Department of the Environment (MDE), continued

PARAMETERS MEASURED DIRECTLY	ALL CBL Cruises 40-47 6/86-9/86*	ALL CBL Cruises 48-67 10/86-9/87	ALL CBL Cruises 68- 10/87-
Carbon species:	PC(=POC), DOC	TOC, DOC	PC(=POC),DOC
Nitrogen species:	NO23, NO2, NH4 TDN, PON, TKNW**, TKNF**	NO23, NO2, NH4 TKNW**, TKNF**	NO23,NO2,NH4 TDN, PON
Phosphorus species:	TDP,TDP***,TP, TP***,PO4F, PHOSP	TDP***,TP***,PO4F	TDP,PO4F,PHOSP
Other:	TSS, SI	TSS, SI	TSS, SI
Pigment/OD species:	OD630B,645B,647B, 663B, 664B, 665A, 750A,B	OD630B,645B,647B, 663B, 664B, 665A, 750A,B	OD630B,645B, 647B, 663B, 664B,665A,750A,B
COMPUTED VARIABLES			
Monochromatic active chlorophyll_a :	26.7*[(OD664B-OD750B) - (OD665A-OD750A)] * K		
Monochromatic phaeophytin :	26.7*[1.7(OD665A-OD750A) - (OD664B-OD750B)]*K where (K=extract vol/sample volume*light path)		
Carbon spp: POC:	(direct)	TOC - DOC	(direct)
TOC:	POC + DOC	(direct)	POC + DOC
Nitrogen spp: NO3:	NO23 - NO2	NO23 - NO2	NO23 - NO2
TDN:	(direct) and TKNF** + NO23	TKNF** + NO23	(direct)
PON:	TKNW** - TKNF** and (direct)	TKNW** - TKNF**	(direct)
DON:	TKNF** - NH4 and TDN - NH4 - NO23	TKNF** - NH4	TDN-NH4-NO23
TON:	TKNW** - NH4 and TN - NH4 - NO23	TKNW** - NH4	TN-NH4-NO23
DIN:	NO23 + NH4	NO23 + NH4	NO23 + NH4
TN:	PON + TDN and TKNW** + NO23	TKNW** + NO23	PON + TDN
Phos. spp: DOP:	TDP - PO4F	TDP - PO4F	TDP - PO4F
PHOSP:	TP - TDP & direct	TP - TDP	(direct)
TP:	TDP+PHOSP & direct	(direct)	TDP + PHOSP

* Overlap period included both sets of methods to permit method comparisons.
** Using block digestion.
*** Acid persulfate digestion; other TP & TDP by CBL used alkaline persulfate.

Table 4 (continued). Measured and Calculated Laboratory Parameters.

Virginia Water Control Board (VWCB) / Virginia Institute of Marine Science (VIMS)

PARAMETERS MEASURED DIRECTLY	Cruises 1 - 67 6/84 - 9/87	Cruises 68 - 10/87 -
Carbon species:	TOC*, DOC*	DOC*, POC, (TOC* TO 12/87)
Nitrogen species:	NO23, NO2, NH4, TKNW**, TKNF**	NO23, NO2, NH4, (TKNW**,TKNF**TO 12/87), TDN, PON
Phosphorus species:	TP, TDP, PO4F	TDP***,PO4F,PHOSP (TP TO 12/87)
Other:	TSS, SI	TSS, SI
Pigment/OD species:	OD630B, 647B, 664B, 665A, 750A,B	OD630B,647B,664B,665A, 750A,B

COMPUTED VARIABLES

Active chlorophyll_a: 26.7*[(OD664B-OD750B)-(OD665A-OD750A)]*K

Monochromatic phaeophytin: 26.7*[1.7(OD665A-OD750A)-(OD664B-OD750B)]*K
where K=extract vol/sample volume*light path.

Carbon spp.	POC:	TOC* - DOC*	(direct)****
Nitrogen	NO3:	NO23 - NO2	NO23 - NO2
	TDN:	TKNF** + NO23	(direct)****
	PON:	TKNW** - TKNF**	(direct)****
	DON:	TKNF** - NH4	TDN - NO23 - NH4****
	TON:	TKNW** - NH4	TN - NO23 - NH4****
	DIN:	NO23 + NH4	NO23 + NH4
	TN:	TKNW** + NO23	PON + TDN****
Phos. spp	DOP:	TDP - PO4F	TDP - PO4F
	DIP:	PO4F	PO4F
	PHOSP:	TP - TDP	(direct, 11/87)****
	TP:	(direct)	TDP + PHOSP****

* TOC & DOC analyzed by ODU, until VIMS started analyzing DOC in 7/90.
** Using macro manual digestion; acid persulfate, then alkaline persulfate in 7/87. TKNF not measured in bottom or below pycnocline samples.
*** Changed from acid persulfate to alkaline persulfate digestion in 7/88.
**** Where methods changed, both formulas can be used from 10/87 to 12/87.

Table 4 (continued). Measured and Calculated Laboratory Parameters.

Virginia Water Control Board (VWCB) / Old Dominion University (ODU)

PARAMETERS MEASURED DIRECTLY	Cruises 1-11 6/84 - 12/84	Cruises 12-67 1/85 - 9/87
Carbon species:	TOC, DOC	TOC, DOC
Nitrogen species:	NO23, NH4, TKNW*, TKNF*	NO23, NH4, TKNW*, TKNF*
Phosphorus species:	TP**, TDP**, PO4F	TP**, TDP**, PO4F
Other:	TSS, SI	TSS, SI
Pigment/OD species:	OD630B,645B,663B, 665A, 750A,B	OD630B,647B,664B 665A,750A,B***
COMPUTED VARIABLES		
Monochromatic active chlorophyll_a:	26.73*[(OD663B-OD750B) -(OD665A-OD750A)])*K	26.7*[(OD664B-OD750B) -(OD665A-OD750A)]*K
Monochromatic phaeophytin:	26.73*[1.7(OD665A-OD750A) -(OD663B-OD750B)]*K	26.7*[1.7(OD665A-OD750A) -(OD664B-OD750B)]*K
where (K=extract vol/sample volume*light path)		
Carbon spp. POC:	TOC - DOC	TOC-DOC
Nitrogen : NO3:	NO23 - NO2	NO23 - NO2
TDN:	TKNF* + NO23	TKNF* + NO23
PON:	TKNW* - TKNF*	TKNW* - TKNF*
DON:	TKNF* - NH4	TKNF* - NH4
TON:	TKNW* - NH4	TKNW* - NH4
DIN:	NO23 + NH4	NO23 + NH4
TN:	TKNW* + NO23	TKNW* + NO23
Phos. spp: DOP:	TDP - PO4F	TDP - PO4F
DIP:	PO4F	PO4F
PHOSP:	TP - TDP	TP - TDP

* No data for June 1984; using block digestion after that. TKNF was not measured in bottom or below pycnocline samples.

** Using acid persulfate digestion.

*** OD480B and OD510B were added to the data submission in 11/85, but are not used in calculations.

Table 4 (continued). Measured and Calculated Laboratory Parameters.

Virginia Water Control Board / ODU, continued

PARAMETERS MEASURED DIRECTLY	Cruises 68 -- 10/87 -
Carbon species:	PC(=POC), DOC (TOC to 12/87)
Nitrogen species:	NO23, NH4, TDN, PON (TKNW*, TKNF* to 12/87)
Phosphorus species:	TDP**, PO4F, PHOSP (TP** to 12/87)
Other:	TSS, SI
Pigment/OD species:	OD480B,510B,630B,647B, 664B,665A,750A,B

COMPUTED VARIABLES

Monochromatic active chlorophyll_a:	26.7*[(OD664B-OD750B) -(OD665A-OD750A)]*K
Monochromatic phaeophytin:	26.7*[1.7(OD665A-OD750A) -(OD664B-OD750B)]*K

where (K=extract vol/sample volume*light path)

Carbon spp.	POC:	(direct) (and TOC - DOC through 12/87)
Nitrogen :	NO3:	NO23 - NO2
	TDN:	(direct) (and TKNF* + NO23 through 12/87)
	PON:	(direct) (and TKNW* - TKNF through 12/87)
	DON:	TDN - NO23 - NH4 (and TKNF* - NH4 through 12/87)
	TON:	TN - NO23 - NH4 (and TKNW* - NH4 through 12/87)
	DIN:	NO23 + NH4
	TN:	TDN + PON (and TKNW* + NO23 through 12/87)
Phos. spp	DOP:	TDP - PO4F
	DIP:	PO4F
	PHOSP:	(direct) (and TP - TDP through 12/87)

* Using block digestion. TKNF was not measured in bottom or below pycnocline samples.

** Using acid persulfate digestion.

F. Lower Detection Limits of Water Quality Parameters

Laboratories in the Chesapeake Bay Program submit data that are censored at a lower detection limit, called the Method Detection Limit or MDL. These are listed in Table 5; units are in mg/l as the element except where noted. Concentrations that are less than this limit are raised to the MDL, and the associated detection limit flag (variable_D) is set to "<". For example, if the MDL for ammonium (NH4) was 0.003 mg/l, and the measured concentration was 0.002 mg/l, the reported value would be 0.003 mg/l, and the variable NH4_D would be set to "<".

The method of calculating the MDL at mainstem laboratories varied over time, and at different laboratories. The current method at most laboratories was agreed upon by Analytical Methods and Quality Assurance Workgroup (AMQAW) members in 1988. Using this method, MDLs represent 3 times the standard deviation of 7 low-level replicates. This method has been used at CBL since 1987, and at VIMS starting 5/1/88. MDLs at CBL prior to 1987 were based on 3 times the standard deviation of laboratory duplicates for each analyte. MDLs at VIMS before 5/88 were based on the lowest standard used. VIMS limits varied before 5/88 because their MDL was the predicted value for the lowest standard, based on the regression for that cruise. ODU calculates 3 times the standard deviation of 7 low-level replicates, but only uses this as their MDL if that concentration has a peak height that is at least 1-2% of full scale for that parameter. ODU uses the concentration equal to 1-2% of full scale as their MDL if the calculated MDL is less than that value, similar to an Instrument Detection Limit. The MDL method used at OEP/CRL (the Maryland lab before 5/15/85) is unknown, but was probably based on lowest standard used. Some laboratories determine MDLs annually, while others determine them only when there is a method change. See the Chesapeake Bay Program Data Management Plan (CBP 1992a) for definitions of different types of detection limits.

Field parameter MDLs from MDE and ODU are "calibrated accuracy" from the manufacturer of the instrument they use (Hydrolab), and MDE & ODU field data are not censored at these values. VIMS MDLs for field parameters are determined by the replicate method using the Winkler method for dissolved oxygen and a salinometer for salinity. MDLs for their CTD and DO meter measurements are not available. The SECCHI MDL is the minimum depth marking.

Calculated parameters in the CBP data base are flagged "<" if any of the components are below the MDL. See Table 4, "Measured and calculated parameters" to determine which parameters were measured directly at each laboratory during each time period. The MDLs for calculated parameters in this table are the sum of the MDLs of the components, and are followed by a "+". MDLs for three of the less frequently used calculated parameters are not listed (DOP, DON, TON), but these can be calculated by the data user. During overlap periods, when two methods can be used for calculated parameters, the MDLs shown are for the newer method, which is what CBP data retrieval software uses for overlap periods. For example, when TN can be calculated as TKNW+NO23 or TDN+PON, CBP software uses TN = TDN+PON.

Some parameters also have upper detection limits, but since most parameters can be diluted and re-analyzed when these are encountered, these rarely result in censored values in the data base. Parameters analyzed directly from filters (e.g., POC and PON) cannot be diluted, and SECCHI can have an upper detection limit when the disk is visible on the bottom.

When using the values in this list for trend analysis, data users should be aware that there were not necessarily any reported values that were censored at the values shown. An examination of the data used is necessary to determine the highest censored concentration during the period analyzed. For calculated parameters, such as Total Nitrogen, there is the added complication that only one component may be censored, and it may make up a small part of the total. For more information see "Trends in Nitrogen in the Chesapeake Bay (1984-1990)" (CBP 1992b).

If the day of the month is not given, it is the start of the month for starting dates, or the end of the month for ending dates.

Table 5. Lower Detection Limits of Water Quality Parameters.

Chesapeake Bay Mainstem Monitoring Program

PARAMETER	MD/OEP-MDE (CRL then CBL)	VA/VWCB (ODU)	VA/VWCB (VIMS)
TN	.240+ (6/84-2/85)	.11+ (6/84-3/15/86)	.11*+ (6/84-9/87)
(Calc.	.2009+(3/85-5/15/85)	.105+ (3/16/86-4/15/86)	.124*+(10/87-4/88)
TKNW +	.031+ (5/16/85-9/86)	.11+ (4/16/86-4/30/86)	.071+ (5/88-5/89)
NO23,or	.2009+(10/86-9/87)	.105+ (5/86-9/87)	.069+ (6/89-6/90)
TDN+	.0305+(10/87-)	.10+ (10/87-8/90)	.045+ (7/90-6/91)
PON)		.075+ (9/90-10/90)	.081+ (7/91-1/92)
		.061+ (11/90-)	.045+ (2/92-)
TKNW &	.20 (6/84-5/15/85)	.10 (6/84-2/88)	.10*(.1-.198)
TKNF	.20 (6/86-9/87)		(6/84-1/88)
TDN	.240+ (6/84-2/85)	.11+ (6/84-3/15/86)	.12*+ (6/84-10/15/86)
(Calcu-	.2009+(3/85-5/15/85)	.105+ (3/16/86-4/15/86)	.11*+ (10/16/86-9/87)
lated,	.03 (5/16/85-9/86)	.11+ (4/16/86-4/30/86)	.1*(.05-.462)
then	.02 (10/87-)	.105+ (5/86-9/87)	(10/87-4/88)
direct)		.05 (10/87-8/90)	.045 (5/88-5/89)
		.025 (9/90-)	.040 (6/89-6/90)
			.026 (7/90-6/91)
			.075 (7/91-1/92)
			.026 (2/92-)
PON	.40+ (6/84-5/15/85)	.20+ (6/84-9/87)	.20*+ (6/84-9/87)
(Calcu-	.001 (5/16/85-9/86)	.05 (10/87-10/90)	.024*(.023-.026)
lated,	.40+ (10/86-9/87)	.036 (11/90-)	(10/87-4/88)
then	.0105 (10/87-)		.026 (5/88-5/89)
direct)			.029 (6/89-6/90)
			.019 (7/90-6/91)
			.006 (7/91-1/92)
			.019 (2/92-)
DIN	.060+ (6/84-1/85)	.02+ (6/84-5/15/85)	.02*+ (6/84-4/88)
(Calcu-	.080+ (2/85)	.0156+(5/16/85-3/15/86)	.0144+ (5/88-5/89)
lated	.0039+ (3/85-9/87)	.0106+(3/16/86-4/15/86)	.0081+ (6/89-6/90)
NH4+	.00315+(10/87-4/15/88)	.0156+(4/16/86-4/30/86)	.0064+ (7/90-6/91)
NO23)	.00515+(4/16/88-7/88)	.0106+(5/86-6/88)	.0044+ (7/91-1/92)
	.00315+(8/88)	.0081+(7/88-)	.0048+ (2/92-2/93)
	.0032+ (9/88-)		.0023+ (3/93-)

* VIMS had variable detection limits during this period, within range shown.

+ Parameter calculated during this period; MDL shown is the sum of the detection limits of the components. See "List of measured and calculated parameters" for calculation method during each time period.

Table 5 (continued). Lower Detection Limits of Water Quality Parameters.

Chesapeake Bay Mainstem Monitoring Program

PARAMETER	MD/OEP-MDE (CRL then CBL)		VA/VWCB (ODU)		VA/VWCB (VIMS)	
NH4	.020	(6/84-1/85)	.01	(6/84-5/15/85)	.01*(.002-.051)	
	.040	(2/85)	.0056	(5/16/85-)		(6/84-4/88)
	.003	(3/85-4/15/88)			.013	(5/88-5/89)
	.005	(4/16/88-7/88)			.006	(6/89-6/90)
	.003	(8/88-)			.004	(7/90-6/91)
					.002	(7/91-1/92)
					.004	(2/92-2/93)
					.0015	(3/93-)
NO23	.040	(6/84-2/85)	.01	(6/84-3/15/86)	.01*(.001-.025)	
	.0009	(3/85-9/87)	.005	(3/16/86-4/15/86)		(6/84-4/88)
	.00015	(10/87-8/88)	.01	(4/16/86-4/30/86)	.0014	(5/88-5/89)
	.0002	(9/88-)	.005	(5/86-6/88)	.0021	(6/89-6/90)
			.0025	(7/88-)	.0024	(7/90-1/92)
					.0008	(2/92-)
NO2	.01	(6/84-2/85)	.001	(6/84-)	.004*(.001-.007)	
	.0005	(3/85-9/87)				(6/84-4/88)
	.00015	(10/87-8/88)			.0008	(5/88-5/89)
	.0002	(9/88-)			.0015	(6/89-6/90)
					.0006	(7/90-6/91)
					.0005	(7/91-1/92)
					.0002	(2/92-)
NO3	.050+	(6/84-2/85)	.011+	(6/84-3/15/86)	.014*+	(6/84-4/88)
	.0014+	(3/85-9/87)	.006+	(3/16/86-4/15/86)	.0022+	(5/88-5/89)
	.0003+	(10/87-8/88)	.011+	(4/16/86-4/30/86)	.0036+	(6/89-6/90)
	.0004+	(9/88-)	.006+	(5/86-6/88)	.0030+	(7/90-6/91)
			.0035+	(7/88-)	.0029+	(7/91-1/92)
					.0010+	(2/92-)
TP	.012	(6/84-1/85)	.01	(6/84-12/86)	.01*(.009-.01)	
(Di-	.01	(2/85)	.005	(1/87-9/87)		(6/84-10/87)
rect,	.005	(3/85-5/15/85)	.012+	(10/87-)	.02*+	(11/87-4/88)
then	.0063+	(5/16/85-9/86)			.007+	(5/88-5/89)
calc.)	.012	(10/86-9/87)			.008+	(6/89-6/90)
	.0022+	(10/87-)			.005+	(7/90-5/92)
					.0022+	(6/92-2/93)
					.0032+	(3/93-)

* VIMS had variable detection limits during this period, within range shown.

\+ Parameter calculated during this period; MDL shown is the sum of the detection limits of the components.

Table 5 (continued). Lower Detection Limits of Water Quality Parameters.

Chesapeake Bay Mainstem Monitoring Program

PARAMETER	MD/OEP-MDE (CRL then CBL)		VA/VWCB (ODU)		VA/VWCB (VIMS)	
TDP	.012	(6/84-1/85)	.01	(6/84-11/86)	.01*(.009-.012)	
	.01	(2/85)	.005	(12/86-)		(6/84-4/88)
	.005	(3/85-9/86)			.006	(5/88-5/89)
	.012	(10/86-9/87)			.005	(6/89-6/90)
	.001	(10/87-)			.002	(7/90-)
PHOSP	.024+	(6/84-1/85)	.02+	(6/84-11/86)	.02*+	(6/84-10/87)
(Calc.,	.02+	(2/85)	.015+	(12/86)	.01*(.009-.01)	
then	.010+	(3/85-5/15/85)	.01+	(1/87-9/87)		(11/87-4/88)
direct)	.0013	(5/16/85-9/86)	.007	(10/87-)	.001	(5/88-5/89)
	.024+	(10/86-9/87)			.003	(6/89-5/92)
	.0012	(10/87-)			.0002	(6/92-2/93)
					.0012	(3/93-)
PO4F	.012	(6/84)	.01	(6/84-11/86)	.01*(.009-.013)	
	.007	(7/84-2/85)	.005	(12/86-)		(6/84-7/87)
	.0016	(3/85-9/87)			.002*(.001-.004)	
	.0006	(10/87-)				(8/87-4/88)
					.0005	(5/88-5/89)
					.003	(6/89-6/90)
					.0006	(7/90-6/91)
					.0008	(7/91-1/92)
					.0006	(2/92-)
TOC	1.0	(6/84-5/15/85)	1.0	(6/84-9/87)	1.0	(ODU**, 6/84-9/87)
(Di-	.501+	(5/16/85-9/86)	1.24+	(10/87-8/88)	1.581*+	(10/87-4/88)
rect,	1.0	(10/86-9/87)	.74+	(9/88-10/90)	1.099+	(5/88-8/88)
then	.501+	(10/87-8/88)	.63+	(11/90-)	.599+	(9/88-5/89)
calc.)	.303+	(9/88-)			.604+	(6/89-6/90)
					.457+	(7/90-6/91)
					.234+	(7/91-1/92)
					.597+	(2/92-2/93
					.297+	(3/93-)

* VIMS had variable detection limits during this period, within range shown.

** ODU analyzed TOC and DOC for VIMS stations until 7/90.

\+ Parameter calculated during this period; MDL shown is the sum of the detection limits of the components.

Table 5 (continued). Lower Detection Limits of Water Quality Parameters.
Chesapeake Bay Mainstem Monitoring Program

PARAMETER	MD/OEP-MDE (CRL then CBL)		VA/VWCB (ODU)		VA/VWCB (VIMS)	
DOC	1.0	(6/84-5/15/85)	1.0	(6/84-8/88)	1.0	(ODU**, 6/84-8/88)
	.50	(5/16/85-8/88)	.50	(9/88-)	.50	(ODU**, 9/88-6/90)
	.24	(9/88-)			.36	(VIMS, 7/90-6/91)
					.15	(VIMS, 7/91-1/92)
					.50	(VIMS, 2/92-2/93)
					.20	(VIMS, 3/93-)
POC	2.0+	(6/84-5/15/85)	2.0+	(6/84-9/87)	2.0+	(6/84-9/87)
(Calc.,	.001	(5/16/85-9/86)	.24	(10/87-10/90)	.581*	(.581-.581)
then	1.5+	(10/86-9/87)	.13	(11/90-)		(10/87-4/88)
direct)	.001	(10/87-8/88)			.099	(5/88-5/89)
	.063	(9/88-)			.104	(6/89-6/90)
					.097	(7/90-6/91)
					.084	(7/91-1/92)
					.097	(2/92-)
SI	.1	(6/84-2/85)	.028	(6/84-5/86)	.056*	(.009-.1)
(as SI)	.012	(3/85-3/87)	.023	(6/86-12/90)		(6/84-4/88)
	.01	(4/87-)	.0281	(1/91-)	.009	(5/88-5/89)
					.007	(6/89-6/90)
					.013	(7/90-6/91)
					.006	(7/91-1/92)
					.013	(2/92-)
TSS	4.0	(6/84-5/15/85)	4.0	(6/84-8/88)	4.0	(6/84-4/88)
	1.0	(5/16/85-9/87)	2.0	(9/88-)	5.0	(5/88-6/91)
	1.98	(10/87-8/88)			1.4	(7/91-1/92)
	1.5	(9/88-)			2.0	(2/92-)
CHLA	1+	(6/84-5/15/85)	0.2+	(6/84-1/91)	1.0+	(6/84-5/89)
(ug/l)	0.2+	(MDHMH,	1.1+	(2/91-)	3.2+	(6/89-6/90)
		5/16/85-)			1.32+	(7/90-6/91)
					1.95+	(7/91-1/92)
					0.95+	(2/92-)
PHEA	1+	(6/84-5/15/85)	0.2+	(6/84-1/91)	1.0+	(6/84-5/89)
(ug/l)	0.2+	(MDHMH,	0.8+	(2/91-)	3.2+	(6/89-6/90)
		5/16/85-)			1.91+	(7/90-6/91)
					3.43+	(7/91-1/92)
					1.34+	(2/92-)

* VIMS had variable detection limits during this period, within range shown.
** ODU analyzed TOC and DOC for VIMS stations until 7/90.
\+ Parameter calculated during this period.

Table 5 (continued). Lower Detection Limits of Water Quality Parameters.

Chesapeake Bay Mainstem Monitoring Program

PARAMETER	MD/OEP-MDE (CRL then CBL)	VA/VWCB (ODU)	VA/VWCB (VIMS)
Field parameters			
CHLAF (ug/l)	?*	?	1.5 (6/89-6/90) 1.23 (7/90-)
PHEAF (ug/l)	?*	?	0.71 (6/89-6/90) 1.10 (7/90-)
PH (pH units)	0.1** (6/84-)	0.1** (6/84-)	?
DISOXY	0.2** (6/84-)	0.2** (6/84-)	0.0?*** (6/84-4/88) 0.1 *** (5/88-5/89) 0.15*** (6/89-6/90) 0.20*** (7/90-6/91) 0.08*** (7/91-)
SALIN (ppt)	0.7** (6/84-)	0.7** (6/84-)	? (6/84-4/88) 0.04*** (5/88-5/89) 0.05*** (6/89-6/90) 0.08*** (7/90-6/91) 0.07*** (7/91-)
KD (1/m)	?*	0.0	?
SECCHI (m)	0.1 (6/84-)	0.1 (6/84-)	0.1 (6/84-)

* Fluorometric chlorophyll, phaeophytin, and KD (light attenuation) are analyzed by Benedict Laboratory personnel, but not at all MDE mainstem stations.

** Calibrated accuracy provided by manufacturer (Hydrolab); these values are not used to censor results.

*** These limits only apply to Winkler results for DO (DISOX3), not to DISOXY measured by YSI meter, and to salinometer results for salinity (SALIN2), not to SALIN measured by the CTD.

Please send any corrections to Peter Bergstrom, CSC/CBPO, 410 Severn Ave., Annapolis, MD 21403, (800) 523-2281.

G. Data Analysis Issues Tracking System (DAITS)

Documentation of any problems with data quality is an important part of a monitoring program. As the Chesapeake Bay Program Mainstem Monitoring Program reached its fifth anniversary, EPA initiated a systematic review of the program design and implementation. In the process of this review, numerous questions were raised which required investigation. To insure that all of these issues received appropriate attention and to provide thorough documentation of this process for future users of this important database, a tracking system was designed which is known as the Data Analysis Issues Tracking System (DAITS).

DAITS is a central collection point for the registry of all issues which are raised by those involved in the management, operation and review of the Chesapeake Bay Program (CBP) monitoring programs. The DAITS will encompass issues relating to any programs contributing data to the CBP data base.

Issues focused on the current water quality monitoring program as well as historical data sets are included. Quality Assurance (QA) data issues are included in this system as well. The magnitude of the issue is not a concern. Issues need not be fully developed before they are introduced into the system. Issues can be informally introduced to the system with a brief note although contributors are strongly urged to follow the elements of the format provided below to assist in accomplishing the appropriate follow-through.

DAITS provides a way to document analysis issues and achieve consensus on how to deal with them. Pending issues are usually referred to members of the appropriate Monitoring Subcommittee (MSC) workgroup for resolution; more than one workgroup may be involved. Issues concerning field or laboratory methods or QA data are usually referred to the Analytical Methods and Quality Assurance Workgroup (AMQAW); issues concerning statistics or other data analysis methods are usually referred to the Data Analysis Workgroup (DAWG); and issues concerning data management are referred to the Data Management and Acquisition Workgroup (DMAW). Once resolved, issues that require permanent changes to the CBP data base, such as data adjustments, are approved by the full Monitoring Subcommittee (MSC).

The documentation for each issue is stored in computer files. The storage location and retrieval method are currently under review and may change. Please contact CBPCC staff to get copies of any issue. The following summary (Table 6) of pending and completed issues is provided to give data users an idea of the scope of the issues included; this list is revised frequently as new issues are added and pending ones are resolved. Contact CBPCC staff to get the latest information on the status of DAITS issues.

Table 6. Chesapeake Bay Program Data Analysis Issues Tracking System.

#	ENTRY DATE	TARGET DATE	>>>PENDING ISSUES<<< TITLE	STATUS	Contact
016	12/10/90	4/93	Blank correction for MDHMH TP/TDP data	Revise	BM/MDE
019	5/15/91	4/93	Field and laboratory methods matrix	Revise	CW/EPA
021	11/21/91	5/93	DOC method comparison study	Revise	BS/VIMS
022	11/21/91	5/93	Field data validation/adjustment	Write	BN/VIMS
023	11/21/91	6/93	PC/PN filter and rinsing study	Pending data	GB/VIMS KW/CBL
024	1/13/92	5/93	Method detection limit (MDL) methods	Response	PB/CSC
025	7/7/92	6/93	Water quality/nutrient depth sampling protocol for mid-water samples	Response	JL/CSC
026	8/5/92	5/93	Revision of analytical problem codes	Response	CW/EPA
027	10/6/92	5/93	Fluorometric Chlorophyll Data Struct.	Write	JL/CSC

Status = Write: Writing up issue Response: waiting for responses, Revise: revising issue with responses, Pending data: waiting for data collection

Contacts: PB/CSC= Peter Bergstrom, BM/MDE = Bruce Michael, CZ/CBL = Carl Zimmermann, SS/ODU = Steve Sokolowski, CW/EPA = Claudia Walters, BS/VIMS = Betty Salley, BN/VIMS = Bruce Neilson, GB/VIMS = Grace Battisto, KW/CBL = Kathy Wood, JL/CSC = John Lecourt.

CSC = Computer Sciences Corp., MDE = Maryland Department of the Environment, CBL = Chesapeake Biological Laboratory, EPA = Environmental Protection Agency, ODU = Old Dominion University, VIMS = Virginia Institute of Marine Science.

Table 6 (continued). Chesapeake Bay Program Data Analysis Issues Tracking System.

#	ENTRY DATE	>>>COMPLETED ISSUES<<< TITLE
001	5/08/90	Criteria for Data Censoring
		RESOLUTION: Criteria documented, approved by Analytical Methods and Quality Assurance Workgroup (AMQAW) on 2/25/92, writeup done 7/8/92
002	5/14/90	Adjusting Helix Kjeldahl Nitrogen Data
		RESOLUTION: Report completed 9/11/91, approved by AMQAW on 11/21/91, by Monitoring Subcommittee (MSC) on 1/22/92, data adjusted on 8/24/91
003	5/14/90	Field and Lab Replicate Methods
		RESOLUTION: Documentation completed and reviewed by AMQAW on 7/24/92
004	5-14-90	Monitoring Data Re-submission
		RESOLUTION: Discussed in 9/12/90 Data Management and Acquisition Workgroup (DMAW) conference call w. Bob Stone, decided priority too low to pursue
005	5-14-90	Submitting Control Charts with QA data
		RESOLUTION: Same as #4
006	5-25-90	Setting of Range check limits
		RESOLUTION: Part of new Chesapeake Automated Monitoring System (CAMS) software
007	8-28-90	Secchi variability
		RESOLUTION: Documentation of methods received

Table 6 (continued). Chesapeake Bay Program Data Analysis Issues Tracking System.

#	ENTRY DATE	TITLE
		>>>COMPLETED ISSUES<<<
008	8/28/90	Data management procedures
		RESOLUTION: Documentation of methods completed, for three mainstem and three tributary laboratories
009	8-28-90	Using Proc Means in data submission
		RESOLUTION: Implemented by CBL, ODU, VIMS
010	9-4-90	Inventory of Method comparison data
		RESOLUTION: Completed & approved by AMQAW on 5/14/91
011	9/4/90	Lowering method detection limits
		RESOLUTION: DCLS and DCRA/CRL lab personnel documented the steps that will be taken to lower their highest MDLs. Both labs will use a new autoanalyzer to accomplish this.
012	9-4-90	Criteria for selecting historical data
		RESOLUTION: Desirable but not currently funded
013	9-12-90	Data Screening software
		RESOLUTION: Part of new CAMS software
014	9-28-90	Reporting of WINDSPD data
		RESOLUTION: Reviewed procedures, no changes needed
015	12-10-90	Salinity correction for CBL PO4F data
		RESOLUTION: Writeup finished, approved by AMQAW on 5/14/91, change to CBP data base submitted by MDE on 8/28/92

Table 6 (continued). Chesapeake Bay Program Data Analysis Issues Tracking System.

#	ENTRY DATE	TITLE	>>>COMPLETED ISSUES<<<
017	12-19-90	Percent recovery calculation methods	RESOLUTION: Guidelines for spiking and for percent recovery calculation were adopted by AMQAW members on 11/13/92.
018	1-29-91	Manual injection carbon data (MD mainstem, 6/84-5/15/85)	RESOLUTION: Writeup finished, approved by AMQAW on 2/19/91, recommended leaving data in the data base but warning users of their variability.
020	7/11/91	Adjustment for ODU TN Kjeldahl data	RESOLUTION: AMQAW and Data Analysis Workgroup (DAWG) reviewed issue, DAWG recommended dummy variable coefficients to lower Kjeldahl data on 2/4/92, MSC gave final approval to adjust data base on 4/1/92, data adjusted on 5/8/92

IV. QUALITY ASSURANCE (QA) DATA

A. Introduction

The CBP Mainstem Monitoring data base includes several types of Quality Assurance (QA) data. They estimate the precision and accuracy of the water quality data, and include comparisons within the same organization, and comparisons among results from different organizations. In many cases, the same data are used by the laboratories involved for Quality Control (QC) purposes, before the data are sent to CBPO.

Quality assurance data for chemical analyses provides estimates of precision and accuracy. Precision is the repeatability of measurements by a single laboratory or monitoring organization, or the agreement of measurements of the same sample by different monitoring organizations. The goal of precision measurements is to assess the variability introduced by the measurement system. This should be known before any variability in the actual data can be interpreted. Attempting to detect a change in concentration that is smaller than the inherent variability of the measurement system will be difficult.

Accuracy is the closeness of analytical measurements to a "true" value for that method, and is more difficult to assess than precision. In situations where the "true" value cannot be determined, precision may be used as a surrogate for accuracy, assuming that measurements which are very repeatable, especially among different organizations, will tend to be accurate. A consistent deviation from accuracy is called bias. When bias is identified, the CBP data involved may be adjusted (if possible) to increase accuracy, and method changes may be made to reduce the bias. Adjustments for bias have been made to CBP Total Nitrogen data (see Chapter III, section C for details).

Precision estimates include differing amounts of the possible variability in the measurement system. Precision estimates measured by CBP QA data include three different sources of variability (Table 7, "Summary of CBP Precision Estimates").

Table 7. Summary of CBP Precision Estimates.

DATA SOURCE	SOURCES OF VARIABILITY: Different laboratories	Sample acquisition	Laboratory analysis
WITHIN-ORGANIZATION PRECISION QA DATA			
CBP Monitoring data	*	field replicates (from some labs) (REP_NUM=1,2)	*
CBP QA data**	*	field replicates (from some labs)	lab replicates (from all labs)
INTER-ORGANIZATION PRECISION QA DATA			
CBP CSSP***	inter-organization splits	field replicates	lab replicates

* Data to assess this are not available from this source.
** CBP QA data are kept in separate data sets, available on request. Summaries are provided below.
*** Coordinated Split Sample Program (CSSP) data are kept in separate data sets, available on request. See CSSP reports (below) for summaries of the data.

Accuracy estimates in CBP QA data come from two sources: results from spike samples, and results from Standard Reference Material (SRM) analyses. Spike samples estimate the percent recovery when a known amount of the substance being analyzed is added to a water sample. The spike is usually added in the laboratory, but may also be added in the field to include more of the analysis process in the estimate. Percent recovery should be 100% under ideal conditions. Parameters that are analyzed directly from filters cannot be spiked, so they have no accuracy data from this source.

SRM analyses are standards prepared by EPA or other laboratories, and are provided with a "true" concentration. Percent recovery for SRMs represents the percentage of the true value recovered. SRMs are not available for all parameters analyzed in the CBP. Accuracy estimates are reported in two different places (Table 8, "Summary of CBP Accuracy Estimates").

Table 8. Summary of CBP Accuracy Estimates.

DATA SOURCE	SOURCE OF ESTIMATE: Laboratory spikes	Field spikes	Standard Reference Materials (SRMs)
WITHIN-ORGANIZATION ACCURACY QA DATA			
CBP Monitoring data	*	*	*
CBP QA data**	Percent recovery (from all labs)	Percent recovery (from some labs)	*
INTER-ORGANIZATION ACCURACY QA DATA			
CBP CSSP***	Percent recovery (from all labs)	*	Percent recovery (from all labs)

* Data to assess this are not available from this source.
** CBP QA data are kept in separate data sets, available on request. Summaries are provided below.
*** Coordinated Split Sample Program (CSSP) data are kept in separate data sets, available on request. See CSSP reports (below) for summaries of the data.

More detailed definitions of QA terms, and data submission guidelines for QA data, are given in the Chesapeake Bay Program Data Management Plan (CBP 1992a).

B. Within-organization QA data

Field QA Data

Field precision is estimated with field replicates. The CBP monitoring data base contains two different types of field replicates, both identified by the variable REP_NUM.

Field splits:

MDE includes field splits of single grab samples in its regular submission to the data base. Stations and layers which have field splits are: CB1.1 - B, CB2.2 - S, CB3.3 - B, CB4.1W - S, CB4.2E - B, CB4.3C - AP, CB4.4 - B, and CB5.2 - S. Field replicates (separate grabs) are not collected.

VIMS began collecting field splits with Cruise 96 (first April 1989 cruise). The mean, but not the separate results from each of the splits are submitted in the regular monitoring data sets, and the corresponding QA data set has the value of one replicate and the standard deviation with REP_TYPE = "FLD".

Field replicates:

ODU collects true field replicate samples (separate grabs) at a specified station (CB7.3, then CB7.4N) and includes these as individual observations in both its monitoring and QA data submissions.

For parameters that involve digestion (TDP, TDN, PHOSP, TKNW, TKNF), field replicates or splits always receive separate digestion. They are treated as separate samples once they are collected in the field. See DAITS #3 for details.

The QA data sets may also contain field split results from ODU and VIMS. ODU sometimes does lab replicates on each of the two field replicates; these are on separate lines for the same date and station, with the variable FIELDREP = 1 or 2.

Laboratory QA Data

Laboratory precision and accuracy are estimated with laboratory replicates and laboratory spike samples. Ten percent of samples coming into the laboratory (including the field replicates) are randomly selected (on a parameter by parameter basis) for lab replicate analysis. See DAITS #3 for details. For those lab replicates, the mean of the two results is the value reported in the monitoring and QA data bases. The mean, standard deviation, and sample size is reported in the QA data base. Sometimes more than two replicates are analyzed.

Any number in the monitoring data base, whether a single sample, or one or both field replicate/split samples, may actually be a mean of two lab replicates, if the sample was randomly selected in the lab to be replicated.

For parameters that involve digestion (TDP, TP direct, TDN direct, TKNW, TKNF), lab replicates can be created before or after the digestion. VIMS and ODU have always created the replicates before digestion, while CBL creates them after it. This tends to make CBL results from lab replicates less variable for these parameters, and would also tend to make CBL results for field replicates more variable than CBL results for lab replicates. This should be kept in mind when reviewing the "Summary of Laboratory QA data" below. For several parameters analyzed from filters (PHOSP direct, POC direct, PON direct, TSS, and CHLA) the "lab" replicates actually represent duplicate filters from samples split in the field, since no sample filtration is done in the laboratory. See DAITS #3 for details.

Laboratory spikes are also performed on 10% of samples for those parameters that can be spiked. Parameters analyzed directly from a filter pad cannot be spiked: POC, PON, and CHLA. These parameters get extra replication at most labs, as duplicate filters. PHOSP is analyzed from a filter pad but the extract from the pad can be spiked. Percent recovery can be calculated by two methods, the EPA method and the alternative method. VIMS and CRL use the EPA method, while CBL and ODU use the alternative calculation. However, CBL and ODU percent recovery results are recalculated by the EPA method before inclusion in the CBPCC QA data base. See DAITS #17 for details.

Laboratory precision and accuracy data are submitted to the CBPCC in QA data sets. Table 9, "Summary of Laboratory Quality Assurance (QA) data," gives descriptive statistics for estimates of precision and accuracy for each laboratory. These are summarized over all years for which we had consistent data: June 1984-May 1985 for OEP/CRL, and October 1986-December 1991 for CBL, VIMS, and ODU. CBL submitted QA data from May 1985 onward, but it was summarized here starting October 1986 to make their summary comparable to the ones for VIMS and ODU. The CBP did not require QA data submission until October 1986.

The definitions of the parameters are, using PARAM to represent the name of the parameter (NH4, etc.):

PARAM_S : Standard deviation of laboratory duplicates (n-1 or df in the denominator)

PARAM_CV: Percent coefficient of variation of laboratory duplicates, calculated from (PARAM_S/PARAM)*100.

PARAM_P: Percent recovery of a laboratory spike sample, calculated by EPA method:

PARAM_P = [(Concentration of mixture of spike + sample) - (concentration of sample before spiking)] / (Known concentration of spike) * 100; in CBP names, PARAM_P = [PARAM_SK - PARAM]/PARAM_C * 100.

See the "Chesapeake Bay Program Data Management Plan" (CBP 1992a) for details.

Descriptive statistics are given over all years to save space; in most cases, the precision and accuracy both improved over time (smaller PARAM_S and PARAM_CV values, and PARAM_P values closer to 100%). Annual summaries of these data, and the raw data, are available from CBPCC staff on request.

Table 9. Summary of Laboratory Quality Assurance Data.
MD Office of Environmental Programs (OEP)/Central Regional Laboratory (CRL) QA data, June 1984 through May 1985

Variable	N	Mean	Std Dev	Minimum	Maximum
TP_S	103	0.00076	0.00121	0.00000	0.00700
TP_CV	103	1.80379	2.06803	0.00000	7.36842
TDP_S	71	0.00032	0.00050	0.00000	0.00200
TDP_CV	71	1.62359	2.92626	0.00000	14.28571
PO4F_S	42	0.00390	0.01493	0.00000	0.07400
PO4F_CV	40	2.95793	4.86494	0.00000	20.00000
TKNW_S	134	0.02321	0.04436	0.00000	0.48000
TKNW_CV	134	6.37104	9.18353	0.00000	93.02326
TKNF_S	62	0.01723	0.01549	0.00000	0.05800
TKNF_CV	62	5.08508	4.66545	0.00000	18.64952
NO23_S	76	0.00234	0.00267	0.00000	0.01000
NO23_CV	76	0.97375	1.49683	0.00000	9.33333
NO2_S	50	0.00020	0.00045	0.00000	0.00200
NO2_CV	50	1.48739	3.44316	0.00000	14.28571
NH4_S	92	0.00199	0.00256	0.00000	0.01000
NH4_CV	92	2.06928	3.38579	0.00000	17.85714
TOC_S	132	0.15576	0.22377	0.00000	1.30000
TOC_CV	132	6.02664	8.33919	0.00000	48.14815
DOC_S	122	0.10066	0.15792	0.00000	1.13000
DOC_CV	122	5.40420	8.71940	0.00000	51.36364
SI_S	106	0.00263	0.00432	0.00000	0.02100
SI_CV	106	0.35017	0.66110	0.00000	3.70370
TSS_S	49	1.22714	1.24344	0.00000	4.00000
TSS_CV	49	11.25835	13.72170	0.00000	66.66667
TP_P	103	103.06796	2.87744	97.00000	112.00000
TDP_P	101	104.45545	3.85363	97.00000	114.00000
PO4F_P	112	101.77679	7.35424	88.00000	117.00000
TKNW_P	170	103.74118	12.75175	74.00000	156.00000
TKNF_P	93	101.79570	10.92221	70.00000	143.00000
NO23_P	111	103.27027	5.75712	85.00000	116.00000
NO2_P	111	106.10811	3.98258	94.00000	117.00000
NH4_P	111	110.11712	6.39565	96.00000	125.00000
TOC_P	133	92.70677	14.47400	62.00000	124.00000
DOC_P	135	93.71852	15.96575	58.00000	140.00000
SI_P	106	98.61321	5.15765	88.00000	111.00000

Table 9 (continued). Summary of Laboratory Quality Assurance Data.
Chesapeake Biological Laboratory (CBL) QA data, Oct. 86 through Dec. 91

Variable	N	Mean	Std Dev	Minimum	Maximum
TP_S*	60	0.00075	0.00058	0.00000	0.00212
TP_CV*	60	2.11948	1.96714	0.00000	8.31890
TDP_S*	400	0.00048	0.00072	0.00000	0.00860
TDP_CV*	390	4.57147	7.58138	0.00000	47.14045
PHOSP_S	303	0.00084	0.00135	0.00000	0.01138
PHOSP_CV	303	3.92604	5.05758	0.00000	33.96886
PO4F_S	400	0.00045	0.00051	0.00000	0.00300
PO4F_CV	400	6.58526	7.98822	0.00000	56.60377
TDN_S*	291	0.00527	0.00917	0.00000	0.12020
TDN_CV*	291	0.71163	0.98808	0.00000	7.60759
PON_S	573	0.00904	0.03083	0.00000	0.57590
PON_CV	568	3.82973	5.27268	0.00000	64.58333
TKNW_S*	54	0.01584	0.01460	0.00000	0.07071
TKNW_CV*	54	2.98740	3.04242	0.00000	16.22868
TKNF_S*	72	0.01316	0.01096	0.00000	0.04950
TKNF_CV*	72	4.24527	5.21735	0.00000	28.28427
NO23_S	379	0.00281	0.00763	0.00000	0.12876
NO23_CV	378	1.83962	3.46845	0.00000	30.45685
NO2_S	369	0.00200	0.03300	0.00000	0.63410
NO2_CV	368	4.68426	10.21043	0.00000	85.71429
NH4_S	367	0.00190	0.00294	0.00000	0.03000
NH4_CV	367	5.12282	11.74351	0.00000	85.71429
TOC_S	75	0.18366	0.38813	0.00000	3.18198
TOC_CV	75	4.63636	7.17926	0.00000	52.42143
DOC_S	404	0.07409	0.11228	0.00000	1.01823
DOC_CV	404	2.69971	3.87134	0.00000	33.14563
POC_S	574	0.04625	0.08846	0.00000	1.04652
POC_CV	573	3.80713	4.71091	0.00000	55.66585
SI_S	376	0.00997	0.04307	0.00000	0.71000
SI_CV	376	2.13077	5.72167	0.00000	60.68376
TSS_S	431	0.67522	0.90683	0.00000	8.10000
TSS_CV	431	8.97367	11.46129	0.00000	100.00000
TP_P	51	101.37173	4.18213	91.39785	115.00000
TDP_P	346	100.59062	5.94015	84.21053	143.47826
PO4F_P	386	99.06718	7.40074	67.82842	164.51613
TDN_P	302	99.51096	4.28727	79.02098	118.86792
TKNW_P	22	119.34560	30.79436	61.29032	206.45161
TKNF_P	11	134.63422	24.39354	93.65079	163.49206
NO23_P	380	99.90162	5.32877	71.33333	115.77061
NO2_P	389	98.98532	4.71491	66.73804	119.04762
NH4_P	388	107.62848	12.19326	55.55556	168.25397
TOC_P	88	105.16957	14.97587	63.92786	190.58116
DOC_P	382	106.60108	13.19551	25.60000	194.00000
SI_P	382	98.89557	6.20797	77.46479	135.71429

* Lab replicates were split after digestion; see above for explanation.

Table 9 (continued). Summary of Laboratory Quality Assurance Data.
Virginia Institute of Marine Science (VIMS) QA data, Oct. 86 through Dec. 91

Variable	N	Mean	Std Dev	Minimum	Maximum
TP_S	113	0.00115	0.00120	0.00000	0.00707
TP_CV	113	3.67094	3.76497	0.00000	15.71348
TDP_S	542	0.00069	0.00096	0.00000	0.00707
TDP_CV	542	6.31473	10.47104	0.00000	70.71066
PHOSP_S	425	0.00121	0.00164	0.00000	0.01131
PHOSP_CV	425	7.29754	9.84897	0.00000	53.03302
PO4F_S	532	0.00014	0.00039	0.00000	0.00283
PO4F_CV	532	3.52779	11.48506	0.00000	77.13891
TDN_S	423	0.01750	0.01574	0.00000	0.10748
TDN_CV	423	4.31195	3.75075	0.00000	19.79899
PON_S	514	0.01052	0.01319	0.00000	0.14991
PON_CV	514	8.63402	9.70290	0.00000	66.55122
TKNW_S	102	0.01306	0.01150	0.00000	0.05515
TKNW_CV	102	2.80935	2.57593	0.00000	14.82642
TKNF_S	49	0.01564	0.01584	0.00000	0.10041
TKNF_CV	49	4.50531	4.52627	0.00000	29.53210
NO23_S	517	0.00038	0.00074	0.00000	0.00552
NO23_CV	517	1.90045	5.38549	0.00000	45.75397
NO2_S	534	0.00009	0.00025	0.00000	0.00156
NO2_CV	534	2.26867	7.41796	0.00000	80.81221
NH4_S	522	0.00061	0.00150	0.00000	0.02687
NH4_CV	522	2.45657	7.02653	0.00000	86.67759
DOC_S	1044	0.08078	0.07939	0.00000	0.86974
DOC_CV	1044	2.39702	2.34822	0.00000	20.06321
POC_S	507	0.05382	0.06293	0.00000	0.53174
POC_CV	507	7.05440	9.94466	0.00000	78.06968
SI_S	519	0.00146	0.00240	0.00000	0.02546
SI_CV	519	0.93563	2.95791	0.00000	40.40609
TSS_S	293	1.86619	2.84525	0.00000	23.47594
TSS_CV	293	13.15424	19.97452	0.00000	172.69717
CHLA_S	248	1.05080	1.41033	0.00000	9.65133
CHLA_CV	248	11.85803	12.86288	0.00000	79.86743
TP_P	92	98.19564	6.34232	83.00000	128.99997
TDP_P	403	97.12045	10.79982	60.00001	168.18179
PO4F_P	412	96.02280	6.86227	70.00000	112.49998
TDN_P	316	94.70812	14.44001	52.00001	147.33331
TKNW_P	123	101.05165	12.34995	46.99999	138.79999
TKNF_P	67	102.31345	11.45564	80.80002	136.39996
NO23_P	409	96.85741	7.49625	67.49998	121.87498
NO2_P	457	103.39530	10.11891	52.49999	147.49997
NH4_P	430	96.27411	10.26046	58.12498	149.37497
DOC_P	227	98.58908	7.24144	76.50001	115.33334
SI_P	459	95.23879	5.95093	74.73309	113.75000

Note: Excluding REP_TYPE="FLD" (field replicates). No TOC data.

Table 9 (continued). Summary of Laboratory Quality Assurance Data.

Old Dominion University (ODU) QA data, Oct. 86 through Aug. 91

Variable	N	Mean	Std Dev	Minimum	Maximum
TP_S	66	0.00090	0.00114	0.00000	0.00566
TP_CV	66	2.25572	3.00805	0.00000	13.25825
TDP_S	263	0.00144	0.01537	0.00000	0.24942
TDP_CV	263	3.67391	8.68346	0.00000	111.34612
PHOSP_S	295	0.00102	0.00120	0.00000	0.00849
PHOSP_CV	295	6.23528	6.31651	0.00000	37.14096
PO4F_S	295	0.00053	0.00083	0.00000	0.00707
PO4F_CV	295	4.39250	7.60687	0.00000	70.71068
TDN_S	292	0.00933	0.00883	0.00000	0.05020
TDN_CV	292	4.25255	4.48706	0.00000	24.74874
PON_S	1386	0.00993	0.02825	0.00000	0.65054
PON_CV	1386	9.42919	10.09803	0.00000	132.82957
TKNW_S	66	0.02346	0.01715	0.00000	0.07778
TKNW_CV	66	4.90787	4.29839	0.00000	28.28427
TKNF_S	69	0.02603	0.01704	0.00000	0.06364
TKNF_CV	69	7.90252	5.28860	0.00000	24.59502
NO23_S	319	0.00030	0.00053	0.00000	0.00445
NO23_CV	319	2.01867	4.34988	0.00000	38.49002
NO2_S	231	0.00004	0.00009	0.00000	0.00042
NO2_CV	231	1.23718	3.27706	0.00000	18.44626
NH4_S	387	0.00046	0.00090	0.00000	0.00923
NH4_CV	387	1.96333	5.03606	0.00000	64.85133
TOC_S	144	0.18381	0.23440	0.00000	1.90919
TOC_CV	144	6.89472	7.23438	0.00000	47.14045
DOC_S	1386	0.08982	0.09065	0.00000	0.77782
DOC_CV	1386	3.82111	3.97536	0.00000	32.63570
POC_S	1518	0.04518	0.04371	0.00000	0.50301
POC_CV	1518	7.74970	6.83906	0.00000	47.14045
SI_S	302	0.00168	0.00334	0.00000	0.02087
SI_CV	302	1.23631	3.92045	0.00000	38.19176
TSS_S	69	1.16488	1.30274	0.00000	6.01041
TSS_CV	69	10.78004	11.45561	0.00000	51.73952
CHLA_S	52	0.91203	0.96373	0.00000	4.22850
CHLA_CV	52	16.45009	14.15011	0.00000	50.91169
TP_P	66	102.77273	3.73670	95.00000	110.00000
TDP_P	244	101.14098	3.02915	90.00000	111.00000
PO4F_P	274	98.10584	4.64423	85.00000	115.00000
TDN_P	270	103.28000	11.97678	57.00000	134.50000
TKNW_P	66	97.68939	8.05403	75.00000	112.50000
TKNF_P	70	99.16071	6.52379	86.25000	112.50000
NO23_P	222	98.21489	4.87407	83.00000	110.50000
NO2_P	247	93.59514	13.85810	35.00000	111.00000
NH4_P	233	97.37891	6.18257	76.25000	115.71429
TOC_P	76	93.41165	22.80876	50.00000	157.14286
DOC_P	436	96.92708	13.15385	50.00000	185.71429
SI_P	234	103.82707	19.59614	83.39752	209.58494

C. Inter-organization QA data

Early Split Sample and Co-located Sample Results

VIMS and ODU exchanged field split samples from 1985 through 1989; these results were analyzed in Bergstrom (1989), "Split sample water quality results from laboratories participating in the Chesapeake Bay Program: 1985-1989." MDE laboratories were not involved in mainstem splits until the Coordinated Split Sample Program (CSSP) began.

The original design of the Mainstem Monitoring Program included co-located sampling by MDE and VIMS at station CB5.3, near the Maryland-Virginia line. The goal was to

> maximize the synoptic nature of our samples. . .by having the Virginia and Maryland teams meet at a common station in mid-Bay off the Potomac and sample the vertical profile as nearly together as possible and then proceed, respectively, down and up the estuary (CBP 1985).

In practice, the MDE and VIMS research vessels usually did not meet at CB5.3, due to boat scheduling problems and weather delays. As a result, the "co-located" CB5.3 samples were usually collected at slightly different sites at different times, sometimes on different days. Because the "co-located" sample results contained variability due to different places and times of sampling, members of the Analytical Methods and Quality Assurance Workgroup (AMQAW) decided on 4/24/90 that they should not be used to assess inter-organization agreement. Since it was not aiding the original goal of synoptic sampling, VIMS discontinued sampling at CB5.3 in July 1990. To avoid duplicated data, the VIMS results from CB5.3 are not routinely included in data requests for CBP data, but are available from the CBPCC on request.

Coordinated Split Sample Program (CSSP)

This was organized in 1988 to include all the laboratories in the Chesapeake Bay Program (CBP). Mainstem laboratories have analyzed split samples quarterly since June 1988, sending mainstem samples to the three mainstem laboratories (CBL, VIMS, and ODU) as well as the two main tributary laboratories (Maryland Department of Health and Mental Hygiene, MDHMH, and Virginia Division of Consolidated Laboratory Services, DCLS). See AMQAW 1991, "Chesapeake Bay Coordinated Split Sample Program Implementation Guidelines, Revision 3" for details. The results are used to identify any parameters and laboratories where inter-organization agreement needs to be increased; several special comparison studies, and several minor method changes, have been done to increase inter-organization agreement in water quality results. Regular reports are produced summarizing the results (AMQAW 1992).

V. RELATED DOCUMENTATION

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